



LUBE SOURCE HANDBOOK

INDUSTRY-LEADING PRODUCTS
FOR IMPROVED BUSINESS
PERFORMANCE





PETRO-CANADA LUBRICANTS

Petro-Canada Lubricants branded products have a longstanding, proven track record in many sectors including heavy-duty on/off road fleet, gas plant, pipelines and power generation, mining, food manufacturing, automotive and construction. Products in our Petro-Canada Lubricants brand of engine oils, gear oils, greases and specialty fluids have been engineered specifically to make customers' operations more robust, more efficient and more profitable.

With decades of experience formulating high-performance lubricants our R&D team understands base oil requirements. The team selects high-quality base oils that are perfectly suited to each product application for Petro-Canada Lubricants products. Our R&D experts then work in partnership with our technical services team and customers to further refine product formulations in real world applications. This ensures finished products deliver to the specifications we demand and the performance standards our customers need.

That's how we deliver high-performance lubricants and why customers around the globe are turning to Petro-Canada Lubricants products to help them meet increasingly technical performance standards as well as profitability, sustainability and efficiency targets.

This handbook is current as of time of publication; however, Petro-Canada Lubricants products are constantly evolving to meet the ever-changing demands of the marketplace; the information contained herein is subject to change.

This handbook is also available on **www.lubricants.petro-canada.com**. The products throughout are available in a wide range of package sizes and are stocked at our strategic locations around the world or at one of our many global distributors.

PETRO-CANADA LUBRICANTS INTEGRATED MANAGEMENT SYSTEM

The Petro-Canada Lubricants Inc. (PCLI) Lubricants Management System (LMS) is a disciplined way of using consistent standards and practices to continually improve product performance. The LMS focuses on the risk-based management of operations, related activities, and supporting functions. The LMS is designed to control and mitigate environmental impacts, enable safe and reliable operations, deliver customer satisfaction, and support continual improvement.

Leveraging the LMS enables commitment to:

- the health and safety of employees and contractors who support the creation of Petro-Canada Lubricants products
- fulfill the environmental obligations to regulators, customers and the community in which we operate
- meet customer requirements and specific performance standards to deliver customer satisfaction
- materially improve maintenance and reliability

The LMS is a fully integrated management system encompassing standards and regulations such as ISO, IATF, GMP, & OEMS

ISO 9001 AND IATF 16949 CERTIFICATION

PCLI maintains the ISO 9001 and IATF 16949 certifications to demonstrate to customers its commitment to quality.

ISO 9001 is an international standard that emphasizes the importance of a process approach when developing, implementing and improving the quality management system in order to enhance customer satisfaction by meeting customer requirements.

In 1993 Petro-Canada Lubricants earned the distinction of being the first lubricants manufacturer in North America to be ISO 9001 certified. Stringent audits are conducted to ensure detailed procedures are rigidly adhered to and all products are manufactured consistently to the highest quality.

In October 2002, PCLI opened the door to the global market by being the first lubricants manufacturer in the world to be certified to IATF 16949.

ISO 14001 CERTIFICATION

ISO 14001 is chosen as the foundation for our Environmental Management System due to its wide recognition and global acceptance. In 2001, Petro-Canada Lubricants Inc. earned the distinction of being the first lubricants manufacturer in the world to be ISO 14001 certified. ISO 14001 is an internationally recognized approach to Environmental Management. It is a disciplined approach to identification, prioritization, and management of environmental impacts resulting from business operations.

ISO 14001 differs fundamentally from IATF 16949 and ISO 9001. IATF 16949 and ISO 9001 provide requirements to address customer needs and expectations in terms of quality of product/service. ISO 14001 improves and sustains environmental regulatory compliance and focuses on continual improvement in environmental performance.



OUR NO-NONSENSE LUBRICANTS **WARRANTY**

“We will repair equipment or replace equipment parts that are damaged due to defects of a Petro-Canada Lubricants product, as long as the lubricant is used in accordance with your equipment manufacturer’s and our recommendations.”

IT'S MORE THAN JUST A WARRANTY. **IT'S A COMMITMENT.**

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SYMBOLS



Agriculture



Construction



Consumer Automotive



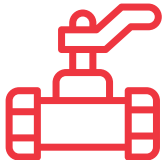
Corrugated Packaging



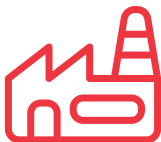
Food & Beverage



Forestry & Saw Mill



Gas Plants, Pipelines
& Power Generation



General
Manufacturing



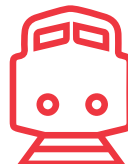
Heavy-Duty
Transportation



Medium-Duty
Transportation



Mining



Rail



Transit



Waste Operations



SPECIALTY BASE
OILS & FLUIDS.
**START PURE.
FINISH STRONG.**

We apply more than 40 years of experience in choosing the right catalyst and selecting high-quality feedstock to provide you with crystal-clear, 99.9% pure base oil.

Visit lubricants.petro-canada.com to find out more.



INTRODUCTION

This lubricants handbook is a comprehensive reference guide designed to provide users with broad knowledge of the many Petro-Canada Lubricants products.

This handbook is divided into five (5) colour-coded sections:

- | | |
|--------------------------|-------------|
| 1. Introduction | (Grey Tab) |
| 2. Automotive Lubricants | (Green Tab) |
| 3. Industrial | (Blue Tab) |
| 4. Greases | (Tan Tab) |
| 5. Glossary of Terms | (Red Tab) |

The Introduction section includes a reference guide with current and former names where products have undergone name changes.

Each of the three (3) product groups, Automotive Lubricants, Industrial and Greases is comprised of sub-sections that begin with a general description of the product and its applications. Contents are arranged by product application and product brand name. This includes the certifications and approvals granted by various specification writing bodies and technical organizations. The product description is followed by the typical characteristics for each of the various grades of the product.

The Glossary of Terms comprises valuable general lubricant and industry information in addition to various conversion tables.

More comprehensive technical data for each lubricant can be sourced from our extensive TechData series, available from your representative or one of our many global distributors. TechDatas are also available on the global website, lubricants.petro-canada.com. You can request additional information via email, lubecsr@hollyfrontier.com.

LUBRICANTS HANDLING & STORAGE

Petro-Canada Lubricants lubricating oils and greases are the result of considerable research and development work; they are carefully manufactured and delivered, for optimum product performance. During storage it is important to guard against contamination, which can drastically impact the performance and life of a lubricant. Numerous studies have shown that both water and dirt can decrease the life of bearings and other components. Preventing contamination during storage has a direct pay-back in terms of ensuring optimum lubricant performance, longer lubricant life and reduced maintenance costs.

INSIDE STORAGE

Lubricants should preferably be stored inside. However, even then there are certain precautions that should be followed:

- The temperature of the storage area should remain moderate and not be subject to wide fluctuations.
- The storage area should be located away from industrial contamination, such as fumes or dust.
- The storage area and dispensing equipment should be clean and be part of a regular cleaning schedule.
- Labels, stencils, markings on containers and dispensing equipment should be kept legible to avoid cross-contamination or incorrect application.
- All oils should use separate dispensing equipment.
- The oldest dated product that is required should be used first (First IN First OUT)
- Grease tubes should be stored vertically, rather than horizontally.

OUTSIDE STORAGE

If outside storage is unavoidable, then the following additional precautions should be followed:

- Ensure that the bungs on drums are screwed in tight.
- Store drums horizontally, with bungs below the oil level (i.e. at 3 o'clock and 9 o'clock). This prevents the seals from drying out and leaking.
- Drums stored on their sides should be clear of the ground and preferably rest on wooden or steel beams. They may be stacked three high if wedged properly to prevent movement.
- Stacking often results in the bottom drums never being used, so the use of a rack is preferred.
- Do not store drums on end with the bungs on top. Rain water collects on the drum head and is drawn into the oil when the drum breathes during temperature cycles. If drums must be stored this way, they should be tilted first by standing on edge (say on a 2 x 4 piece of lumber) with the bungs parallel to the tilt. When oil is drawn from the drum, the head should be wiped clean first.

- Drums should preferably be covered with a tarpaulin or plastic drum cover to protect them from the elements.
- To minimize contamination and the effects of weathering, time spent in outdoor storage should be kept to a minimum.
- Outdoor storage locations should be away from dusty areas such as quarries or unpaved roads. Opening drums in such conditions will contaminate the contents.
- Smaller package sizes (e.g. pails) and larger package sizes (e.g. Intermediate Bulk Containers (IBCs)) should be properly stored, covered, examined regularly and kept to a minimum inventory to provide a quick turnover.
- For product delivered in plastic IBCs, they must be stored out of direct sunlight. These packages have minimal UV protective qualities, and exposure to direct sunlight may cause discoloration of the oil.
- Plastic IBCs should not be used for long term storage outside.

HANDLING

Lubricating oils and greases are a relatively harmless class of material. Nevertheless, care should be taken to avoid skin contact and inhalation of oil mists. There are Safety Data Sheets (SDS) on all Petro-Canada Lubricants products which are available from your sales representative, customer order management representative (COMR) or can be accessed on the website, lubricants.petro-canada.com.

Some general guidelines for handling lubricating oils and greases are as follows:

- Use personal protective equipment to avoid skin contact. This may also include the use of a barrier cream to reduce direct contact.
- Quickly remove any product that does get on the skin.
- Do not use gasoline, kerosene or similar solvents to remove lubricants from the skin as they take the natural oils from the skin and cause dryness.
- Use only mild soap and warm water or a recommended hand cleaner to remove lubricating oil and grease from the skin. Dry the skin using clean hand towels.
- Wash hands and arms at the end of the working day and before eating and smoking.
- Remove any contaminated clothing and clean thoroughly before re-use.
- Avoid breathing in oil mists.
- Clean-up lubricating oil and grease spills immediately and dispose of them according to environmental guidelines.
- Obtain medical advice concerning any potential health problems.
- Take special consideration to prevent any injection into the skin (hydraulics, pneumatics, pressurized delivery equipment, etc.)

Always refer to product SDS for specific safety and handling requirements.

PRODUCT SHELF LIFE

PRODUCT SHELF LIFE – LUBRICATING OILS

Depending on their composition, the performance properties and stability of liquid lubricants (oils) will remain intact for a number of years provided they are in their unopened, original sealed containers and have been in protected storage* that prevents exposure to UV light or severe high/low temperature cycles.

Industry performance standards and lubrication formulations can change. A lubricant which is near its expiry date may still perform to its original design, but it may not meet the latest requirements and specifications of newer equipment. It is always advised to consult the OEM manual.

The shelf life of Petro-Canada Lubricants lubricating oils is as follows:

**Protected conditions: indoor or covered storage with no freeze/thaw cycles.*

Indefinite Storage Life – Base Oils and Process Oils

These may be stored indefinitely under protected conditions without any significant deterioration in performance. Slight changes in appearance / color may occur. If they are used as part of a manufacturing process or application, the product properties should be reconfirmed if over 5 years old. The only exceptions are the PARAFLEX™ HT3 and PARAFLEX™ HT5 process oils which should be reconfirmed at 3 years.

5 Year Shelf Life

- ENDURATEX™ EP and XL Syn Blend EP industrial gear oils
- Engine oils (diesel, gasoline, locomotive, natural gas, biogas) with the exception of SENTRON™ Ashless 40
- Heat Transfer Fluids
- Hydraulic oils (except HYDREX™ Extreme)
- METWORX™ Spindle Oil 2
- PURITY™ FG Silicone Spray and Penetrating Spray
- R&O and turbine oils
- SEPRO™ paper machine oils
- Tackified products such as way oils, chain oils, rock drill oils, saw guide oils
- Transmission and Drive Train Oils meeting Caterpillar TO-4 or FD-1

4 Year Shelf Life

- Automatic Transmission Fluids

3 Year Shelf Life

- Axle, Gear and Manual Transmission Oils
- Compressor fluids for air, ammonia, natural gas and other gases
- ENDURATEX Mild WG oils
- ENDURATEX SYNTHETIC gear fluids
- HARNEX™ wind turbine gear fluid
- HYDREX™ Extreme hydraulic fluid

- LUMINOL™ electrical insulating oils
- PURITY™ FG AW Hydraulic Fluids, EP Gear Fluids, Compressor Fluids, Chain Fluids
- PURITY FG Spray
- SENTRON™ Ashless 40 natural gas engine oil
- SYNDURO™ SHB multifunctional synthetic lubricants
- UTF/THF/UTTO fluids
- White Mineral Oils USP (North America) with Vitamin E

2 Year Shelf Life

- PURITY FG Corrcut-E Fluid 15
- VULTREX™ Gearshield NC
- White Mineral Oil DAB (Europe), without Vitamin E

1 Year Shelf Life

- PURITY FG Trolley Fluid

Storage under unprotected conditions can result in water ingress.

Water is detrimental to the appearance of the lubricant (hazy and milky) but more importantly, it affects the additive system and greatly reduces the performance level of the lubricant. It can also cause rust formation/corrosion in metal containers and subsequently in the equipment.

PRODUCT SHELF LIFE – GREASE

The shelf life of a grease is affected by the type and amount of thickener used, consistency of the grease, manufacturing method employed and the formulation complexity. Generally, lithium, lithium complex and calcium sulfonate complex greases remain stable for a long time. Some thickeners may have a tendency to set and harden over long storage periods (such as aluminum complex), while others may soften on aging (such as barium greases).

The shelf life of Petro-Canada Lubricants greases of NLGI grade 1 or higher is five (5) years.

Petro-Canada Lubricants greases of NLGI grade 0 or softer (#0, 00 or 000) generally have a shelf life of three (3) years. The list includes, but may not be limited to:

- PEERLESS™ OG0
- PRECISION™ XL EP00, PRECISION XL EP000, PRECISION XL 5 Moly EP0
- PRECISION Synthetic EP00
- PURITY FG00
- VULTREX™ Rock Drill EP000
- VULTREX MPG Synthetic Arctic
- VULTREX OGL Heavy 6200 and OGL Synthetic 2200.

The only exceptions are the following greases which have a shelf life of two (2) years:

- VULTREX OGL Synthetic All Season 680

For specialty or niche products not listed, please consult your sales representative.

PRODUCT FILL DATES

Product fill dates appear on all packaging and indicate the date that the particular package was filled. The shelf life of Petro-Canada Lubricants products begins with these fill dates.

Here is a summary of how to interpret the fill dates on the products packaged at the manufacturing plant in Mississauga, Canada (Lubeplex). For all others, please contact your sales representative.

1L Bottle and 4L Jug: - 1L & 4L Case:

160305LX indicates the fill date March 5th 2016 and LX is for Lubeplex

Pails:

Label beneath handle inserts on side of pail. Fill date indicated as YYYY-MM-DDLX (eg 2016-03-05LX). LX indicates Lubeplex.

Kegs:

2016/03/05LX indicates the fill date March 5th 2016 and LX is for Lubeplex

Drums:

2016/03/05LX indicates the fill date March 5th 2016 and LX is for Lubeplex

IBC/Cubes:

2016/03/05LX indicates the fill date March 5th 2016 and LX is for Lubeplex

Greases:

- Tubes:

03/05/2016LX indicates the fill date March 5th 2016 and LX is for Lubeplex

- Inner Pack (10 Tube Carton):

2016/03/05 indicates the fill date March 5th 2016

- Case:

2016/03/05 indicates the fill date March 5th 2016

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PRODUCT APPLICATION
AND SUBJECT INDICES

INDEX OF PRODUCT NAMES:
FORMER VERSUS REPLACEMENTS

FORMER	REPLACEMENTS	YEAR OF CHANGE
HYDRAULIC OILS		
HARMONY/PREMIUM AW 22, 32, 46, 68, 80, 100	HYDREX™ AW 22, 32, 46, 68, 80, 100	2001
HARMONY/PREMIUM ARCTIC 15	HYDREX MV ARCTIC 15	2001
HARMONY/PREMIUM HVI 22,	HYDREX MV 22	2001
HARMONY/PREMIUM HVI 36, 60	HYDREX MV 32, 68	2015
HARMONY/PREMIUM PLUS	HYDREX XV ALL SEASON	2001
HEAVY-DUTY DIESEL ENGINE OILS		
DURON-E	DURON™ HP	2016
DURON-E XL	DURON SHP	2016
DURON-E SYNTHETIC	DURON UHP	2016
DURON-E UHP	DURON UHP	2016
DURON	DURON Monogrades	2016
DURON	DURON HP	2016
DURON XL	DURON SHP	2016
DURON SYNTHETIC	DURON UHP	2016
COMPRESSOR FLUIDS		
PURITY FG SYNTHETIC COMPRESSOR	PURITY™ FG SYNTHETIC FLUID 46	2010
HEAT TRANSFER FLUIDS		
CALFLO FG	PURITY FG HEAT TRANSFER FLUID	2004
CALFLO SYNTHETIC ARCTIC	CALFLO™ SYNTHETIC	2011
SMALL ENGINE OIL		
SNOWMOBILE MOTOR OIL	SUPREME™ SYNTHETIC BLEND 2-STROKE SMALL ENGINE OIL	2014
TWO CYCLE MOTOR OIL	SUPREME SYNTHETIC BLEND 2-STROKE SMALL ENGINE OIL	2014
STATIONARY GAS ENGINE OILS		
SENTRON 541C	SENTRON™ ASHLESS 40	2014
SENTRON 445, 470	SENTRON LD 3000	2014
SENTRON FLEET 10W-40	SENTRON VTP 10W-40	2014
SENTRON FLEET 0W-30	SENTRON VTP 0W-30	2014
INDUSTRIAL GEAR OILS		

FORMER	REPLACEMENTS	YEAR OF CHANGE
ULTIMA SYNTHETIC	ENDURATEX™ SYNTHETIC EP	2006
ULTIMA EP	ENDURATEX EP	2006
ULTIMA PLUS	ENDURATEX XL SYNTHETIC BLEND 68/220	2006
ULTIMA EP 68/150	ENDURATEX XL SYNTHETIC BLEND 68/150	2006
STEAM CYLINDER AND WORM GEAR OIL		
SENATE	ENDURATEX MILD WG	2006
GREASES		
PRECISION GOLD HEAVY EP00	PRECISION™ SYNTHETIC EP00	2005
PRECISION GOLD	PRECISION SYNTHETIC*	2005
PRECISION GOLD HEAVY	PRECISION SYNTHETIC HEAVY 460	2005
PRECISION SYNTHETIC HEAVY	PRECISION SYNTHETIC HEAVY 460	2011
PRECISION GOLD MOLY	PRECISION SYNTHETIC MOLY	2005
PRECISION EP1, EP2	PRECISION XL EP1*, EP2*	2005
PRECISION EP00	PRECISION XL EP00	2005
PRECISION MOLY EP1, EP2	PRECISION XL 3 MOLY EP1, EP2	2005
MULTIPURPOSE EP1, EP2	PRECISION GENERAL PURPOSE EP1, EP2	2005
MULTIFLEX MOLY SPECIAL	PRECISION XL 3 MOLY ARCTIC	2005
GREASE OG-0, OG-1, OG-2 OG-2 (RED), OG-PLUS	PEERLESS™ OG0, OG1*, OG2* PEERLESS OG2 RED*; PEERLESS OG PLUS	2005
VULCAN SYNTHETIC ALL SEASON	VULTREX™ OGL SYNTHETIC ALL SEASON 680	2008
VULTREX OGL HEAVY 3600	VULTREX OGL HEAVY 6200	2012

*This product has CG-LB certification.

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*This product has CG-LB certification.

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*This product has CG-LB certification.

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[†]MICROL™ MAX is an antimicrobial product preservative.

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*This product has CG-LB certification.

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	DURON EXTRA	87
	DURON HP	80
	DURON Monograde	83
	DURON SHP	80
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	DURON CLASSIC	86
	DURON EXTRA	87
	DURON GEO LD	90
	DURON HP	80
	DURON Monograde	83
	DURON SHP	80
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¹MICROL™ MAX is an antimicrobial product preservative.

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Gear Oil	DURATRAN™, DURATRAN XL, DURATRAN Synthetic	123
	ENDURATEX™ EP	180
	ENDURATEX Mild WG	181
	ENDURATEX Synthetic EP	183
	ENDURATEX Synthetic OHV 680	182
	ENDURATEX XL Synthetic Blend	180
	HARNEX™ 320 Wind Turbine Gear Oil	184
	PRODURO™ FD-1 and FD-1 Synthetic	128,129
	PRODURO T0-4+	126
	PURITY™ FG EP Gear Fluid	159
	PUIRTY FG PAG	160
	PURITY FG Synthetic EP Gear Fluid	160
	SYNDURO™ SHB	185
	TRAXON™	112
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	PRECISION Synthetic 220	218
	PRECISION Synthetic Heavy 460	218
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Industrial Gear Oil	ENDURATEX™ EP	180
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	ENDURATEX Synthetic OHV 680	182
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	SYNDURO™ SHB	185
	PURITY FG EP Gear Fluids	159
	PURITY FG Synthetic EP Gear Fluids	160
	TURBOFLO™ R&O	205

*This product has CG-LB certification.

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	HYDREX™ AW	170
	TURBOFLO™ R&O	205
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	PURITY™ FG00	155
Limited Slip Gear Oil	DEXRON® LS 75W-90 Gear Oil	111
Locomotive Diesel Engine Oil	RALUBE™	92
	Red Giant Locomotive Engine Oil 20W-40 G7	92
Low Temperature Grease	PRECISION Synthetic* Greases	217
	PRECISION Synthetic Moly	218
	PRECISION XL EP00	215
	PRECISION XL 3 Moly Arctic	216
	PRECISION XL 5 Moly EP0	216
	PURITY FG2 Synthetic	158
	VULTREX™ MPG Synthetic Arctic	228
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Mining Grease	PRECISION Synthetic* Greases	217
	PRECISION Synthetic Moly	218
	PRECISION XL 3 Moly Grease	215
	PRECISION XL 5 Moly Grease	216
	VULTREX Drill Rod Heavy	229
	VULTREX G-124	228
	VULTREX MPG	228
	VULTREX OGL	226
Motor Oil	DURON™ CLASSIC	86
	DURON EXTRA	87
	DURON GEO LD	90
	DURON HP	80
	DURON SHP	80
	DURON UHP	80
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*This product has CG-LB certification.

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	PETRO-CANADA SUPREME SYNTHETIC HYBRID MOTOR OILS	77
	SUPREME C3-X SYNTHETIC 5W-30 MOTOR OIL	76
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	RALUBE™	92
	Red Giant Locomotive Oils	92
	SENTRON™	196
	SUPREME C3 SYNTHETIC 5W-30	75
	SUPREME Synthetic Blend 2-Stroke Small Engine Oil	131
Multi-Service Grease	PEERLESS™ OG1*, OG2* and LLG*	219,220
	PEERLESS OG2 Red	220
	PRECISION™ General Purpose EP1, EP2	214
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	PRECISION Synthetic 220	218
	PRECISION XL EP1*, EP2*	215
	PURITY™ FG00, 1, 2	155
	PURITY FG2 Synthetic	158
	PURITY FG2 Synthetic Heavy 220	158
Natural Gas Compressor Fluids	SPX	146
	NG Screw Oils	148
	NG Comp Oil AW	147
	Compressor Oil RP	142
Gas Engine Oil	DURON™ GEO LD	90
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	PETRO-CANADA SUPREME Synthetic MOTOR OILS	71
	PETRO-CANADA SUPREME Synthetic 5W-40	72
	PETRO-CANADA SUPREME EU-X SYNTHETIC 5W-40 MOTOR OIL	73
	PETRO-CANADA SUPREME HIGH MILEAGE MOTOR OILS	78
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	SUPREME C3 SYNTHETIC 5W-30	75
	SUPREME C3-X SYNTHETIC 5W-30 MOTOR OIL	76
	SUPREME C3-X SYNTHETIC 5W-40 MOTOR OIL	74
Penetrating Oil	PURITY FG Penetrating Oil Spray	164
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Premium Grease	PEERLESS OG2 RED	220
	PEERLESS LLG*	219
	PRECISION XL Moly, Synthetic Moly	216,218
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Saw Guide Oil	PETROGLIDE™	191
	PETROGLIDE MC 32	192
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Screw Compressor Oil	COMPRO XL-S	139
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Single Point Lubrication Grease	PRECISION™ Synthetic*	217
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	PRECISION Synthetic Heavy Greases	218
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	DURON™ SHP	80
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	DURATRAN	123
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*This product has CG-LB certification.

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BASE OIL MANUFACTURE

Lubricant base oils are produced in a series of steps which are designed to enhance certain desirable properties. For paraffinic oils, these include viscosity index, oxidation resistance, thermal stability and low temperature fluidity.

Starting from petroleum crude oil, the typical process for making a base oil is as follows:

- Separation of lighter boiling materials, such as gasoline, diesel, etc.
- Distillation to isolate desired base oil viscosity grades
- Selective removal of impurities, such as aromatics and polar compounds
- Dewaxing to improve low temperature fluidity
- Finishing to improve oxidation resistance and heat stability

In general, both solvent refined and hydrotreated base oils are manufactured this way, but differ in the type and severity of processes used.

BASE OIL CLASSIFICATION

Before reviewing how base oil is manufactured, the American Petroleum Institute's (API) Base Oil Classification system should be explained. As shown below, the API system classifies base oils into five major groups. While these groups were originally intended to be used for formulation of engine oils, their definition is widely understood and usage has expanded beyond this area.

Base Oil Characteristics				
API Group	Sulfur Wt, %	Saturates Wt, %	Viscosity Index VI	Manufacturing Method
I	>0.03	<90	80-119	Solvent Refined
II	≤ 0.03	≥90	80-119	Hydroprocessed
III	≤ 0.03	≥90	120+	Severely Hydroprocessed
IV	Polyalphaolefins (PAOs)			Oligomerization
V	Other Base Oils			Various

Although not officially recognized by the API, the following additional terms are often used in the industry.

Base Oil Characteristics				
API Group	Sulfur Wt, %	Saturates Wt, %	Viscosity Index VI	Manufacturing Method
II+	≤ 0.03	≥90	110-119	Hydroprocessed
III+	≤ 0.03	≥90	130+	Severely Hydroprocessed



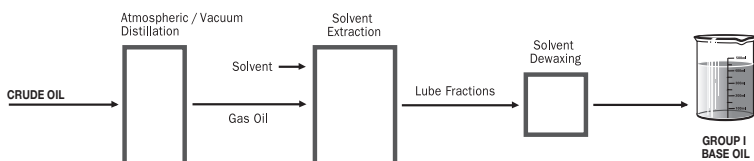
Group I, or conventional base oils are manufactured by solvent refining and contain more than 0.03 wt % sulfur and/or less than 90 wt % saturates. Group I oils continue to be used in a number of applications due to their solvency and performance characteristics.

Group II and III base oils are manufactured by what the API calls hydroprocessing or severe hydroprocessing. With sulfur content of less than or equal to 0.03 wt % and saturates content of more than or equal to 90 wt %, they are more pure than Group I base oils. Many of the Petro-Canada Lubricants products are produced using a special high severity version of hydroprocessing, called severe hydrotreating, to produce Group II, II+, III and III+ base oils.

SOLVENT REFINING PROCESS

Initially, lighter products such as gasoline, diesel, etc., are separated from crude oil by atmospheric distillation. The heavier material is then charged to a vacuum distillation tower, where lubricant fractions of specific viscosity ranges are taken off. These fractions are then treated individually in a solvent extraction tower. A solvent such as furfural is mixed with the fractions and extracts about 70-85% of the aromatic material present. The solvent extracted lube fraction is then dewaxed by chilling to a low temperature, which removes much of the wax. This improves the low temperature fluidity of the product. Finally, the dewaxed lube fractions can be finished to improve their color and stability, depending on the application requirements. One common method of finishing is mild hydrofinishing. The API classifies the products of solvent refining as Group I base oils.

Solvent Refining / Extraction Process



SEVERE HYDROTREATING PROCESS

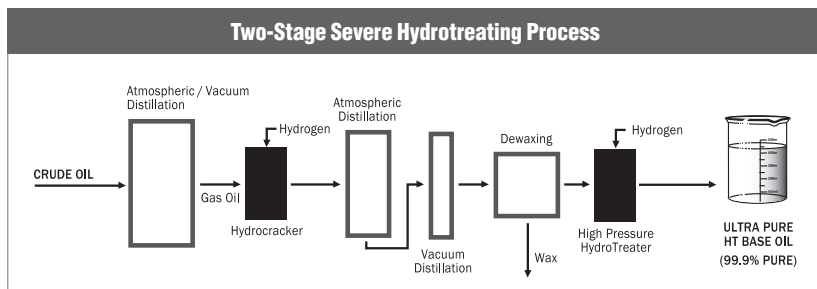
The severe hydrotreating process works to eliminate aromatics and polar compounds by reacting the feedstock with hydrogen in the presence of a catalyst at high temperatures and pressures.

Several different reactions occur in this process, the principal ones being:

- Removal of unwanted or undesirable polar compounds containing sulfur, nitrogen and oxygen
- Conversion of aromatic hydrocarbons to saturated cyclic hydrocarbons
- Breaking up of heavy polycyclo-paraffins into lighter, saturated hydrocarbons

These reactions take place at temperatures as high as 400°C/752°F, pressures around 3000 psi and in the presence of a catalyst. The hydrocarbon molecules that are formed are very stable and this makes them ideal for base oils used for lubricant blending. They are classified by the API as Group II base oils.

There are two stages in the severe hydrotreating process. The first stage removes unwanted polar compounds and converts the aromatic components to saturated hydrocarbons. After separation into desired viscosity grades by vacuum distillation, batches of waxy lube base oil are chilled and dewaxed. These are then passed through a second stage high pressure hydrotreater for additional saturation. This final step maximizes stability by removing the last traces of aromatic and polar molecules, producing a water-white and 99.9% pure base oil.





SEVERE HYDROTREATING/ HYDROISOMERIZATION

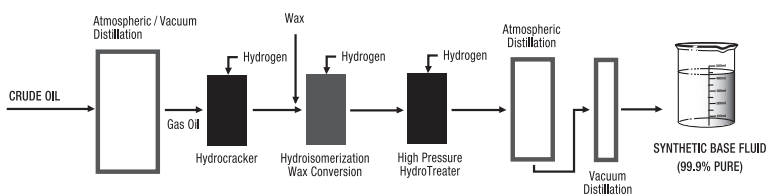
In addition to severe hydrotreating, the hydroisomerization process employs a specialized catalyst to selectively isomerize wax (mixture of long chain n-paraffins) to high VI, low pour point, isoparaffinic base oil. The process yields base oils with higher VIs and improved yields, compared to previous conventional dewaxing techniques. The process is capable of producing base oil with a VI above 130. More often, it is set up to produce high viscosity index (Group II+ and III) base fluids with VIs ranging from 115 to 127. A further process feature is the flexibility it offers to produce base oils with pour points lower than $-25^{\circ}\text{C}/-13^{\circ}\text{F}$.

Hydroisomerization is employed in conjunction with severe hydrotreating to produce superior base oils that have:

- High Viscosity Index (VI)
- Low Volatility
- Excellent Oxidation Resistance
- High Thermal Stability
- Excellent Low Temperature Fluidity
- Low Toxicity

These features give performance characteristics very similar to lubricants formulated with polyalphaolefin (PAO), the most common type of synthetic.

Two-Stage Severe Hydrotreating/Hydroisomerization Process



KEY BASE OIL PROPERTIES

Base oils are fundamental building blocks of finished lubricants. Their composition and physical properties are influenced by the refining technology used. Formulators will choose base oils with characteristics suited to the end application, and match them with specially selected additives to optimize performance of finished products.

CHARACTERISTIC	SIGNIFICANCE
Color	Often used as a visual indicator of purity, as it is usually related to the amount of aromatics present. Severely hydrotreated base oils are clear and colorless.
Viscosity Index (VI)	Is a measure of the rate of change of viscosity with temperature. Severely hydrotreated base oils have high VIs so they 'thin out' less at high temperatures yet remain pumpable (or fluid) at low temperatures.
Oxidation Resistance	The ability to resist chemical degradation caused by oxygen and /or increasing temperatures. Severely hydrotreated base oils respond very well to anti-oxidants resulting in excellent resistance to oxidation and long lubricant life in finished products.
Thermal Stability	The ability to resist permanent changes to physical and chemical properties caused by heat. Severely hydrotreated base oils have very good resistance to heat.
Carbon Residue	The amount of insoluble residue produced due to thermal stress. Severely hydrotreated base oils produce low amounts of carbon residue.
Demulsibility	The ability of a lubricating oil to separate from water. Severely hydrotreated base oils separate readily from water.
Low Toxicity	The degree to which a substance harms a living organism. Severely hydrotreated base oils have low toxicity, due to a virtual absence of impurities.
Biodegradability	The degree of biodegradability in a lubricant is measured by calculating its rate of conversion to carbon dioxide by living organisms. Severely hydrotreated base oils have good biodegradability characteristics.



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INTRODUCTION

Automotive equipment is the largest user of lubricants and the steady improvement of this equipment can only be maintained with the continued close association with leading lubricant manufacturers. Operators of automotive equipment have come to expect high quality and reliable performance from today's automotive lubricants.

We are committed to maintaining our leadership in automotive lubricant quality. Researchers at our Lubricants Centre are continually developing new and improved products, conducting performance tests in both the lab and the field. Our goal is to meet the ever-changing needs of the market so we keep in close contact with all major car, truck, engine and other Original Equipment Manufacturers (OEMs) as well as with our customers.

ENGINE OIL FUNCTIONS

Modern engine oil has been carefully developed by engineers and chemists to perform several important functions. The efficient operation of an engine depends on the oil to:

- Permit easy starting
- Disperse soot
- Lubricate engine parts and prevent wear
- Reduce friction
- Protect against rust and corrosion
- Help prevent sludge and varnish formation
- Reduce combustion chamber deposits
- Cool engine parts
- Seal combustion pressures
- Resist foaming
- Provide fuel efficiency
- Protect against low speed pre-ignition

Permit Easy Starting

The ease of starting an engine depends not only on the condition of the battery, ignition and fuel quality, but also on the flow properties of the engine oil. If the oil is too viscous or heavy at starting temperatures, it will impose enough drag on the moving parts that the engine cannot be cranked fast enough to start promptly and keep running.

Since cold temperatures thicken all oils, an oil for winter use must be thin enough to permit adequate cranking speeds at the lowest anticipated temperature. It must also be fluid enough to quickly flow to the bearings to prevent wear. In addition, the oil must be thick enough, when the engine reaches normal operating temperatures, to provide adequate protection.



Viscosity is an important characteristic of an oil which is defined as the oil's resistance to flow. It can be measured in many ways, but a critical one for engine oil is referred to as the cold cranking temperature. It evaluates the ease with which the engine crankshaft can rotate at the specified temperature. This resistance, or fluid friction, keeps the oil from being squeezed out from between engine surfaces when they are moving under load or pressure. Resistance to motion or flow is a function of the molecular structure of the oil. Since it is this internal fluid friction that is responsible for most of the drag put on the starter during cranking, it is important to use an oil with viscosity characteristics that ensure ease of cranking, proper oil circulation, and high temperature protection.

The effect of temperature on viscosity varies widely with different types of oil. For this reason, a calculation has been developed to quantify the amount of viscosity change with temperature, which is known as the Viscosity Index (VI). An oil with a high viscosity index is one that shows less change in viscosity with temperature variation. Today, through the use of enhanced refining methods and special chemical additives, many high viscosity index engine oils are light enough to enable easy cranking at low temperatures and yet will still be viscous enough to protect satisfactorily at high temperatures.

These oils with high viscosity indexes are known as "multi-grade" oils. Often they are also called by names that imply all-season usage since they perform satisfactorily in both winter and summer. Multi-grade oils are most often recommended by vehicle manufacturers.

Disperse Soot

Soot is a by-product of diesel and some direct injection gasoline engine combustion. It is black carbonaceous particulate matter, which does not dissolve in lubricating oil, but can be suspended by the oil and removed during an oil change. If soot is not well dispersed it will cause the oil to thicken up from its original SAE viscosity grade. In addition, soot can agglomerate to form particles large enough to initiate abrasive wear and when the soot load of an oil gets too high, it settles out and forms sludge. Agglomerated soot and/or highly thickened oil can result in high pressure at the oil filter inlet. This can cause the filter by-pass to open and allow unfiltered oil into the engine.

Engine oils formulated to fight soot are able to disperse large amounts of soot without thickening up. Good soot dispersal stops large particles agglomerating, reduces abrasive wear and inhibits the formation of sludge.

For many years the U.S. Environmental Protection Agency (EPA) has set stringent limits on nitrogen oxide (NOx) and particulate matter (PM) emissions from on-road trucks and buses. Through a combination of engine redesign, ultra-low-sulfur diesel (ULSD) fuel and new engine oil technology, these new vehicles cut harmful emissions by 98 percent. In addition, the regulation required a 97 percent reduction in the sulfur content of on-road diesel fuel – from 500 parts per million (ppm) to 15 ppm – so the fuel won't damage the new exhaust aftertreatment devices, specifically Diesel Particulate Filters (DPFs) that trap and further reduce soot emissions.

Engine manufacturers have been developing engines that not only utilize DPFs but also run on pollution-reducing ULSD fuel and utilize cooled exhaust gas recirculation (EGR) devices to redirect some of the exhaust gases normally emitted by the vehicle back into the engine, thus lowering NOx production but creating more internal soot.

Effective with the 2010 model year, limits for nitrogen oxide (NOx) emissions were further reduced. Most original equipment manufacturers (OEMs) implemented the use of Selective Catalytic Reduction (SCR) devices in order to meet the 2010 emission levels. The 2010 implementation of lower emissions limits did not require any changes to the lubricants specifications.

Lubricate Engine Parts and Prevent Wear

Once an engine is started, the oil must circulate promptly and lubricate all moving surfaces to prevent the metal-to-metal contact that would result in wear, scoring, or seizure of engine parts. Oil films on bearings and cylinder walls are sensitive to movement, pressure and oil supply. These films must be continually replenished by adequate flow and proper oil distribution.

As mentioned earlier, the viscosity of an oil must be low enough at the starting temperature to permit rapid cranking and starting, and high enough at peak operating temperatures to ensure adequate separation of moving parts for guaranteed engine protection.

Once the oil reaches the moving parts its function is to lubricate and prevent wear of the surfaces. Lubrication specialists describe several classes of lubrication.

Full-film or elasto-hydrodynamic lubrication occurs when the moving surfaces are continuously separated by a film of oil. The determining factor in keeping these parts separated is the viscosity of the oil at its operating temperature. The viscosity must remain high enough to prevent metal-to-metal contact.

Since the metals do not make contact in full-film lubrication, wear is negligible unless the separated parts are scratched by particles of equal size or larger than the thickness of the oil film itself. Bearings on crankshafts, connecting rods, and camshafts normally operate with full-film lubrication.

Under some conditions, it is impossible to maintain a continuous oil film between moving parts and there is intermittent metal-to-metal contact between the high spots (asperities) on sliding surfaces. Lubrication specialists call this mixed film lubrication. Under these circumstances, the load is only partially supported by the oil film. The oil film is ruptured resulting in significant metal-to-metal contact. When this occurs, the friction generated between the surfaces can produce enough heat to cause one or both of the metals in contact to melt and weld together. Unless counteracted by proper additive treatment, the result is either immediate seizure or the tearing apart and roughening of the surfaces.

Boundary lubrication conditions exist during engine start-up and shutdown and often during the operation of a new or rebuilt engine. Boundary lubrication is also found around the top piston ring where oil supply is limited, temperatures are high, and a reversal of piston motion occurs. Without additive protection, the result would be excessive wear or seizure of the two surfaces.



Reduce Friction

Under full-film lubrication conditions, a thick film of oil prevents metal-to-metal contact between moving engine parts. Relative movement of these lubricated parts requires enough force to overcome the fluid friction of the lubricant.

The viscosity of the oil should be high enough to maintain an unbroken film, but should not be higher than necessary, since this increases the amount of force required to overcome this fluid friction.

Vehicle manufacturers specify proper oil viscosity ranges according to expected ambient temperatures. This is to ensure that the lubricant will provide adequate, but not excessive, viscosity at normal operating conditions. When oil becomes contaminated, its viscosity changes. With soot, dirt, oxidation, or sludge, viscosity increases; with fuel dilution it decreases. Both directions of viscosity change are potentially harmful to the engine. For this reason, contaminant levels in engine oil must be kept low. This can be best accomplished by changing the oil and filter at proper intervals. If an engine oil does not disperse contaminants properly, the oil filter will plug and go into bypass allowing the contaminants to cause damage to the internal parts of the engine.

The amount and type of chemical additives is important for reducing friction under the extreme pressure conditions of boundary lubrication. The proper balance of the total additive system in a modern engine oil is critical if all lubrication conditions of an engine are to be satisfied. The oil formulator can achieve this balance of motor oil compounding only through much research, with emphasis on proof-testing in actual engines, both in the laboratory and in field service.

Protect Against Rust and Corrosion

For each gallon of fuel burned in an engine, more than one gallon of water is formed. Although most of this water is in vapour form and goes out the exhaust, some condenses on the cylinder walls or escapes past the piston rings and is trapped, at least temporarily, in the crankcase. This occurs most frequently in cold weather before the engine has warmed up.

In addition to water and the by-products from incomplete combustion of the fuel, other corrosive combustion gases also get past the rings and are condensed or dissolved in the engine oil. Add to this the acids formed by the normal oxidation of oil and the potential for rust and corrosive engine deposits becomes significant.

The life of engine parts depends in part on the ability of the motor oil to neutralize these corrosive substances. Thanks to extensive research, effective oil-soluble chemical compounds have been developed. These are added to engine oils during manufacture to provide vital protection to engine parts.

Help Prevent Sludge and Varnish Formation

In formulating today's high quality motor oils, a basic objective is not only to keep engine parts clean, but also to prevent sludge and varnish deposits from interfering with proper engine operation.

Engine sludge formation is generally a problem of low engine temperature operation. Engine sludge deposits are formed by combinations of water from condensation,

dirt and the products of oil deterioration and incomplete combustion. Sludge-forming materials are often so small initially that no oil filter can remove them. They are much smaller than the thickness of the oil film on engine parts and therefore cause no wear or damage so long as they remain small and well-dispersed. However, as their levels increase in the oil during use, they tend to join together to form larger masses and oil flow can be restricted.

Sludge formation is aggravated by water vapour which condenses in the crankcase in cold engine operation. The rate at which sludge-forming materials accumulate in the crankcase oil is related to several factors of engine operation. Factors such as, rich air-fuel mixtures which occur during starting or when a choke is sticking; operating with dirty air cleaners; or cases of ignition misfiring, increase the rate of sludge accumulation in the oil.

Straight mineral oils have only a very limited ability to keep these contaminants from coagulating and forming masses of sludge within the engine. This is the job of the detergent/dispersant additives that are blended into modern engine oils. These additives keep vital engine parts clean and oil contaminants suspended in such a fine form that they can be removed by regular oil and filter changes.

Detergent/dispersants are also very effective in preventing varnish deposits within an engine. Varnish-forming materials react chemically or combine with oxygen in the crankcase to form complex chemical compounds. These compounds continue to react with each other and with oxygen on the hotter parts of the engine, especially exhaust gas recirculation (ERG) valves and oxygen sensors and are baked by engine heat into a hard coating on the hotter parts of the engine. The hydraulic lifters, piston rings, and bearings are particularly sensitive to varnish deposits. If varnish-forming materials are allowed to accumulate in these areas, engine operation is impaired.

Engines cannot tolerate excessive amounts of sludge and varnish on sensitive parts. Sludge deposits collect on oil pump screens, limiting the flow of oil to vital engine parts and resulting in rapid and destructive wear. Piston rings which are stuck or sluggish because of varnish accumulation prevent the engine from developing full power. Sludged or plugged oil-control rings prevent removal of excess lubricant from the cylinder walls and result in excessive oil consumption.

Reduce Combustion Chamber Deposits

In performing its lubrication function, some oil must reach the area of the top piston ring in order to lubricate and seal the rings and the cylinder walls. This oil is then exposed to the heat and flame of burning fuel and part of it actually burns off.

Modern refining techniques have produced oils that burn cleanly under these conditions, leaving little or no carbon residue. The detergent/dispersant additives in modern motor oils keep the piston rings free in their grooves, thereby maintaining compression pressures and minimizing the amount of oil reaching the combustion chamber. This not only reduces oil consumption, but more importantly, keeps combustion chamber deposits to a minimum.



Excessive combustion chamber deposits adversely affect engine operation. Deposits that form on spark plugs may cause the plugs to foul. Excessive deposit build-up causes pinging, knocking, or other combustion irregularities that reduce the efficiency and economy of the engine. Since these deposits also act as heat barriers, pistons, rings, spark plugs, and valves are not properly cooled. This can result in damage or even failure of the parts necessitating premature replacement/overhaul.

In preventing excessive combustion chamber deposits, it is important that a motor oil accomplish two things:

- The oil must keep the piston rings free so that they can minimize the amount of oil reaching the combustion chamber.
- That portion of the oil reaching the combustion chamber should burn as cleanly as possible.

Cool Engine Parts

Many people assume that engine cooling is accomplished only through the action of the fluid in the cooling system. This in fact does only about 60 percent of the cooling job. It cools the upper part of the engine only – the cylinder heads, cylinder walls, and the valves. The crankshaft, the main and connecting rod bearings, the camshaft and its bearings, the timing gears, the pistons, and many other components in the lower part of the engine are directly dependent on the motor oil for necessary cooling. All these parts have defined operating temperature limits which must not be exceeded. Some can tolerate fairly high temperatures while others, such as the main and connecting rod bearings, must run relatively cool to avoid failure. Circulating oil picks up heat and carries it to the crankcase or oil cooler. Afterwards, cooler fluid or surrounding air removes the excess heat.

To keep this cooling process working, large volumes of oil must be constantly circulated to the bearings and other engine parts before eventually returning to the oil pan to cool and be recirculated again. If the oil supply is interrupted, these parts heat up rapidly from increased friction and combustion temperatures. A bearing failure is often referred to as a “burned-out bearing” because temperatures rose high enough to actually melt the bearing metal.

While only a small quantity of oil is required at any one time and place to provide lubrication, the oil pump must circulate many litres/gallons of oil per minute. Chemical additives and the physical properties of the oil have little effect on its ability to provide adequate cooling. What is critical is the continuous circulation of large quantities of oil throughout the engine and over hot engine parts. This is made possible through the use of large-capacity oil pumps and oil passages adequate to handle the required volume of oil. These oil passages cannot do the job properly if they are allowed to become partially or completely clogged with deposits. When this happens, the oil cannot circulate or cool properly and early engine failure may result. This is another reason for changing the oil and filter before the contaminant level becomes too high. Proper cooling also requires that the oil level in the crankcase never be permitted to remain below the “add oil” line on the dipstick. This is to ensure sufficient retention time of the oil in the crankcase.

Seal Combustion Pressures

The surfaces of the piston rings, ring grooves, and cylinder walls are not completely smooth. If examined under a microscope, these surfaces would show minute hills and valleys. For this reason, the rings by themselves can never completely prevent high combustion and compression pressures from escaping into the low pressure area of the crankcase, which results in a reduction in engine power and efficiency. Engine oil fills in these hills and valleys on ring surfaces and cylinder walls and helps to seal in compression and combustion pressures. Since the oil film at these points is rather thin – generally less than 0.025 mm thick – it cannot compensate for existing excessive wear of rings, ring grooves, or cylinder walls. Where such conditions already exist, oil consumption may be high. It may also be high in a new or rebuilt engine until the hills and valleys on these surfaces have smoothed out enough to allow the oil to form the right seal.

Resist Foaming

With the many rapidly moving parts in an engine, air in the crankcase is constantly being whipped into the oil. This produces foam, which is simply a lot of air bubbles which may or may not readily collapse. These air bubbles normally rise to the surface and break, but water and certain other contaminants slow down the rate at which this occurs, and the result is foam.

Foam is not a good conductor of heat, so if the amount of foam is excessive, engine cooling will be impaired because the heat will not be dissipated. Foam also does not have much ability to carry a load and has an adverse effect on the operation of hydraulic valve lifters and bearings. This is because it contains air and air is easily compressible. On the other hand, oil which is free of air is virtually incompressible.

Many engines have variable timing units, fuel injectors, valve control solenoids, and many other units that require high pressure oil to make them operate properly. Foam or air entrainment in the oil causes failure modes and shuts the engine down.

Provide Fuel Efficiency

As the lubricating oil performs the combination of functions described above, the collective outcome is fuel efficiency. Providing low frictional resistance among moving and reciprocating parts, the engine's mechanical efficiency is optimized. Energy loss in the engine components is reduced and this results in less drain on the fuel system.

Protect Against Low Speed Pre-Ignition

Low Speed Pre-Ignition (LSPI) is a phenomenon associated with gasoline direct injection (GDI) and turbocharged gasoline direct injection (TGDI) engines. The proper additive balance in a lubricating oil will help mitigate LSPI events. Unprotected, in severe cases, catastrophic engine failure can occur.



ADDITIVES

In summary, an engine oil has to perform many basic functions. To carry out these functions, the base oil must be refined to a very high level and then compounded with specially selected chemical additives. The skillful selection of additives formulated with severely hydrotreated base oils results in engine oils of outstanding performance.

DETERGENTS

These chemicals, usually metallo-organic based, are designed to control deposits and keep engine components clean. They are able to clean up existing deposits in the engine, as well as disperse insoluble matter into the oil. Detergents control contamination resulting from high temperature operation. Over-based detergents also neutralize acidic contaminants from fuel sulfur, engine exhaust, oil oxidation and/or nitration.

DISPERSANTS

These are usually ashless organic chemicals, which control contamination from low temperature operation. Both detergents and dispersants attach themselves to contaminant particles, such as soot or varnish and hold them in suspension, preventing sludge and deposit formation. The suspended particles, together with their additive carrier, are so small that they can pass harmlessly between moving surfaces and through oil filters. This contamination is removed from the engine when the oil is changed.

OXIDATION INHIBITORS

These agents reduce oxygen attack on the lubricant base oil to a minimum. Severely hydrotreated base oils have a superior response to these additives compared to solvent refined base oils. This results in an engine oil with high resistance to oil thickening and the build-up of corrosive acids, hence maintaining good oil flow properties and resistance to bearing corrosion.

CORROSION AND RUST INHIBITORS

Acids are produced by the combustion process and when an engine oil degrades with use. Unless rendered harmless by the engine oil, these acids can cause rapid deterioration of engine components. Corrosion inhibitors protect non-ferrous metals by coating them and forming a barrier between the parts and their environment. Rust Inhibitors protect iron/steel surfaces from oxygen attack, by forming a similar protective screen as mentioned above. Parts such as hydraulic lifters, push rods, etc. are prone to this type of corrosion.

ANTI-WEAR AGENTS

These agents prevent wear due to seizure or scuffing of rubbing surfaces. Compounds such as zinc dialkyl-dithiophosphate (ZDDP) break down at microscopic hot spots and form a chemical film which eliminates metal-to-metal contact before it grows. Thus scuffing, galling and seizure are prevented.

FOAM DEPRESSANTS

Detergent and dispersant additives can facilitate aeration of an oil, which leads to foaming. This can reduce the lubricating ability of an oil and even interfere with oil pumping. Incorporation of a foam depressant controls this tendency by reducing surface tension to speed up the collapse of foam.

VISCOSITY INDEX (VI) IMPROVERS

VI improvers are long chain polymers that can coil and uncoil in response to changes in temperature. They improve an oil's ability to resist changes in viscosity with temperature (i.e. improve its viscosity index). At low temperatures they coil up into tight balls which do not significantly increase the oil's resistance to flow (viscosity). However, at high temperatures, they uncoil into long chains which interweave and increase the oil's viscosity. VI improvers must resist breakdown due to shear and high temperatures to ensure a long lasting effect.

POUR POINT DEPRESSANTS

Base oils in API Groups I, II and III contain hydrocarbons that tend to crystallize into waxy materials at low temperatures. Incorporation of a chemical which reduces the size/rate of wax crystal formation can give an oil better low temperature fluidity, hence a lower pour point. Severely hydrotreated base oils have a minimum of waxy materials, so they have superior response to these additives compared to solvent refined base oils.

FRICTION MODIFIERS

Some oils contain friction-modifying chemicals, which can reduce the fuel consumption of an engine. These chemicals form a chemical or physically bonded film that reduces the friction between the lubricated engine parts.

OIL CLASSIFICATION SYSTEMS

In selecting a proper engine oil, the vehicle operator must consider both the oil viscosity and the lubricant service requirements for their vehicle. To enable the operator to identify a proper oil, the engine manufacturers and the petroleum industry utilize two complementary classification systems that are described below:

SAE ENGINE OIL VISCOSITY CLASSIFICATION

The earliest attempts to classify and identify motor oils were made when the first automobiles appeared. Even then, the physical property viscosity was known to be one of the most important characteristics of an oil and oils were classified as light, medium, or heavy, depending on their viscosity. When calibrated instruments became available to accurately measure viscosity, the Society of Automotive Engineers (SAE) developed a classification system based on viscosity measurements. This system (Engine Oil Viscosity Classification – SAE J300), which has been modified over the years, establishes fifteen distinct motor oil viscosity classifications or grades, as shown in the table on the following page.



SAE VISCOSITY GRADES FOR ENGINE OILS (SAE J300 April 2021)

SAE Viscosity Grade	Low-Temperature (°C) Cranking Viscosity ⁽³⁾ , mPa·s Max	Low-Temperature (°C) Pumping Viscosity ⁽⁴⁾ , mPa·s Max with No Yield Stress ⁽⁴⁾	Low-Shear-Rate Kinematic Viscosity ⁽⁵⁾ (mm ² /s) at 100 °C Min	Low-Shear-Rate Kinematic Viscosity ⁽⁵⁾ (mm ² /s) at 100 °C Max	High-Shear-Rate Viscosity ⁽⁶⁾ (mPa·s) at 150 °C Min
0W	6 200 at -35	60 000 at -40	3.8	-	-
5W	6 600 at -30	60 000 at -35	3.8	-	-
10W	7 000 at -25	60 000 at -30	4.1	-	-
15W	7 000 at -20	60 000 at -25	5.6	-	-
20W	9 500 at -15	60 000 at -20	5.6	-	-
25W	13 000 at -10	60 000 at -15	9.3	-	-
8	-	-	4.0	<6.1	1.7
12	-	-	5.0	<7.1	2.0
16	-	-	6.1	<8.2	2.3
20	-	-	6.9	<9.3	2.6
30	-	-	9.3	<12.5	2.9
40	-	-	12.5	<16.3	3.5 (0W-40, 5W-40, and 10W-40 grades)
40	-	-	12.5	<16.3	3.7 (15W-40, 20W-40, 25W-40, 40 grades)
50	-	-	16.3	<21.9	3.7
60	-	-	21.9	<26.1	3.7

Notes:

- 1 mPa·s = 1cP; 1 mm²/s = 1 cSt.
- All values, with the exception of the low-temperature cranking viscosity, are critical specifications as defined by ASTM D3244.
- ASTM D5293: Cranking viscosity - The non-critical specification protocol in ASTM D3244 shall be applied with a P value of 0.95.
- ASTM D4684: Note that the presence of any yield stress detectable by this method constitutes a failure regardless of viscosity.
- ASTM D445 or ASTM D7042 bias corrected to ASTM D445.
- ASTM D4683, ASTM D4741, ASTM D5481, or CEC L-36-90.

The “W” following the SAE viscosity grade stands for “winter” and indicates that an oil is suitable for use in colder temperatures. Oils carrying the “W” designation must have the proper viscosity value when measured at appropriate low temperatures. Those SAE classifications which do not include the “W” define oil grades for use at higher temperatures. The viscosity of these oils – SAE 8, 12, 16, 20, 30, 40, 50 and 60 – must have the proper value when measured at 100°C and under high shear conditions at 150°C. As noted earlier, the development of viscosity index improvers made the manufacture of multi-graded motor oil possible. Many of these oils - SAE 0W-20, 0W-30, 0W-40, 5W-20, 5W-30, 5W-40, 10W-30, 10W-40, 15W-40 and 20W-50 - have been marketed for decades in North America. The most recent lower viscosity grades (SAE XW-8, XW-12, XW-16) will become more popular in the near future as the engine manufacturers modify their engines to utilize them to maximize fuel economy.

Multigrade motor oils are widely used because they are light enough for easy cranking at low temperatures, but heavy enough to perform satisfactorily at high temperatures as well.

The engine manufacturers' recommendations for oil viscosity remain the primary references, particularly if warranty coverages are in force. However, a basic guide prepared from owners' manuals is shown in the table below:

GUIDE TO SAE GRADES OF ENGINE OIL		
Ambient Temperature Range	SAE Multi-Grades	SAE Grade
°C	°F	
−40°C to +40°C	−40°F to +104°F	0W-8 and 0W-16
−40°C to +40°C	−40°F to +104°F	0W-20 and 0W-30
−35°C to +40°C	−31°F to +104°F	5W-20 and 5W-30
−30°C to excess of +40°C	−22°F to excess of +104°F	10W-30 and 10W-40
−25°C to excess of +40°C	−13°F to excess of +104°F	15W-40
−20°C to excess of +40°C	−4°F to excess of +104°F	20W-50
SAE Single Grades		
−30°C to +20°C	−22°F to +70°F	10W
−20°C to +30°C	−4°F to +86°F	20W
0°C to excess of +40°C	+32°F to excess of +104°F	30
+5°C to excess of +40°C	+40°F to excess of +104°F	40
+10°C to excess of +40°C	+50°F to excess of +104°F	50

Footnotes
i) The lowest ambient temperatures quoted above are for equipment with no starting aids. Starting aids, such as block coolant heaters, oil sump heaters and battery warmers will further reduce the minimum starting temperature.
ii) The ambient temperatures quoted above should only be taken as a guide. For the exact SAE grade required, consult the owner's manual.

It is important to understand that the SAE viscosity grade classification system identifies only viscosity and indicates nothing else about the type or quality of an oil or the service for which it is intended.

API ENGINE SERVICE CLASSIFICATION

Since 1970, the American Petroleum Institute (API), the American Society for Testing and Materials (ASTM), and the Society of Automotive Engineers (SAE) have cooperated in maintaining the API Engine Service Classification System. This system enables engine oils to be defined and selected on the basis of their performance characteristics and the type of service for which they are intended. It should be emphasized that the API Engine Service Classification System has no connection with the SAE Engine Oil Viscosity Classification System. The latter is used to indicate only the SAE viscosities of oils. Both are necessary to adequately define an engine oil's characteristics insofar as customer selection of the proper product to meet the engine's need is concerned.



The API Engine Service Classification System presently includes twenty-five classes of service (current and obsolete) which are summarized in the chart below:

Letter	Designation API Service	Oil Description
SA	Utility gasoline and diesel engine service. (OBSOLETE)	Oil without additive.
SB	Minimum duty gasoline engine service. (OBSOLETE)	Some antioxidant and anti-scurf properties.
SC	1964 gasoline engine warranty requirements. (OBSOLETE)	Meets 1964-67 requirements of automotive manufacturers.
SD	1968 gasoline engine warranty requirements. (OBSOLETE)	Meets 1968-71 requirements of automotive manufacturers.
SE	1972 gasoline engine warranty requirements. (OBSOLETE)	Meets 1972-79 requirements of automotive manufacturers.
SF	1980 gasoline engine warranty requirements (OBSOLETE)	Meets 1980-88 requirements of automotive manufacturers.
SG	1989 gasoline engine warranty requirements (OBSOLETE)	Meets 1989-93 requirements of automotive manufacturers.
SH	1994 gasoline engine warranty requirements (OBSOLETE)	Meets 1994-96 requirements of automotive manufacturers.
SJ	1997 gasoline engine warranty requirements	Meets 1997-2000 requirements of automotive manufacturers.
SL	2001 gasoline engine warranty requirements	Meets 2001-2004 requirements of automotive manufacturers.
SM	2004 gasoline engine warranty requirements	Meets 2004-2010 requirements of automotive manufacturers.
SN (SN Plus)	2011 gasoline engine warranty requirements	Meets 2011-2019 requirements of automotive manufacturers. Some SN oils may meet the needs of API SN Plus which includes additional protection against low speed pre-ignition (LSPI).
SP	2020 gasoline engine warranty requirements	Meets 2020 onwards requirements of automotive manufacturers.
CA	Light duty service on high quality fuels. (OBSOLETE)	Meets Military requirement MIL-L-2104A (1954).
CB	Moderate duty service on lower quality fuels. (OBSOLETE)	Meets Military requirement MIL-L-2104A, but test run on high sulfur fuel (Suppl. 1).
CC	Moderate to severe duty diesel and gasoline service. (OBSOLETE)	Meets Military requirement MIL-L-2104B (1964).
CD	Severe duty diesel service. (OBSOLETE)	Provides moderately super charged diesel performance. Meets requirements of MIL-L-2104C and Caterpillar Series 3 lubricants.
CD-II	Severe duty 2-stroke cycle diesel engine service. (OBSOLETE)	Meets requirements for API CD service, plus Detroit Diesel 6V53T approval.
CE	Turbo-charged and Super-charged heavy-duty diesel engines, manufactured since 1983. (OBSOLETE)	Meets the requirements for API CD service, plus those for Mack EO-K/2 and Cummins NTC-400 approvals.

Letter	Designation API Service	Oil Description
CF	Off-road indirect injected diesel engines and other diesel engines using a broad range of fuel types including high sulfur (>0.5%) fuel. (OBSOLETE)	Provides effective control of piston deposits, wear and corrosion in naturally aspirated turbocharged or supercharged diesel engines. Can be used to replace CD oils.
CF-2	Severe duty 2-stroke cycle diesel engine service. (OBSOLETE)	Service typical of 1994 severe duty two-stroke cycle diesel engines requiring highly effective control over deposits and wear. Can be used to replace CD-II oils.
CF-4	Severe duty turbocharged 4-stroke cycle diesel engines, especially late model (since 1988) lower emission engines. (OBSOLETE)	Meets requirements of Caterpillar 1-K spec, plus those for Mack EO-K/2 and Cummins NTC-400 approvals.
CG-4	Severe duty service in 4-stroke cycle diesel engines designed to meet 1994 emission standards using low sulfur-fuel (<0.05% to <0.5%). (OBSOLETE)	Provides effective control over high temperature piston deposits, wear, corrosion, foaming, oxidation stability and soot accumulation. Can be used to replace CD, CE and CF-4 oils.
CH-4	For high-speed, 4-stroke cycle diesel engines, designed to meet 1998 emission standards, using low sulfur fuel (<0.05% to <0.5%).	Provides superior control over high temperature piston deposits, wear, corrosion, foaming, oxidation stability and soot accumulation. Can be used to replace CF-4 and CG-4 oils.
CI-4 (CI-4 Plus)	Represents a performance boost over CH-4. For use in high speed, four-stroke cycle diesel engines used in highway and off-road applications where fuel sulfur contents range from less than 0.05% by weight. Designed to meet 2002 emission standards and to meet increased engine severity caused by Exhaust Gas Recirculation (EGR).	Provides enhanced performance over that provided by CH-4, in terms of viscosity control, soot accumulation, oxidation stability and piston deposits. May be used to replace CF-4, CG-4, and CH-4 oils. Some CI-4 oils may also qualify for the CI-4 Plus designation which represents even better protection against wear, improved soot handling and shear stability.
CJ-4	For use in high-speed four-stroke cycle diesel engines designed to meet 2007 and 2010 model year on-highway exhaust emission standards as well as for previous model years. These oils are suitable for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). This category is designed to cope with stringent environmental emissions legislation and increased engine severity caused by Exhaust Gas Recirculation (EGR).	Oils designated for this service are currently available from Petro-Canada Lubricants and may also be used where API CH-4 and CI-4 / CI-4 Plus oils are required.
CK-4	API Service Category CK-4 describes oils for use in high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway and Tier 4 off-road exhaust emission standards as well as for previous model year diesel engines. These oils are formulated for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact exhaust after treatment system durability and/or oil drain interval.	API CK-4 oils exceed the performance criteria and are backwards compatible to API CJ-4, CI-4 PLUS, CI-4, and CH-4 API Service Categories. When using CK-4 oil with higher than 15 ppm sulfur fuel, consult the engine manufacturer for service interval recommendations.
FA-4	API Service Category FA-4 describes certain XW-30 oils specifically formulated for use in select high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway greenhouse gas (GHG) emission standards. These oils are formulated for use in on-highway applications with diesel fuel sulfur content up to 15 ppm (0.0015% by weight). Refer to individual engine manufacturer recommendations regarding compatibility with API FA-4 oils.	API FA-4 oils are not interchangeable or backward compatible with API CK-4, CJ-4, CI-4 PLUS, CI-4, and CH-4 oils. Refer to engine manufacturer recommendations to determine if API FA-4 oils are suitable for use. API FA-4 oils are not recommended for use with fuels having greater than 15 ppm sulfur. For fuels with sulfur content greater than 15 ppm, refer to engine manufacturer recommendations.



The following are more detailed descriptions of the API Service Classification. They are a guide to the proper selection of engine oils for significantly different engine service operations.

API “S” (“Service”) CATEGORIES

This category applies to Gasoline, Propane and Compressed Natural Gas (CNG) engines. Standards SA to SH have been removed as they are considered obsolete. The current standard is backservicable to prior “S” standards.

“S” category oils are generally associated with spark ignition engines.

SJ FOR 1997 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

Service typical of gasoline engines in passenger cars, sport utility vehicles, vans and light trucks beginning with 1997 model year, operating under manufacturers’ recommended maintenance procedures. Oils meeting API Service Classification SJ may be used where API Service Classifications SH and earlier have been recommended.

SL FOR 2001 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

Service typical of gasoline engines in passenger cars, sport utility vehicles, vans and light trucks effective July 1, 2001. In addition to a general improvement in quality, this new standard aims specifically to improve oil volatility, oil life, fuel economy and emissions system compatibility. Oils meeting API Service Classification SL may be used where API Service Classifications SJ and earlier have been recommended.

SM FOR 2004 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

Service typical of gasoline engines in passenger cars, sport utility vehicles, vans and light trucks effective December 2004. In addition to a general improvement in quality, this new standard aims specifically to improve oil volatility, oil life, fuel economy and emissions system compatibility. Oils meeting API Service Classification SM may be used where API Service Classifications SL and earlier have been recommended.

SN FOR 2011 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

API Service Category SN was adopted in October 2010 for use in describing engine oils first available in 2011. These oils are for use in service typical of gasoline engines in current and earlier passenger cars, sport utility vehicles, vans, and light-duty trucks operating under vehicle manufacturers’ recommended maintenance procedures. Vehicle owners and operators should follow their vehicle manufacturer’s recommendations on engine oil viscosity and performance standard. API SN aims generally to improve oil robustness and seal compatibility over API SM. In November of 2017, API approved the adoption of a new classification to be used in conjunction with API SN and API SN with Resource Conserving. This supplement to the SN category was introduced as “SN Plus” and API began licensing against it on May 1, 2018. The main purpose for this supplement is protection against low speed pre-ignition (LSPI). Engine oils that meet the API Service Category SN designation may be used where API Service Category SM and earlier S categories have been recommended. Oils that have successfully met or exceeded the limits of SN Plus and are properly licensed by API may also display “SN Plus” in the lower portion of the API service symbol.

SP FOR 2020 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

API Service Category SP was adopted in May 2020 for use in describing engine oils specified for model year 2021. These oils are for use in service typical of gasoline engines in current and earlier passenger cars, sport utility vehicles, vans, and light-duty trucks operating under vehicle manufacturers' recommended maintenance procedures. Vehicle owners and operators should follow their vehicle manufacturer's recommendations on engine oil viscosity and performance standard. API SP aims generally to improve oil robustness and protection against accelerated timing-chain wear in GDI engines over API SN or API SN with SN Plus.

When combined with Resource Conserving (see below), SP oils help improve fuel economy, protect emissions systems, protect turbochargers and protect engines when ethanol-containing fuels up to E85 are used. Engine oils that meet the API Service Category SP designation may be used where API Service Category SN or API SN with SN Plus and earlier S categories have been recommended.

**PASSENGER CAR, SPORT UTILITY VEHICLE, VAN
AND LIGHT TRUCK RESOURCE CONSERVING OIL
CLASSIFICATION**

The Resource Conserving classification for gasoline-powered passenger cars, sport utility vehicles, vans and light trucks is a supplementary classification for engine oils. Resource Conserving oils have been formulated to help improve fuel economy, protect emissions system components, protect turbochargers from deposits and help protect engines when operating on ethanol-containing fuels up to E85. The performance requirements for this supplementary classification are technically described in API 1509, 20th Edition, May 2021.

**RESOURCE CONSERVING IN CONJUNCTION WITH API SERVICE
CATEGORY SP**

API Service SP engine oils designated as Resource Conserving are formulated to help improve fuel economy and protect vehicle emission system components in passenger cars, sport utility vehicles, vans, and light-duty trucks powered by gasoline engines. These oils have demonstrated a fuel economy improvement (FEI) in the Sequence VIE (XW-20/XW-30 grades) or Sequence VIF (XW-16) test at the percentages listed in the following table when compared with a baseline oil (BL) used in the Sequence VIE or Sequence VIF test. Additionally, these oils have demonstrated in the tests listed that they provide greater emission system and turbocharger protection and help protect engines when operating on ethanol-containing fuels up to E85.

Many previous S-categories made reference to "Energy Conserving", but this reflected an emphasis on fuel-economy performance alone. Resource Conserving in conjunction with API SP focuses on fuel economy, emission system and turbocharger protection, and compatibility with ethanol-containing fuel up to E85. Oils that have passed the tests at the limits shown and are properly licensed by API may display "Resource Conserving" in the lower portion of the API Service Symbol in conjunction with API Service SP in the upper portion. The fuel economy and other resource conserving benefits obtained by individual vehicle operators using engine oils labeled Resource Conserving may differ because of many factors, including the type of vehicle and engine, engine manufacturing variables, the mechanical



condition and maintenance of the engine, oil that has been previously used, operating conditions, and driving habits.

Resource Conserving Primary Performance Criteria with API Service Category SP		
PERFORMANCE TEST	PERFORMANCE CRITERIA	
Sequence VIE (ASTM D8114) ^a Viscosity Grade XW-20 XW-30 10W-30 and all other viscosity grades not listed above.	FEI SUM minimum 3.8% 3.1% 2.8%	FEI2 minimum after 125 hours aging 1.8% 1.5% 1.3%
Sequence VIF (ASTM D8226) ^a Viscosity Grade XW-16	FEI SUM minimum 4.1%	FEI2 minimum after 125 hours aging 1.9%
Sequence IIIHB (ASTM D8111)	81% phosphorus retention min	
Emulsion Retention (ASTM D7563)	No water separation	
High Temperature Deposits, TEOST 33C (ASTM D6335), Total Deposit Weight, mg SAE XW-16, 0W-20 All other viscosity grades	Not Required 30 Max	

^aViscosity grades are limited to 0W, 5W and 10W multi-grade oils.

API “C” (“COMMERCIAL”) CATEGORIES (DIESEL)

“C” category oils are generally associated with diesel (aka heavy-duty) engines.

CA FOR DIESEL ENGINE SERVICE

Service typical of diesel engines operated in mild to moderate duty with high quality fuels and occasionally has included gasoline engines in mild service. They were widely used in the late 1940’s and 1950’s. (Obsolete)

CB FOR DIESEL ENGINE SERVICE

Service typical of diesel engines operated in mild to moderate duty, but with lower quality fuels which necessitate more protection from wear and deposits. Oils designed for this service were introduced in 1949. (Obsolete)

CC FOR DIESEL ENGINE SERVICE

Service typical of certain naturally aspirated, turbocharged or supercharged diesel engines operated in moderate to severe duty service and certain heavy-duty gasoline engines. Oils designed for this service provide protection from high temperature deposits and bearing corrosion in these diesel engines and also from rust, corrosion and low-temperature deposits in gasoline engines. These oils were introduced in 1961. (Obsolete)

CD FOR DIESEL ENGINE SERVICE

Service typical of certain naturally aspirated, turbocharged or supercharged diesel engines where highly effective control of wear and deposits is vital, or when using fuels of a wide quality range including high sulfur fuels. Oils designed for this service were introduced in 1955 and provide protection from bearing corrosion and from high-temperature deposits in these diesel engines. (Obsolete)

CD-II FOR SEVERE DUTY 2-STROKE CYCLE DIESEL ENGINE SERVICE

Service typical of 2-stroke cycle diesel engines requiring highly effective control over wear and deposits. Oils designed for this service also meet all performance requirements of API Service Category CD. (Obsolete)

CE FOR 1983 DIESEL ENGINE SERVICE

Service typical of certain turbocharged or supercharged heavy-duty diesel engines manufactured since 1983 and operated under both low speed high load and high speed high load conditions. Oils designed for this service must also meet the requirements of the API Engine Service Categories CC and CD. (Obsolete)

CF FOR 1994 OFF-ROAD INDIRECT INJECTED DIESEL ENGINE SERVICE

API Service Category CF denotes service typical of off-road indirect injected diesel engines and other diesel engines that use a broad range of fuel types including those using fuel with higher sulfur content, for example, over 0.5% wt. Effective control of piston deposits, wear and corrosion of copper-containing bearings is essential for these engines which may be naturally aspirated, turbocharged or supercharged. Oils designated for this service may also be used when API Service Category CD is recommended. (Obsolete)

CF-2 FOR 1994 SEVERE DUTY 2-STROKE CYCLE DIESEL ENGINE SERVICE

API Service Category CF-2 denotes service typical of two-stroke cycle engines requiring highly effective control over cylinder and ring-face scuffing and deposits. Oils designated for this service have been in existence since 1994 and may also be used when API Service Category CD-II is recommended. These oils do not necessarily meet the requirements of CF or CF-4 unless the oils have specifically met the performance requirements of these categories. (Obsolete)

CF-4 FOR 1991 DIESEL ENGINE SERVICE

Service typical of severe duty turbocharged, 4-stroke cycle diesel engines, particularly late models designed to give lower emissions. These engines are usually found in on-highway, heavy-duty truck applications. API CF-4 oils exceed the requirements of CE category oils and can be used in place of earlier CC, CD and CE oils. (Obsolete)

CG-4 FOR 1994 SEVERE DUTY DIESEL ENGINE SERVICE

For use in high speed, four-stroke cycle diesel engines used in highway and off-road applications where the fuel sulfur may vary from less than 0.05 percent to less than 0.5 percent by weight. CG-4 oils provide effective control over high temperature piston deposits, wear, corrosion, foaming, oxidation stability and soot accumulation. These oils are especially effective in engines designed to meet 1994 emission standards and may also be used in engines requiring API Service Categories CD, CE and CF-4. (Obsolete).



CH-4 FOR 1999 SEVERE DUTY DIESEL ENGINE SERVICE

For use in high speed, four-stroke cycle diesel engines used in highway and off-road applications, where the fuel contents range from less than 0.05% to less than 0.5% by weight. CH-4 oils provide superior control over high temperature piston deposits, wear, corrosion, foaming, oxidation stability and soot accumulation. These oils have been specifically formulated for engines designed to meet November 1998 EPA emission standards and may be used where API CD, CE, CF-4 and CG-4 oils are required. Oils designated for this service have been available since 1999.

CI-4 (CI-4 PLUS) FOR 2002 SEVERE DUTY DIESEL ENGINE SERVICE

For use in high speed, four-stroke cycle diesel engines used in highway and off-road applications where fuel sulfur contents range from less than 0.05% to less than 0.5% by weight. This new category is designed to cope with stringent environmental emissions legislation and increased engine severity caused by Exhaust Gas Recirculation (EGR). Oils designated for this service are currently available from Petro-Canada Lubricants and may also be used where API CD, CE, CF-4, CG-4 and CH-4 oils are required.

CJ-4 FOR 2007 and 2010 SEVERE DUTY DIESEL ENGINE SERVICE

For use in high-speed four-stroke cycle diesel engines designed to meet 2007 and 2010 model year on-highway exhaust emission standards as well as for previous model years. These oils are compounded for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact exhaust after treatment system durability and/or oil drain interval.

CK-4—For 2017 HEAVY-DUTY DIESEL ENGINE SERVICE

For use in high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway and Tier 4 non-road exhaust emission standards as well as for previous model year diesel engines. These oils are formulated for use in all applications with diesel fuels ranging in sulfur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulfur fuel may impact exhaust after treatment system durability and/or oil drain interval.

FA-4—For 2017 HEAVY-DUTY DIESEL ENGINE SERVICE

For use in select high-speed four-stroke cycle diesel engines designed to meet 2017 model year on-highway greenhouse gas (GHG) emission standards. These oils are formulated for use in on-highway applications with diesel fuel sulfur content up to 15 ppm (0.0015% by weight). Refer to individual engine manufacturer recommendations regarding compatibility with API FA-4 oils.

OTHER DIESEL ENGINE OIL SPECIFICATIONS

Some diesel engine manufacturers have engine oil requirements that are not completely covered by API classifications.

CATERPILLAR ECF-1

A specification introduced in 2003, designed for the ACERT (Advanced Combustion Emission Reduction Technology) engines. This requires oils to be either CI-4/CH-4 and <1.3% sulphated ash and 1 pass of CAT 1P test or to be CI-4/CH-4 and 1.3-1.5% sulphated ash and 2 passes of CAT 1P test.

CATERPILLAR ECF-1-a

A specification introduced in 2007, to replace ECF-1, designed for all 2006 and older Caterpillar on-highway diesel engines, Caterpillar 3500 Series and smaller commercial and machine diesel ACERT (Advanced Combustion Emission Reduction Technology) engines. This requires oils to be either CH-4 and <1.3% sulphated ash and 1 pass of CAT 1P test or to be CH-4 and 1.3-1.5% sulphated ash and 2 passes of CAT 1P test.

CATERPILLAR ECF-2

A specification introduced in 2007, designed for all 2006 and older Cat on-highway diesel engines, Cat 3500 Series and smaller commercial and machine diesel ACERT (Advanced Combustion Emission Reduction Technology) engines. This requires oils to be either CI-4/CI-4 Plus and $\leq 1.5\%$ sulphated ash.

CATERPILLAR ECF-3

This specification is equivalent to API CJ-4 and the chief recommendation by Caterpillar for their 2007 compliant engines equipped with diesel particulate filters (DPFs). It is also recommended in legacy on-road equipment when used with diesel fuel up to 500 ppm of sulfur.

CUMMINS 20071

The Cummins 20071 specification defines the premium quality engine oil that must be used in Cummins 1997 year engines, operating in North America with extended oil drain intervals. Cummins 20071 oils must pass the Cummins M-11 engine test at 200 hours, together with a matrix of other diesel engine tests (Mack, Caterpillar and GM).

CUMMINS 20072

The Cummins 20072 specification defines the premium quality engine oil that must be used in Cummins 1997 engines, operating globally with poor fuel quality and inferior engine maintenance practices.

Cummins 20072 oils must pass the Cummins M-11 engine test at 200 hours, a matrix of other diesel engine tests (Mack, Caterpillar and GM) and meet the ACEA E3 requirements for a diesel engine oil.

CUMMINS 20076

The Cummins 20076 specification defines the premium quality engine oil that must be used in Cummins 1999 year engines, operating in North America with extended oil drain intervals. Cummins 20076 oils must pass the Cummins M-11 engine test at 300 hours, together with a matrix of other diesel engine tests with tightened limits, compared to the earlier 20071 specification.



CUMMINS 20078

Cummins 20078 is also defined around the increased performance embodied in the CI-4 tests and limits.

CUMMINS 20081

A premium specification for Cummins 2007 and 2010 compliant engines equipped with diesel particulate filters (DPFs). It contains no new tests beyond API CJ-4 requirements, however it has tighter pass limits on some of the engine tests. Can be used with diesel fuel containing up to 500 ppm of sulfur.

CUMMINS 20086

A premium specification for Cummins 2017 compliant engines equipped with diesel particulate filters (DPFs). It contains no new tests beyond API CK-4 requirements, however it has tighter pass limits on some of the engine tests. Can be used with diesel fuel containing up to 15 ppm of sulfur.

CUMMINS 20087

This specification describes the requirements for premium quality engine oils for use in Cummins engines that require an API FA-4 oil, and are equipped with exhaust gas recirculation (EGR) and exhaust aftertreatment. The requirements in the Cummins Engine Standard are more strenuous or equivalent to API FA-4 category oils. Can be used with diesel fuel containing up to 15 ppm of sulfur.

DETROIT DIESEL DFS 93K218

This specification defines the requirements for Detroit Diesel engines designed to meet the EPA 2007 and 2010 on-road emission requirements. These engine emission systems are equipped with cooled EGR and diesel particulate filters (DPFs). 93K218 is a premium oil specification and it exceeds API CJ-4 with higher pass limits on several of the key engine tests of the CJ-4 test program. 93K218 surpasses the requirements of previous DD specifications and therefore the oils are considered to be back serviceable in older engines. Preferred fuel for this application is Ultra Low Sulfur Diesel (ULSD; 15 ppm Sulfur). In applications where Low Sulfur Diesel (500 ppm) is used, drain intervals may be slightly shortened relative to ULSD.

Detroit Diesel Corporation 2-stroke cycle engines require SAE 40 or 30 oils of CF-2 quality and with a sulphated ash level of no more than 1.0% weight. SAE 15W-40 oils of API CF-2 quality and having a High Temperature-High Shear (HTHS) Viscosity of at least 3.7 cP are permitted as a third choice in Detroit Diesel Model 53, 71, and 92 engines (must meet 1.0% wt ash limit). SAE 15W-40 and SAE 30 oils are not permitted at all in the large Model 149 engines. Note that Detroit Diesel Corporation no longer manufactures 2-stroke engines for the commercial market.

DETROIT DIESEL DFS 93K222

This specification describes the type of engine lubricants preferred for use in DDC engines meeting EPA 2007, EPA 2010, GHG 2014, and GHG 2017 exhaust emission regulations, particularly those equipped with cooled EGR, Diesel Particulate Filters

(DPF) and Selective Catalytic Reaction (SCR), including DD5, DD8, DD13, DD15, DD16, MBE 900, MBE 4000, Series 50, and Series 60 engines. To meet emission design criteria, these engines must burn ≤ 15 ppm Ultra Low Sulfur Fuels and use the lubricants meeting this specification. These lubricants are also recommended for all four-cycle Detroit Diesel engines including with and without an after treatment system.

DFS93K222 is a premium oil specification that exceeds API CK-4 with higher pass limits on several of the key engine tests as well requires additional testing requirements.

DETROIT DIESEL DFS 93K223

This specification describes the type of engine lubricants recommended for use in DDC engines meeting EPA2010 and GHG 2017 exhaust emission regulations, particularly those equipped with cooled EGR, Diesel Particulate Filters (DPF) and Selective Catalytic Reaction (SCR), including DD5, DD8, DD13, DD15, and DD16. To meet emission design criteria, these engines must burn ≤ 15 ppm Ultra Low Sulfur Fuels and use the lubricants meeting this specification.

DFS93K223 is a premium oil specification that exceeds API FA-4 with higher pass limits on several of the key engine as well requires additional testing requirements. Further information regarding the application and use of oils meeting this specification is available in the DDC Service Brochure Publication DDC-SVC-BRO-0001.

MACK EO-M PLUS

The MACK EO-M Plus specification was introduced in 1999. Use of MACK EO-M Plus oils is mandatory in all MACK 1999 year engines, where oil drain intervals are as long as 50,000 miles or 80,000 km.

MACK EO-M Plus oils must be multigraded, meet the requirements of API CH-4 and pass the following engine tests: Mack T-8E & Mack T-9 with tightened limits and the Cummins M-11 extended to 300 hours.

MACK EO-N PLUS

This specification defines a premium oil performance above and beyond the stringent CI-4 tests, and consequently beyond the MACK EO-N specification.

MACK EO-N PREMIUM PLUS '03

This specification is required for the Mack ASET family of engines, which utilize exhaust gas recirculation (EGR) and also highly recommended for all other Mack engine models, regardless of vintage. MACK EO-N Premium Plus '03 engine oils exceed both the API CI-4 and previous EO-N performance specifications.

MACK EO-O PREMIUM PLUS '07 / VOLVO VDS-4 / RENAULT VI RLD-3

These specifications define the requirements for Mack, Volvo, and Renault engines designed to meet the EPA 2007 and 2010 on-road emission requirements. The new engines are equipped with diesel particulate filters (DPFs). As premium specifications, they exceed API CJ-4 with tighter pass limits in the Mack T-12,



Cummins ISM and Cummins ISB engine tests plus the addition of the Volvo D12D test. EO-O Premium Plus surpasses the requirements of previous Mack specifications and therefore the oils are considered to be backward serviceable in older engines. Can be used with diesel fuel containing up to 500 ppm of sulfur.

MACK EOS-4.5 / VOLVO VDS-4.5 / RENAULT RLD-3

These specifications define the requirements for Mack, Volvo, and Renault engines designed to meet the EPA 2017 and GHG 2017 on-road emission requirements. The new engines are equipped with diesel particulate filters (DPFs) and SCR. As premium specifications, they exceed API CK-4 with tighter pass limits in the Mack T-12 and T-13, Cummins ISM and Cummins ISB engine tests plus the addition of the Volvo D12D test. EOS-4.5 surpasses the requirements of previous Mack specifications and therefore the oils are considered to be backward serviceable in older engines.

MAN 3477, 3677

These specifications define the performance requirements for MAN engines designed to meet Euro IV, Euro V and Euro VI engines (only diesel fuel EN 590 with max. 50 ppm sulfur) requirements. The oils must be low SAPS. An SAE 5W-30 oil is the only viscosity grade that can be approved for MAN 3677, or MAN 3477. MAN no longer approves SAE 10W-40 grade oils (10.2021).

MERCEDES-BENZ 228.31, 228.51

These specifications define the performance requirements for MB engines designed to meet Euro IV, Euro V and Euro VI engines requirements. The oils must be low SAPS to give the required protection for after treatment system like DPF, EGR and SCR.

SCANIA LA, LDF-4

These specifications define the performance requirements for SCANIA. The new engines are tested tough. Long drain means that SCANIA tests the oils and engines for double the recommended mileages. For example, an ordinary long haulage truck may normally call for an oil change every 60,000 km (SCANIA LA oils) and LDF-4 a minimum drain of 120,000 – 150,000 km, depending on specific fuel consumption. SCANIA LDF-4 needs the latest available high-performance engine oil technologies focusing on optimizing performance on latest technology engines. To meet the needs of the modern Euro VI engines and their exhaust gas after treatment systems, SCANIA created the LDF-4 specification that allows the service life of the diesel particulate filter (DPF) to be doubled in comparison with LDF-3. SCANIA LDF-4 is used as factory fill for Euro VI vehicles and used in nearly all SCANIA trucks (excluded are the V8 engines which should use LDF-3 or LA generation oils).

API CERTIFICATION MARK

API's Lubricants Subcommittee established the symbol illustrated below, commonly referred to as "the donut", to provide uniform identification and an improved means for the general public to identify appropriate engine oils according to the manufacturer's recommendation for the needs of a particular vehicle. The symbol is used to display the appropriate API service category or categories (upper part of the symbol), the SAE viscosity grade (center of the symbol), and, if applicable, Resource Conserving and SN Plus features of an oil (bottom part of the symbol). Resource Conserving and SN Plus are not applicable for heavy-duty diesel engines. The symbol clearly provides all the pertinent information a customer needs in one convenient location.

**API CERTIFICATION MARK**

The API Certification Mark identifies engine oils meeting the International Lubricants Standardization and Advisory Committee (ILSAC) performance requirements and is commonly referred to as "the Starburst", shown below.



This symbol enables the general public to easily recognize oils which meet the warranty requirements of Chrysler, Ford and the Japanese automakers and must be displayed on the front of the motor oil container. General Motors currently recommends "dexos® 1 Gen 3" product for their more recent gasoline engines. Consult the owner's manual to determine whether the engine requires ILSAC GF-6A/API SP or dexos® 1 Gen 3 approved engine oil.

The current ILSAC specification is ILSAC GF-6 (as of May 2020). The ILSAC GF-6 specification was split into 2 categories, ILSAC GF-6A and ILSAC GF-6B, each with their own trademarked symbol. The API "Starburst" only applies to SAE 0W-20, 0W-30, 5W-20, 5W-30 and 10W-30 viscosity oils that not only meet the ILSAC GF-6A specification, but also meet and are licensed API SP and the Resource Conserving classification.

API CERTIFICATION MARK "SHIELD"

The Shield certification mark, shown here, is used on the front of containers for SAE 0W-16 products only, that meet ILSAC GF-6B,





API SP and the Resource Conserving classification. It is used in place of the Starburst, and can be combined with the API Certification "Donut".

USED OIL ANALYSIS

Used oil analysis programs for engine oils, such as the 360 Technical Expertise Oil Diagnostics program, provides several customer benefits:

- Reduce unscheduled vehicle downtime
- Improve vehicle reliability
- Help organize effective maintenance schedules
- Extend engine life
- Forecast extended oil change intervals
- Reduce cost of vehicle maintenance

Used engine oil analyses are carried out principally to determine the overall condition of the oil and the engine. Monitoring an oil's condition at successive intervals, over a relatively long time period, can be used to establish:

- Presence of Undesirable Contaminants, such as:
 - Excess Wear Metals
 - Gasoline or Diesel Fuel
 - Coolant and excess water
 - Road Salt
 - Dirt, Sand or Dust
- Optimum Oil Change Interval

The following items are tested to determine the condition of an engine oil:

- **Viscosity** - is the measure of an oil's resistance to flow. An oil can "thicken-up" due to oxidation, the presence of contaminants, or evaporation of light components. It can "thin-down" due to oil shearing or fuel dilution. Reported as cSt @ 40°C and cSt @ 100°C.
- **Coolant** - ethylene glycol is the major component of antifreeze coolant systems, so the presence of glycol is determined. A positive test result indicates a defective gasket or a cracked head/block. Detection of glycol requires immediate attention, as it reacts quickly in a hot engine to become acidic and form varnish and sludge.
- **Water** - presence due to condensation from low temperature engine operation or from a leak in the cooling system.
- **Dilution** - the amount of gasoline or diesel present in an oil.
- **Acid Number** - expresses the quantity of base required to neutralize all the acidic constituents present in the oil. Often an indicator of how oxidized an oil has become.
- **Base Number** - measures the reserve alkalinity of an oil, which is the ability of an alkali to neutralize the effect of acid formation.
- **Wear Metals or Additive Elements** - The presence of the following elements is usually determined by Inductively Coupled Plasma Emission Spectroscopy: Aluminum, Barium, Boron, Calcium, Chromium, Copper, Iron, Magnesium, Molybdenum, Phosphorus, Sodium, Tin and Zinc.

- **Degradation by-product** - includes oxidation, nitration and sulphation as determined by the FTIR method. Elevated results, above normal trends, generally indicate excessive stress of the oil due to extended oil service or other combustion related issues.
- **Soot** - The fine black particles, chiefly composed of carbon, produced by incomplete combustion of the fuel.

USED OIL ANALYSIS TESTS

CONTAMINANT WARNING LEVELS	
TEST	WARNING LIMIT
Viscosity - cSt @ 40°C	25% change versus the new oil viscosity
- cSt @ 100°C	15% change versus the new oil viscosity
Coolant	Any positive identification
Water	Greater than 0.1%
Fuel Dilution	Greater than 5%
Acid Number	More than 5 units (engine oil) or 1 unit (industrial oil)
Base Number	No lower than 3 to 4 units
Soot	Greater than 5%*
Oxidation	Greater than 30 A/cm (above baseline)

* Confirm OEM recommended limits

AUTOMOTIVE WEAR METALS WARNING LEVELS		
ELEMENT	WARNING LIMITS	COMMENTS
Iron (Fe)	Greater than 100 ppm	High levels indicate worn valves, cylinder-liner, bearings, crankshafts.
Chromium (Cr)	Greater than 10 ppm	High levels indicate worn piston rings, bearings or contamination by antifreeze.
Copper (Cu)	Greater than 20 ppm	High levels indicate worn bearings and bushings.
Tin (Sn)	Greater than 10 ppm	High levels indicate worn bearings, bushings and oil cooler leeching.
Aluminum (Al)	Greater than 20 ppm (>80 ppm Aluminum Block Engines)	High levels indicate worn pistons or engine block.
Lead (Pb)	Greater than 25 ppm	High levels indicate worn bearings. Where leaded gasoline used, results are meaningless.
Boron (B)	Greater than 20 ppm	High levels indicate radiator fluid leak. Some engine oils contain a boron dispersant additive. Check sample of new oil.
Silicon (Si)	Greater than 20 ppm	High levels indicate presence of dust or sand. May also be due to high level of silicone anti-foam. Check sample of new oil. Radiator fluids contain silicates that show up as Silicon in sample.
Magnesium (Mg), Molybdenum (Mo), Calcium (Ca) Barium (Ba), Sodium (Na) Phosphorus (P), Zinc (Zn), Potassium (K)		These elements may be part of the additive package. They remain in the oil and do not deplete. The presence of Na and K can indicate a leak of radiator fluid.

ppm = parts per million



PASSENGER CAR MOTOR OILS

Passenger cars are delivering more power and performance than ever before. Engine power outputs, in horsepower per litre, have increased tremendously over the past decade or so. Current smaller, higher powered passenger car engines not only run hotter, but also work harder than ever before. As a result, engines are much more demanding on motor oils for their lubrication. The very close tolerances of rapidly moving engine parts together with pressures for lower oil consumption, reduced engine emissions, increased equipment durability and fuel economy, place heavy demands on today's passenger car motor oils. The Petro-Canada Lubricants line of passenger car motor oils, formulated using the latest in lubricant technology, is ready and able to meet these new challenges.

PETRO-CANADA SUPREME™ MULTIGRADE MOTOR OIL

PETRO-CANADA SUPREME is a superior passenger car motor oil formulated using a high performance additive system. It exceeds the latest service requirements for most gasoline powered engines found in North American and Asian passenger cars and light duty trucks.

PETRO-CANADA SUPREME 5W-20, 5W-30 and 10W-30 synthetic blend motor oils give excellent year-round performance in today's passenger car engines, equipped with the latest emission controls and turbochargers. Meeting API SP, these oils demonstrate superior control of ring-zone deposits in small high-output engines. PETRO-CANADA SUPREME 5W-20, 5W-30 and 10W-30 are all friction modified to save fuel and meet the latest API Resource Conserving standard as well as the ILSAC GF-6A specification for motor oil.

PETRO-CANADA SUPREME 10W-40 and 20W-50 are specialty grades, designed for older North American cars, or for engines operating under high ambient temperatures.

PETRO-CANADA SUPREME is recommended for use in all passenger car, propane and compressed natural gas (CNG) powered engines.

PETRO-CANADA SUPREME Multigrade Motor Oil is available in five SAE Grades: 5W-20, 5W-30, 10W-30, 10W-40 and 20W-50.

Typical characteristics are shown below:

PETRO-CANADA SUPREME						
SAE Grade		5W-20	5W-30	10W-30	10W-40	20W-50
Viscosity	cSt @ 40°C	50.1	64.4	69.7	102	164
cSt @ 100°C		8.7	10.9	10.7	14.9	19.1
Viscosity Index		153	161	143	153	133
Flash Point, COC, °C/°F		226/439	230/446	225/437	235/455	253/487
Cold Crank Viscosity, cP @ °C		4800 @ -30	4700 @ -30	5000 @ -25	5800 @ -25	6700 @ -15
Borderline Pumping Viscosity, cP @ °C		14500 @ -35	18000 @ -35	16000 @ -30	24000 @ -30	20300 @ -20
Sulphated Ash, % Wt		0.84	0.81	0.84	0.81	0.79
Base Number (D2896), mg KOH/g		7.0	7.0	7.0	7.0	7.0
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C		2.6	3.1	3.0	3.9	4.6

Meet: API SP, SP Resource Conserving (only 5W-20, 5W-30, 10W-30), ILSAC GF-6A (only 5W-20, 5W-30, 10W-30).



PETRO-CANADA SUPREME™ SYNTHETIC MOTOR OILS

PETRO-CANADA SUPREME Synthetic 0W-16, 0W-20, 0W-30, 5W-20, and 5W-30 are premium passenger car motor oils. These oils are specifically formulated with Petro-Canada Lubricants Very High Viscosity Index (VHVI) Synthetic Base Fluids and a unique additive chemistry, which delivers consistent, superior performance under the toughest driving conditions.

PETRO-CANADA SUPREME Synthetic motor oils have outstanding resistance to thermal breakdown and provide exceptional wear protection under both low and high temperature situations. PETRO-CANADA SUPREME Synthetic 0W-16, 0W-20 and 0W-30 help protect against the extremes of Canadian winter, and their exceptional fluidity facilitates starting down to -40°C.

PETRO-CANADA SUPREME Synthetic motor oils exceed most North American and Asian passenger car and light duty truck manufacturers' warranty requirements for gasoline fueled vehicles. They also exceed API Service Category SP, SP Resource Conserving and the ILSAC GF-6A or ILSAC GF-6B (0W-16 grade only) standard.

PETRO-CANADA SUPREME Synthetic 0W-20, 5W-20 and 5W-30 are also fully approved against the GM dexos® 1 Gen 3 specification.

Typical characteristics are shown below:

PETRO-CANADA SUPREME Synthetic						
SAE Grade		0W-16	0W-20	0W-30	5W-20	5W-30
Viscosity	cSt @ 40°C	39.4	44.2	54.8	45.3	64.1
	cSt @ 100°C	7.6	8.3	10.1	8.4	11.3
Viscosity Index		164	164	174	163	171
Flash Point, COC, °C/°F		219/426	219/426	235/455	219/426	224/435
Cold Crank Viscosity, cP @ °C		5000 @ -35	5600 @ -35	5600 @ -35	3500 @ -30	3800 @ -30
Borderline Pumping Viscosity, cP @ °C		15000 @ -40	17000 @ -40	22000 @ -40	8500 @ -35	13000 @ -35
Sulphated Ash, % Wt		0.94	0.94	0.73	0.90	0.94
Base Number (D2896), mg KOH/g		8	7	7	8	8
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C		2.4	2.6	3.0	2.6	3.3

Meet: API SP, SP Resource Conserving, ILSAC GF-6A or ILSAC GF-6B (0W-16 grade only), GM dexos® 1 Gen 3 (0W-20, 5W-20 & 5W-30).

The dexos® specification and trademark are exclusive to General Motors, LLC.

PETRO-CANADA SUPREME™ SYNTHETIC 5W-40 MOTOR OIL

PETRO-CANADA SUPREME Synthetic 5W-40 is a premium advanced synthetic motor oil designed to lubricate the engines of today's gasoline and ethanol (up to E85) fuelled passenger cars, vans, CUVs, SUVs and light duty trucks. It provides exceptional resistance to high temperature thermal breakdown, extended engine life, outstanding low temperature fluidity, reduced oil consumption and protection of exhaust emission control systems. SUPREME Synthetic 5W-40 Motor Oil is specially formulated to exceed the latest API Service Classification for gasoline engines, API SP.

PETRO-CANADA SUPREME Synthetic 5W-40	
SAE Grade	5W-40
Viscosity cSt @ 40°C	87.0
cSt @ 100°C	14.3
Viscosity Index	171
Flash Point, COC, °C/°F	233/451
Cold Crank Viscosity, cP @ °C	5100 @ -30
Borderline Pumping Viscosity, cP @ °C	27000 @ -35
Sulphated Ash, % Wt	0.89
Base Number (D2896), mg KOH/g	7
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	3.8

PETRO-CANADA SUPREME™ EU-X SYNTHETIC 5W-40 MOTOR OIL**(AVAILABLE ONLY IN NORTH AMERICA AND SELECT GEOGRAPHIES)**

PETRO-CANADA SUPREME EU-X synthetic 5W-40 is a premium European synthetic motor oil designed to help provide long engine life by lubricating critical parts effectively.

PETRO-CANADA SUPREME EU-X synthetic 5W-40 motor oil meets ACEA A3/B4-16 and is also suitable for use where API SN is specified. It is also suitable for use in vehicles which specify the following OEM specifications:

- BMW LL-01
- MB 229.3 / 229.5
- Opel GM-LL-B-025
- Peugeot PSA B71 2296
- Porsche A40
- Renault RN0700 / RN0710
- Volkswagen 502 00 / 505 00

PETRO-CANADA SUPREME EU-X Synthetic 5W-40 Motor Oil	
SAE Grade	5W-40
Viscosity cSt @ 40°C	83.2
cSt @ 100°C	13.6
Viscosity Index	167
Flash Point, COC, °C/°F	217 / 422
Cold Crank Viscosity, cP @ °C	5600 @ -30
Borderline Pumping Viscosity, cP @ °C	31000 @ -35
Sulphated Ash, % Wt	1.2
Base Number (D2896), mg KOH/g	10.0
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	3.8



SUPREME™ C3-X SYNTHETIC 5W-40 MOTOR OIL

(AVAILABLE ONLY IN EUROPE AND OTHER SELECT GEOGRAPHIES)

SUPREME C3-X synthetic 5W-40 is a fuel saving synthetic motor oil that is produced with high quality synthetic base oils and an advanced additive system. This full synthetic motor oil provides excellent low temperature fluidity, resistance to high temperature lubricant breakdown, longer oil life, lower oil consumption and outstanding wear protection.

It exceeds the ACEA C3 requirements for gasoline and light duty diesel engines.

SUPREME C3-X synthetic 5W-40 meets VW standards 502 00, 505 00 and 505 01. It also meets the requirements of Mercedes-Benz 229.51, BMW LL-04, Porsche A40 and Ford M2C917-A.

SUPREME C3-X Synthetic 5W-40	
SAE Grade	5W-40
Viscosity cSt @ 40°C	82.8
cSt @ 100°C	14.0
Viscosity Index	175
Flash Point, COC, °C/°F	233/451
Cold Crank Viscosity, cP @ °C	5,050 @-30
Borderline Pumping Viscosity, cP @ °C	33,270 @-35
Sulphated Ash, % Wt	0.8
Base Number (D2896), mg KOH/g	7.7
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	3.6

Contact your sales manager to see if this fluid is available in your geography.



SUPREME™ C3 SYNTHETIC 5W-30 MOTOR OIL

(AVAILABLE ONLY IN EUROPE AND OTHER SELECT GEOGRAPHIES)

SUPREME C3 synthetic 5W-30 motor oil is designed to lubricate gasoline and light duty diesel engines with after-treatment systems; gasoline catalytic converters and diesel particulate filters (DPFs). This fully synthetic motor oil is formulated for European passenger cars, sport utility vehicles, vans and light duty trucks. With today's high-powered engines, SUPREME C3 synthetic 5W-30 motor oil can provide long engine life through enhanced lubrication and protection of critical engine parts. It is specially formulated to protect after-treatment systems and achieve a minimum high-temperature high-shear (HTHS) viscosity of 3.5 cP. HTHS is an indicator of the oil film thickness that will protect the engine from wear at high temperature in the narrow confines between fast moving parts in an engine. SUPREME C3 synthetic 5W-30, meeting ACEA C3 and API SN, offers better wear protection and deposit control under severe high-speed operations while providing excellent fuel economy performance.

SUPREME C3 Synthetic 5W-30	
SAE Grade	5W-30
Viscosity cSt @ 40°C	71.3
cSt @ 100°C	11.9
Viscosity Index	164
Flash Point, COC, °C/°F	235/455
Cold Crank Viscosity, cP @ °C	5500 @ -30
Borderline Pumping Viscosity, cP @ °C	19600 @ -35
Sulphated Ash, % Wt	0.8
Total Base No. (TBN), mgKOH/g	6.7
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	3.5

SUPREME™ C3-X SYNTHETIC 5W-30 MOTOR OIL

SUPREME C3-X synthetic 5W-30 is a top tier “Mid SAPS” motor oil designed to lubricate demanding, high-performance, gasoline and light duty diesel engines and protect their emission systems. This full synthetic motor oil is specially formulated with advanced additive technology for today’s modern passenger cars, sport utility vehicles, vans and light duty trucks. SUPREME C3-X synthetic 5W-30 premium motor oil offers exceptional all-round performance with outstanding wear protection and deposit control under severe high-speed, high-temperature operations while promoting lower fuel consumption and long engine life through balanced lubrication and protection of your engines critical parts. It exceeds the requirements of ACEA C3 and API SN. The formulation is also approved against select European OEM specifications: VW 504 00 / 507 00, MB-Approval 229.51 and Porsche C30. Meets the requirements of BMW LL-04.

SUPREME C3-X Synthetic	
SAE Grade	5W-30
Viscosity cSt @ 40°C	66.4
cSt @ 100°C	11.7
Viscosity Index	172
Flash Point, COC, °C/°F	229/444
Cold Crank Viscosity, cP @ °C	5,900 @ -30
Borderline Pumping Viscosity, cP @ °C	16,400 @ -35
Sulphated Ash, % Wt	0.8
Total Base No. (TBN), mgKOH/g	7.8
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	3.5



PETRO-CANADA SUPREME™ SYNTHETIC HYBRID MOTOR OILS

PETRO-CANADA SUPREME Synthetic Hybrid 0W-16 and 0W-20 are formulated to meet the needs of hybrid engines. The internal combustion (IC) engine in a hybrid vehicle will experience significantly more start-ups than a regular internal combustion engine. Engine start-up is the time in an engine's cycle where the most wear can occur. SUPREME Synthetic Hybrid motor oils provide exceptional lubrication of critical engine parts and protection of the latest gasoline direct injection IC engine emission control systems and turbochargers. SUPREME Synthetic Hybrid motor oils exceed the API Service Classification for gasoline service, API SP and SP Resource Conserving. SUPREME Synthetic Hybrid also exceeds the requirements of ILSAC GF-6A (0W-20) and ILSAC GF-6B (0W-16). The SAE 0W-20 grade is also approved against the GM dexos® 1 Gen 3 global specification.

Typical characteristics are shown below:

SUPREME Synthetic Hybrid		
SAE Grade	0W-16	0W-20
Viscosity cSt @ 40°C	40.6	44.3
	cSt @ 100°C	7.8 8.3
Viscosity Index	164	166
Flash Point, COC, °C/°F	232/450	232/450
Cold Cranking Viscosity, cP @ °C	5300 @ -35	5500 @ -35
Borderline Pumping Viscosity, cP @ °C	14,600 @ -40	17,400 @ -40
Sulphated Ash, % Wt.	0.92	0.87
Base Number, (D2896), mg KOH/g	8	8
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	2.4	2.6

PETRO-CANADA SUPREME™ HIGH MILEAGE
MOTOR OILS

SUPREME High Mileage 5W-20, 5W-30, 10W-30 and Synthetic 0W-20 motor oils are specifically designed with REGEN Technology to meet the needs of vehicles with higher mileage. They are specially designed to reduce sludge deposit build-up that has been accumulating in the engine and to improve ring sealing in the piston-liner interface. Continuous use will help maintain engine cleanliness and support a reduction in engine blow-by. This combination assists in providing more power for the driver. SUPREME High Mileage motor oils with REGEN Technology protect vital engine components and aid its performance as the miles add on.

SUPREME High Mileage motor oils are formulated to exceed the API Service Classification for gasoline service, API SP and SP Resource Conserving, and the ILSAC GF-6A specification.

Typical characteristics are shown below:

SUPREME HIGH MILEAGE				
SAE Grade	0W-20	5W-20	5W-30	10W-30
Viscosity cSt @ 40°C	45.8	50.0	66.3	68.1
cSt @ 100°C	8.5	8.6	11.1	10.5
Viscosity Index	166	150	161	141
Flash Point, COC, °C/°F	235/455	233/451	237/459	237/459
Cold Cranking Viscosity, cP @ °C	5,600 @ -35	5500 @ -30	5800 @ -30	5300 @ -25
Borderline Pumping Viscosity, cP @ °C	18000 @ -40	15000 @ -35	19000 @ -35	16000 @ -30
Sulphated Ash, % Wt.	0.72	0.85	0.72	0.81
Base Number, (D2896), mg KOH/g	7	7	7	7
High-Temperature High-Shear (HTHS) Viscosity, cP @ 150°C	2.7	2.7	3.2	3.1



HEAVY-DUTY DIESEL ENGINE OILS

Commercial and Industrial requirements for heavy-duty engine oils continue to stress higher levels of turbocharging, higher operating temperatures, and power outputs, and demand the use of ultra low sulfur diesel fuel for highway fleet operations. U.S. EPA regulations require heavy-duty diesel engine manufacturers to reduce NOx emissions via modification of their engine and emissions system designs. Exhaust Gas Recirculation (EGR) for example has resulted in a considerable increase in the soot loading of engine oils. 2007 EPA compliant low emission engines have adopted advanced exhaust after-treatment devices such as Diesel Particulate Filters (DPF) with or without Diesel Oxidation Catalysts (DOC), and increased rates of EGR. In addition to these technologies, the 2010 EPA compliant low emissions engines now include emissions systems using Selective Catalytic Reduction (SCR). These regulations resulted in an improvement in quality and performance of diesel engine oils using high performance base oils and additives to create superior products that increase equipment reliability and reduce downtime.

DURON™ ENGINE OILS

The DURON line of premium quality, Heavy-Duty Diesel Engine Oils are designed to improve engine reliability and reduce operating costs through its better engine protection, fuel economy potential and extended drain capabilities. The DURON product line (API CK-4 and FA-4) is formulated to meet the challenges of current low emission engines including the latest EPA standards. DURON multigrades exceed API CK-4 standards required in many on-road and off-road engines and is fully back serviceable to the API CJ-4, CI-4 Plus, CI-4, and CH-4 as required by pre-'07 diesel engines (CJ-4, CI-4, etc), while the monogrades are suitable where former API categories CF or CF-2 are recommended.

DURON Heavy-Duty Diesel Engine Oils may be used in engines fueled by diesel, gasoline, and propane, and in some natural gas (CNG) applications. This allows the selection of one engine oil for a mixed-fuel fleet, which meets most manufacturers' warranty requirements.

DURON Heavy-Duty Diesel Engine Oils are suitable for use in engines powered by both ultra low and low sulfur diesel. DURON is formulated to the highest API diesel and gasoline performance standards for 4-stroke engine oils and is suitable for use in extended oil drain service.

DURON ENGINE OILS (API CK-4)

DURON multigrade engine oils are premium heavy-duty diesel engine oils that exceed the requirements of API CK-4 and are back serviceable to the API CJ-4, CI-4 Plus, CI-4, and CH-4 as required by pre-'07 diesel engines (API CJ-4, CI-4, etc...). They are suitable for use in current EPA compliant low emission engines which employ advanced exhaust aftertreatment devices such as Diesel Particulate Filters (DPF), Diesel Oxidation Catalysts (DOC), Selective Catalytic Reductions (SCR) and increased rates of Exhaust Gas Recirculation (EGR).

DURON™ is available in multiple performance offerings as shown below. These engine oils have undergone rigorous engine testing and have demonstrated extended drain capabilities in severe service field trials in both new and older engine designs. DURON is formulated to meet the latest OEM specifications for current low emission engines equipped with advanced exhaust aftertreatment devices.

DURON HP 15W-40 High Performance heavy-duty diesel engine oil that delivers all weather engine protection including dependable cold start up and exceptional shear stability.

DURON SHP 15W-40 Super High Performance synthetic blend heavy-duty diesel engine oil that delivers exceptional performance and outstanding shear stability that helps deliver comprehensive protection to vital engine parts over a wide range of operating conditions.

DURON SHP 10W-30 Super High Performance synthetic blend heavy-duty diesel engine oil that delivers advanced engine protection and all-weather performance. It provides optimal engine durability and can deliver up to 1%* fuel economy improvements.

DURON UHP 10W-40 Ultra High Performance synthetic all-weather heavy-duty diesel engine oil. It is designed to provide exceptional protection against engine wear and extended drain performance (exceeding OEM standard intervals)[†] even in the harshest operating conditions and maximum allowable load conditions.

DURON UHP 5W-40 Ultra High Performance full synthetic heavy-duty diesel engine oil that provides excellent protection and performance, especially in extreme temperature environments.

DURON UHP 5W-30 Ultra High Performance full synthetic heavy-duty diesel engine oil is formulated with synthetic base oils and high performance additives to provide fuel economy benefits, exceptional protection against engine wear and extended drain performance (exceeding OEM standard intervals)[†] even in severe operating conditions.

DURON UHP 0W-30 Ultra High Performance full synthetic heavy-duty diesel engine oil with unique additives and high quality synthetic base oils to deliver ultimate protection in extreme temperature conditions.

DURON UHP 0W-40 Ultra High Performance full synthetic heavy-duty diesel engine oil specially formulated with a unique high performance additive system in combination with high quality synthetic base oils to deliver ultimate protection in extreme temperature conditions.

* Comparing 15W-40 with 4.1cP HTHS vs 10W-30 with 3.5cP HTHS.

[†] Extending drain intervals should always be undertaken in conjunction with an oil analysis program with guidance from a Technical Services Advisor.



DURON™				
SAE Grade	HP 15W-40	SHP 15W-40	SHP 10W-30	
Viscosity cSt @ 40°C	118	114	80.1	
cSt @ 100°C	15.6	15.4	12.0	
Viscosity Index	139	142	145	
Flash Point, COC, °C/°F	228/442	226/439	220/428	
High Temp/High Shear Viscosity, cP @ 150°C	4.1	4.1	3.5	
Cold Crank Viscosity, cP @ °C/°F	5540 (-20/-4)	5000 (-20/-4)	5570 (-25/-13)	
Pour Point, °C/°F	-36/-33	-36/-33	-42/-44	
Borderline Pumping Viscosity, cP @ °C/°F	21350 (-25/-13)	19880 (-25/-13)	18160 (-30/-22)	
Sulphated Ash, % Wt	1.0	1.0	1.0	
Base Number (D2896), mg KOH/g	9.8	9.8	10.0	

DURON					
SAE Grade	UHP 10W-40	UHP 5W-40	UHP 5W-30	UHP 0W-30	UHP 0W-40
Viscosity cSt @ 40°C	107	88.6	70.3	65.2	82
cSt @ 100°C	15.5	14.3	11.6	11.5	14.5
Viscosity Index	157	168	158	173	180
Flash Point, COC, °C/°F	229/444	235/450	215/418	220/428	224/435
High Temp/High Shear Viscosity, cP @ 150°C	4.1	3.8	3.5	3.4	3.9
Cold Crank Viscosity, cP @ °C/°F	5930 (-25/-13)	6290 (-30/-22)	6200 (-30/-22)	5400 (-35/-31)	5900 (-35/-31)
Pour Point, °C/°F	-42/-44	-45/-49	-42/-44	-45/-49	-45/-49
Borderline Pumping Viscosity, cP @ °C/°F	27450 (-30/-22)	24780 (-35/-31)	21300 (-35/-31)	19600 (-40/-40)	28300 (-40/-40)
Sulphated Ash, % Wt	1.0	<1.0	1.0	1.0	1.0
Base Number (D2896), mg KOH/g	10.0	11.0	11.0	9.7	9.5

For DURON Performance Specifications, Refer to Table (see pages 88 and 89).

DURON™ ADVANCED DIESEL ENGINE OIL (API FA-4)

DURON ADVANCED premium performance synthetic and synthetic blend diesel engine oils deliver industry leading durability against wear in technologically advanced engines and are formulated to exceed API FA-4 requirements. They are suitable for use in 2017 and future engines which specify the use of an API FA-4 oil.

DURON ADVANCED (and all API FA-4 oils) have limited backwards compatibility with older engines as these oils are specifically engineered for newer engines designed to meet legislation around emissions and fuel economy. They are characterized by having a lower high temperature high shear (HTHS) viscosity, meaning they cause less friction and viscous drag in the engine and enable reduced fuel consumption, while still offering increased levels of wear protection. DURON ADVANCED provides additional fuel savings over CK-4 of the same grade, up to 1%*.

Typical characteristics are shown below:

DURON ADVANCED		
SAE Grade	10W-30	5W-30
Viscosity cSt @ 40°C	66.2	56.3
cSt @ 100°C	10.3	9.96
Viscosity Index	143	165
Flash Point, COC, °C/°F	227/440	217/422
Pour Point, °C/°F	-42 / -44	-39 / -38
High Temp/High Shear Viscosity cP@150°C	3.1	3.1
Cold Crank Viscosity cP @ °C/°F	4,900 (-25 / -13)	5,160 (-30 / -22)
Borderline Pumping Viscosity cP @ °C/°F	13,100 (-30 / -22)	19,700 (-35 / -30)
Sulphated Ash, % Wt	1.0	1.0
Base Number (D2896), mg KOH/g	10.0	11.8

For DURON Performance Specifications, Refer to Table (see page 88)

*Comparing a typical CK-4 SAE 10W-30 with 3.5cP HTHS vs a 10W-30 with 3.1cP HTHS.



DURON™ MONOGRADE ENGINE OILS

Petro-Canada Lubricants DURON Monograde Engine Oils meet the performance requirements of the former API categories CF and CF-2. They can be used in older diesel or gasoline engines needing a single viscosity grade engine oil that specifies API CF or CF-2 level of performance. They may also be used in many stationary and marine applications, where automotive diesel fuel is used.

DURON Monograde Engine Oils are available in four SAE grades: 10W, 30, 40, and 50.

Typical characteristics are shown below:

DURON Monograde				
SAE Grade	10W	30	40	50
Viscosity cSt @ 40°C	40.4	91.6	133	206
cSt @ 100°C	6.7	11.2	14.4	19.1
Viscosity Index	124	110	107	105
Flash Point, COC, °C/°F	211/412	249/480	223/433	259/498
Pour Point, °C/°F	-33/-27	-30/-22	-27/-16	-21/-6
Cold Crank Viscosity, cP @ °C	3,640@-25	—	—	—
Phosphorus, % Wt	0.12	0.12	0.12	0.12
Sulfur, % Wt	<0.35	<0.35	<0.35	<0.35
Sulphated Ash, % Wt	1.0	1.0	1.0	1.0
Base Number (D2896), mg KOH/g	8.6	8.0	8.4	8.7

- DURON Monogrades can be used in transmissions, where this type of engine oil is specified.
- DURON Monogrades can function as excellent hydraulic fluids for mobile equipment, where an engine oil is specified.
- DURON 30 & 40 are suitable for use in the following medium and high-speed marine engines, fueled by diesel or gasoline (where water separation is not required): Allis-Chalmers, B&W/Alpha, Buda, Caterpillar, Chrysler, Cummins, Daihatsu, John Deere, Detroit Diesel 2-stroke engines, Deutz, Dorman, English Electric, Fairbanks-Morse, Ford, Gardener, Hatz, Intrepid, Isuzu, Mack, MAN, Mitsubishi, Moteurs Baudouin, MTU, Murphy, Nissan, Nohab, Onan, Paxman, Ruston, Stork/Werkspoor, Volvo, Wartsilla/Wichman, Waukesha/Scania, White, and Yanmar.

DURON™ UHP E6 ENGINE OILS

DURON UHP E6 10W-40 and 5W-30 are high quality Ultra High Performance low SAPS and low viscosity diesel engine oils specifically designed to outperform ACEA E6 requirements (as well as E4, E7 and E9). DURON UHP E6 10W-40 and 5W-30 have a full complement of OEM approvals far exceeding major OEM requirements and they provide excellent engine protection in tough environments. They also help to provide longer engine life, extended oil drain intervals[†], and excellent all weather performance in many applications.

Assessed within a controlled environment designed to reflect real world use, DURON UHP E6 5W-30 was found to offer up to 2.34%* improvement in fuel efficiency and emission reduction.

[†] Extending drain intervals should always be undertaken in conjunction with a regular oil analysis program with guidance from a Technical Services Advisor.
* Comparing SAE 5W-30 with 10W-40. Fuel economy improvements for lower viscosity engine oils will vary and may be affected by numerous external factors including, but not limited to: condition of the vehicle, driver habits, driving terrain, weather conditions, tire pressure and severity of operating conditions.

Typical characteristics are shown below:

	DURON UHP E6	DURON UHP E6
	10W-40	5W-30
Viscosity cSt @ 40°C	95.8	69.4
cSt @ 100°C	14.4	11.8
Viscosity Index	156	167
Pour Point, °C/°F	-42/-44	-45/-49
High Temp/High Shear Viscosity, cP @ 150°C	4.1	3.5
Flash Point, COC, °C/°F	223/433	217/423
Cold Cranking Viscosity, cP @ °C/°F	6,400 (-25 / -13)	5,930 (-30 / -22)
Borderline Pumping Viscosity, cP @ °C/°F	18,290 (-30 / -22)	18,100 (-35 / -30)
Base Number (D2896), mg KOH/g	13.1	13.0
Sulphated Ash, % Wt	1.0	1.0



DURON™ SHP E6 10W-40 (ONLY AVAILABLE IN EUROPE)

DURON SHP E6 10W-40 is a Super High Performance Diesel engine oil specifically designed to meet ACEA E6 requirements and protect engines in severe conditions. With a suite of industry and OEM approvals, DURON SHP E6 10W-40 provides strong engine protection, long engine life, extended oil drain intervals, all weather performance and better operating efficiency for many on-road and off-road applications.

DURON SHP E6 10W-40	
Viscosity, cSt @ 40°C	100.2
cSt @ 100°C	14.9
Viscosity Index	155
Pour Point, °C/°F	-39/-38
High Temp/High Shear Viscosity, cP @ 150°C	4.1
Flash Point, COC, °C/°F	244/471
Cold Cranking Viscosity, cP @ °C/°F	5,970 (-25 / -13)
Borderline Pumping Viscosity, cP @ °C/°F	17,300 (-30 / -22)
Base Number (D2896), mg KOH/g	10.6
Sulphated Ash, % Wt	1.0

HEAVY-DUTY DIESEL ENGINE OIL RECOMMENDED APPLICATIONS						
Approvals	DURON UHP E6 10W-40		DURON UHP E6 5W-30		DURON SHP E6 10W-40	
ACEA	✓	E4, E6, E7, E9	✓	E4, E6, E7, E9	✓	E6, E7, E9
API	★	CJ-4 / SN	★	CJ-4 / SN	✓	CI-4
Caterpillar	✓	ECF-3	✓	ECF-3		
Cummins	★	CES 20081	★	CES 20081	●	CES 20077
DAF	✓	Standard and Extended Drain	✓	Standard and Extended Drain	✓	Standard and Extended Drain
Detroit Diesel	★	DFS 93K218	★	DFS 93K218		
Deutz	★	DQC IV-10 LA	★	DQC IV-10 LA	★	DQC IV-10 LA
Mack	★	EO-0 PP '07	★	EO-0 PP '07	★	EO-N
MAN	●	3477, 3271-1	★	3677, 3271-1, 3477	●	3477, 3271-1
			●	3691		
Mercedes-Benz	★	228.51	★	228.51	★	228.51
	●	228.31	●	228.31	●	228.31
MTU	★	Type 3.1	★	Type 3.1	★	Type 3.1
Renault	★	RLD-3	★	RLD-3	★	RLD-2
Scania	★	LA*	★	LDF-4*		
Volvo	★	VDS-4	★	VDS-4	★	VDS-3

★ Approved ● Suitable For Use ✓ Meets Specifications

* Technical confirmation of meeting performance requirements received from Scania.

DURON™ CLASSIC**(ONLY AVAILABLE IN SELECT GEOGRAPHIES*)**

DURON CLASSIC engine oils are premium multigrade heavy-duty engine oils recommended for engines fueled by diesel, gasoline, propane, or compressed natural gas (CNG), where applications specify API CH-4 / SJ, operating on-highway or off highway in transportation, mining, forestry, construction, farm, and marine applications.

DURON CLASSIC is designed to meet the needs of 1998 emission standards using low sulphur fuel (up to 0.5% sulphur content).

Available in both SAE 15W-40 and 20W-50 grades.

DURON PLUS**(ONLY AVAILABLE IN CHINA)**

DURON PLUS engine oils are premium multigrade heavy-duty engine oils recommended for engines where applications specify API CI-4/SL performance level or earlier. Suitable for on-highway or off-highway operations. DURON PLUS is designed to meet the needs of 2004 emission standards using low sulphur fuel (up to 0.05% / 500ppm sulphur content).

Available in SAE 15W-40, 10W-40 and 20W-50 grades.

Typical characteristics are shown below:

	DURON CLASSIC		DURON PLUS		
	15W-40	20W-50	15W-40	10W-40	20W-50
Viscosity, cSt @ 40°C	110	171	117	96.5	178
cSt @ 100°C	15.4	19.2	15.4	14.2	19.2
Viscosity Index	149	128	138	150	123
Pour Point, °C/°F	-42/-44	-36/-33	-39/-38	-42/-44	-33/-27
High Temp/High Shear Viscosity, cP @ 150°C	4.1	5.0	4.0	3.7	4.8
Flash Point, COC, °C/°F	240/464	258/496	233/452	227/440	238/456
Cold Cranking Viscosity, cP @ °C/°F	6,000 @ -20 / -4	6,860 @ -15 / 5	5,407 @ -20 / -4	6,871 @ -25 / -13	7,579 @ -15 / 5
Base Number (D2896), mg KOH/g	9.0	9.0	11.2	11.1	10.9

* Check with a Sales Account Manager for availability.



DURON™ EXTRA

(ONLY AVAILABLE IN SELECT GEOGRAPHIES*)

DURON EXTRA is formulated to exceed API CJ-4/SN requirements and provides excellent engine protection. It is fully back-serviceable to the API CI-4 Plus, CI-4, and CH-4 as required by pre-'07 diesel engines. It also demonstrates excellent all-weather performance including dependable cold start-up performance and exceptional shear stability, minimizes engine wear and oil consumption. It has demonstrated extended drain capabilities (exceeding OEM standard intervals)** while subjected to tough service conditions. DURON EXTRA is designed to meet 2007 and 2010 on-road exhaust emission standards as well as previous, fuels with up to 500ppm sulphur content. DURON EXTRA 15W-40 is API CJ-4/SN licensed.

Typical characteristics are shown below:

DURON EXTRA		
	15W-40	20W-50
Viscosity, cSt @ 40°C	118	173
cSt @ 100°C	15.6	19.7
Viscosity Index	139	131
Pour Point, °C/°F	-36/-33	-33/-27
High Temp/High Shear Viscosity, cP @ 150°C	4.1	5.0
Flash Point, COC, °C/°F	228/442	231/448
Cold Cranking Viscosity, cP @ °C/°F	6,500 @ -20 / -4	6,400 @ -15 / 5
Base Number (D2896), mg KOH/g	9.8	9.8

* Check with a Sales Account Manager for availability.

** Extending drain intervals should always be undertaken in conjunction with an oil analysis program with guidance from a Technical Services Advisor.

PETRO-CANADA LUBRICANTS HDEO RECOMMENDED APPLICATIONS

Approvals	DURON™ HP 15W-40	DURON SHP 15W-40	DURON SHP 10W-30	DURON UHP 10W-40	DURON™ UHP 5W-30
	✓ E7, E9	✓ E7, E9	✓ E7, E9	✓ E7, E9	✓ E7, E9
	★ CK-4 / SN	★ CK-4 / SN	★ CK-4 SN*	★ CK-4 / SN	★ CK-4 SN*
					
	• ECF-3, TO-2	• ECF-3, TO-2	• ECF-3, TO-2	• ECF-3, TO-2	✓ ECF-3
	★ CES 20086	★ CES 20086	★ CES 20086	★ CES 20086	★ CES 20086
	✓ Standard Drain	✓ Standard Drain	• Standard Drain	✓ Standard Drain	• Standard Drain
	★ DFS 93K222	★ DFS 93K222	★ DFS 93K222	★ DFS 93K222	★ DFS 93K222
	★ DQC III-18 LA	★ DQC III-18 LA		★ DQC III-18 LA	
	★ WSS-M2C171-F1	★ WSS-M2C171-F1	★ WSS-M2C171-F1	★ WSS-M2C171-F1	★ WSS-M2C171-F1
	• 9985930	• 9985930	• 9985930	• 9985930	
JASO	• MA2, DH-1, DH-2	• MA2, DH-1, DH-2	• MA2, DH-1, DH-2	• MA2, DH-1, DH-2	
	★ EOS-4.5	★ EOS-4.5	★ EOS-4.5	★ EOS-4.5	★ EOS-4.5
	• 3575, 3275-1	• 3575, 3275-1			
	★ 228.31	★ 228.31	★ 228.31		
	★ Type 2.1	★ Type 2.1			
	★ RLD-3	★ RLD-3	★ RLD-3	★ RLD-3	★ RLD-3
	★ VDS-4.5	★ VDS-4.5	★ VDS-4.5	★ VDS-4.5	★ VDS-4.5

* Use of a diesel engine oil for gasoline applications may compromise the life of the emissions device.
Please refer to the owner's manual to ensure proper oil is used.



★ Approved • Suitable For Use ✓ Meets Specifications

DURON UHP 5W-40		DURON UHP 0W-30		DURON UHP 0W-40		DURON ADVANCED 10W-30		DURON ADVANCED 5W-30	
★	CK-4 / SN	•	CK-4 / SN	•	CK-4 / SN	★	FA-4	★	FA-4
★	TES 439								
•	ECF-3, TO-2	•	ECF-3, TO-2	•	ECF-3, TO-2				
★	CES 20086	•	CES 20086	•	CES 20086	★	CES 20087	★	CES 20087
★	DFS 93K222					★	DFS 93K223	★	DFS 93K223
★	WSS- M2C171-F1					✓	WSS- M2C214-B1	✓	WSS- M2C214-B1
•	MA2, DH-1, DH-2	•	MA2	•	MA2				
★	EOS-4.5								
★	RLD-3								
★	VDS-4.5								

* Use of a diesel engine oil for gasoline applications may compromise the life of the emissions device.
Please refer to the owner's manual to ensure proper oil is used.

DURON™ GEO LD

DURON GEO Long Drain (LD) natural gas mobile engine oils deliver superior engine protection and extended drain* capabilities for Compressed Natural Gas/ Liquefied Natural Gas (CNG/LNG) engines in mobile applications. With suitability in both heavy-duty diesel and gasoline engines, DURON GEO LD is an ideal choice for ultimate protection in mixed fleets.

Specifically designed for extended drain intervals up to 1000 hours* while protecting critical engine parts, DURON GEO LD can help minimize downtime and service costs by keeping fleets on the road longer.

DURON GEO LD 15W-40 and 10W-30 are recommended for use primarily where oils meeting Cummins CES 20092 specified. It is fully backserviceable to CES 20085 specifications. DURON GEO LD oils are also API Service CK-4/SN licensed and approved by other major diesel engine OEMs like Detroit Diesel, Mack, Volvo and Renault.






Typical characteristics are shown below:

	DURON GEO LD	
	15W-40	10W-30
Viscosity cSt @ 40°C	117	85.4
cSt @ 100°C	15.1	12.4
Flash Point, COC, °C/°F	225/437	221/430
Pour Point, °C/°F	-39/-38	-45/-49
Cold Cranking Viscosity, cP @ °C/°F	6,480 (-20 / -4)	6,610 (-25 / -13)
Borderline Pumping Viscosity cP @ °C/°F	19,280 (-25 / -13)	18,390 (-30 / -22)
Base Number (BN), mg KOH/g	10	10
Sulphated Ash, % Wt	0.9	0.9

* Extending drain intervals should always be undertaken in conjunction with an oil analysis program with guidance from a Technical Services Advisor. Refer to owner's manual or operations and maintenance manual for complete information.



APPROVALS AND RECOMMENDATIONS

Approvals		DURON™ GEO LD 15W-40		DURON GEO LD 10W-30
 ACEA	✓	E7, E9	✓	E7, E9
 AMERICAN PETROLEUM INSTITUTE	★	CK-4/SN	★	CK-4/SN
 CAT®	✓	ECF-3, T0-2	✓	ECF-3, T0-2
 Cummins	★	CES 20092, CES 20086	★	CES 20092, CES 20086
 DETROIT DIESEL	★	DFS 93K222	★	DFS 93K222
JASO	•	DH-2	•	DH-2
 MACK	★	EOS-4.5	★	EOS-4.5
 Mercedes-Benz	✓	228.31		
 mtu	✓	9985930		
 HINO TRUCKS	★	RLD-4	★	RLD-4
 VOLVO	★	VDS-4.5	★	VDS-4.5

LOCOMOTIVE DIESEL ENGINE OIL

The railroad industry is tough, and you need a strong lubricants partner who really understands this business. Their RGO locomotive engine oils have been built over a century-long legacy of rail industry expertise. As engines have evolved, becoming even stronger and more powerful, so have Red Giant Oil products. We have focused on this sector, developing engine oils that are as reliable as our commitment to this industry.

Today, Red Giant Oil engine oils are still going strong. They continue to keep all types of locomotive engines moving every day, in rail companies large and small, from short line railroads to Class I railroads, from yard switching to precision railroading across North America.

Locomotive diesel engine oils are designed to lubricate large medium-speed diesel engines driving railroad locomotives, marine vessels and electric-power generators. These locomotive engine oils are ashless-dispersant, non-zinc, non-chlorinated oils developed to meet the demands of modern railroad, stationary power generation, and marine heavy-duty diesel engines. They are zinc-free for compatibility with silver plated or silver alloy engine components. These oils have been tested and approved in railroad service, in close co-operation with the major locomotive engine builders such as Progress Rail (formerly EMD) and Wabtec (formerly GE).

Red Giant Locomotive Engine Oil 20W-40 G7 is a multi-grade, 11 TBN, LMOA Generation 7 level engine oil. It is approved by Progress Rail (formerly EMD) and Wabtec (formerly GE).

RALUBE™ 40 CFS is an SAE 40 grade, 14 Base Number premium quality crankcase oil, formulated for severe service in diesel locomotive engines, driving railroad locomotives, marine vessels and electric power generators. RALUBE 40 CFS is suitable for use for Progress Rail (formerly EMD), Wabtec (formerly GE), 2-cycle Detroit Diesel engines, including Series 149, and where LMOA Gen 5 is required.

Typical characteristics are shown below:

	RALUBE	RED GIANT LOCOMOTIVE ENGINE OIL
	40 CFS	20W-40 G7
SAE Grade	40	20W-40
Viscosity cSt @ 40°C	142	144
cSt @ 100°C	14.8	15.4
Viscosity Index	104	110
Flash Point, COC, °C/°F	267/513	258/496
Pour Point, °C/°F	-27/-17	-27/-17
Sulphated Ash, % Wt	1.5	1.12
Base Number (D2896), mg KOH/g	14	11



POWER TRANSMISSION & DRIVETRAIN

Power Transmission Fluids (PTFs) are among the most complex lubricants on the market today. The drive for fuel efficiency has resulted in three main automatic transmissions types for light-duty applications; planetary (stepped) transmission, continuously variable transmission (CVT) and dual-clutch transmission (DCT). The transmission hardware diversification lead to different fluids specifically designed to successfully lubricate the wide variety of transmissions. Containing many additive components, PTFs represent a careful balance of properties needed to meet the unique requirements of transmissions. They may be described as viscometrically similar to SAE 0W-20 grade oils, but with exceptionally good low temperature properties. PTFs contain some of the same additives as engine oils, but have additional components to give special frictional properties, shear stability and exceptional oxidation resistance. Their excellent low temperature fluidity and antiwear properties enable PTFs to perform well as hydraulic fluids in industrial equipment, provided that water separation is not required.

These fluids perform five basic functions:

- Transmit hydrodynamic energy in the torque converter, wet start clutch or dual clutch module.
- Transmit hydrostatic energy in hydraulic logic control circuits and servomechanisms.
- Lubricate shaft bearings, thrust bearings, gears, belt/pulleys (CVTs), synchronizers (DCTs).
- Transmit sliding friction energy in bands/clutches and belt/pulleys systems.
- Act as a heat transfer medium controlling transmission operating temperatures.

Conventional planetary stepped automatic transmission fluid specifications are in a state of flux and now there are several types of fluids specified for North American automatic transmissions. For General Motors' transmissions of 2006 model year and onward, the required fluid is DEXRON®-VI or DEXRON®-HP. For late model vehicles (prior to 2006) DEXRON®-III/ MERCON® type ATF, a friction modified fluid is recommended for transmission top-up or refill by many automobile manufacturers.

Ford Motor Company requires all its automatic transmissions to be serviced with MERCON® V, MERCON® SP or MERCON® LV fluid. Ford Type F, a non friction-modified fluid, is still used for 1979 and earlier Ford or other older import cars.

General Motors and Ford Motor Company are now recommending Ultra Low Viscosity (ULV) ATF in select vehicle models with their jointly developed 10 speed (and in some cases their 9 speed) automatic transmissions. The shift towards lower viscosity fluids, such as DEXRON®-VI, MERCON® LV and now ULV ATF is intended to gain improvements in fuel economy.

Stellantis (formerly FCA US LLC) recommends ATF+4® fluid be used in most of their transmissions for all model years.

Continuously variable transmission (CVT) and dual-clutch transmission (DCT) hardware require specifically formulated fluids. Petro-Canada Lubricants offers multi-vehicle CVT and DCT fluids with proven laboratory tests and field performance supporting the applications and claims.

The market fragmentation has led to increasing acceptance of multi-vehicle service fill PTFs. Please consult one of our representatives for an official PTF recommendation.

DEXRON® is a registered trademark of General Motors LLC. MERCON® is a registered trademark of Ford Motor Company.

PETRO-CANADA DEXRON®-VI ATF AUTOMATIC TRANSMISSION FLUID

Petro-Canada DEXRON®-VI is an exceptional automatic transmission fluid approved by General Motors (GM) for use in vehicles with GM automatic transmissions. This unique fluid is specially formulated to provide twice the service life of a DEXRON®-III (H) ATF and offers enhanced performance for both new and older transmissions. It is designed to protect automatic transmissions through improved oxidation resistance, friction durability, shear stability and wear protection to help meet warranty protection requirements in late model vehicles. Designed to provide responsive shift feel throughout the life of the oil, Petro-Canada DEXRON®-VI ATF consistently protects vehicle transmissions longer than all previous DEXRON® type fluids.

Petro-Canada DEXRON®-VI ATF was developed in conjunction with General Motors fluid design criteria for all 2006 and beyond model year vehicles with automatic transmissions requiring the use of fluid meeting the GMW16444 specification. General Motors recommends the use of DEXRON®-VI for many automatic transmissions including those prior to 2006 model year. It is fully back serviceable where the former DEXRON®-III(H), -III(G) and -II(E) specifications were recommended. Petro-Canada DEXRON®-VI is also approved against Mercedes-Benz MB236.41 specification. Petro-Canada DEXRON®-VI ATF is Voith Transmission approved for the 36,000 mile standard drain interval (H55.6335.xx DIWA Service Bulletin 013 and 118, formerly G1363).

Petro-Canada DEXRON®-VI is suitable for use where Volvo specification 97342 is mandated. It is also suitable where Chrysler/Dodge/Jeep vehicles call for Part Number 68043742AA. Note that most Chrysler automatic transmissions require an ATF+4® fluid, also available from Petro-Canada Lubricants.



Typical characteristics are shown below:

DEXRON®-VI ATF		
Viscosity	cSt @ 40°C	29.8
	cSt @ 100°C	6.0
Viscosity Index		151
Brookfield Viscosity, cP @ - 20°C		1,053
	cP @ - 30°C	3,164
	cP @ - 40°C	12,030
Pour Point, °C/°F		-54/-65
Flash Point, COC, °C/°F		206/403
Color		Red

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PETRO-CANADA ATF+4® AUTOMATIC TRANSMISSION FLUID

Petro-Canada ATF+4® is an automatic transmission fluid specially formulated to meet the needs of Stellantis (formerly known as FCA Group LLC) automatic transmissions. This highly shear-stable fluid delivers superior shift performance and wear protection in the Chrysler transmissions for which it was designed. Meets Chrysler MS-9602 specifications. Suitable for top-up or complete fluid changes. It may also be used where earlier Chrysler fluids, such as Chrysler ATF+3® were recommended. Petro-Canada ATF+4® contributes to the overall performance of the transmission by delivering optimized shift efficiency, exceptional oxidation and shear stability and extended drain intervals over ATF+3® fluids.

Typical characteristics are shown below:

PETRO-CANADA ATF+4®		
Viscosity	cSt @ 40°C	33.2
	cSt @ 100°C	7.5
Viscosity Index		204
Brookfield Viscosity, cP @ - 29°C		2,050
	cP @ - 40°C	8,380
Pour Point, °C/°F		-51/-60
Flash Point, COC, °C/°F		198/388
Color		Red

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PETRO-CANADA ATF D3M

Petro-Canada ATF D3M demonstrates outstanding oxidative and thermal stability, giving extremely long service life under severe operating conditions. The fluid's operating range is between -40°C/-40°F and 160°C/320°F. ATF D3M is qualified for use in transmissions where a fluid meeting the former DEXRON®-III(H), -III(G), -II(E), or MERCON® specification is recommended. This would include where the legacy General Motors specification 6297M and Ford specifications M2C166-H or M2C185-A are recommended.

Petro-Canada ATF D3M is designed to meet the severe requirements of the Allison C4 (obsolete) and V-730D specifications for transmission/torque converter fluids. It is approved against the Allison TES-389 Rev. B specification that has replaced Allison C4. Petro-Canada ATF D3M is suitable for use when Caterpillar TO-2 (obsolete), MB 236.1, Ford M2C166H and JASO M315-1A specifications are recommended.

Petro-Canada ATF D3M also acts as an excellent hydraulic fluid with superior antiwear performance when compared to hydraulic fluids or motor oils.

Petro-Canada ATF D3M is superior to 10W motor oils commonly used in mobile equipment hydraulic systems, because it has a better cold starting performance, superior materials compatibility and a greater resistance to oxidation. It may be used in power steering units specifying a DEXRON®-III or II type fluid. It is dyed red for easy identification.

Petro-Canada ATF D3M can be used in General Motors (prior to 2006 and Ford (1980 to 1996) vehicles. It also meets or exceeds the requirements of the following manufacturers where a DEXRON®-III/MERCON® type fluid is recommended.

American Motors	Infiniti	Opel	Suzuki
Audi	Jaguar*	Peugeot	Subaru
BMW	Hyundai/Kia	Porsche	Toyota (except 4-speed 1981-83)
Daewoo	Lexus	Renault	Volkswagen
Daihatsu/Nissan	Mazda	Rover	Volvo (1984 onwards)
Fiat	Mercedes-Benz	Saturn	
Geo	Mitsubishi	Saab (4-speed)	

*Except Borg-Warner transmissions

(The above listings are only a guide. Always consult the vehicle's owner manual and a representative for specific recommendations).

Typical characteristics for Petro-Canada ATFD3M are shown on the following page:

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PETRO-CANADA ATF D3M		
Viscosity	cSt @ 40°C	34.1
	cSt @ 100°C	7.4
Viscosity Index		190
Brookfield Viscosity, cP @ - 20°C		1,100
	cP @ - 30°C	3,370
	cP @ - 40°C	13,280
Pour Point, °C/°F		-54/-65
Flash Point, COC, °C/°F		195/383
Color		Red

DURADRIVE™ MV SYNTHETIC ATF

DURADRIVE MV Synthetic ATF is Petro-Canada Lubricants high viscosity multi-vehicle ATF. This full synthetic formulation offers true multi-vehicle performance, outstanding wear protection, and exceptional fluid life for planetary (stepped) transmissions.

DURADRIVE MV Synthetic ATF provides the frictional properties, wear protection and viscometrics needed by most major North American, Asian, and European automatic transmissions. It is specially formulated to provide consistent shift feel and transmission protection over a long fluid life. DURADRIVE MV Synthetic ATF's benefits include excellent oxidation and shear stability, outstanding wear protection, and exceptional low temperature fluidity. It also provides industry leading anti-shudder durability (ASD) and frictional stability, exceeding the performance of many genuine OEM fluids.

DURADRIVE MV Synthetic ATF is approved for Ford MERCON® V (M5080701) and exceeds JASO 1A requirements. It is fully suitable for use in a wide range of North American, Asian and European automatic transmissions where the following OEM specifications are recommended:

Application	High Viscosity Specification/Vehicle	Low Viscosity Specification/Vehicle
Passenger Car - North American OEM	Ford MERCON® V approved (M5080701)	
	Ford MERCON®	
	Chrysler ATF+3®, MOPAR ASRC	
	Ford FNR5	
	GM DEXRON® -II (IID, IIE) -III (IIIF, IIIG, IIHH)	
	Saturn T-IV Fluid	
Passenger Car - Asian OEM	Aisin Warner JWS 3309 (T-IV) ²	Aisin Warner JWS 3324 (WS) ¹ , AW-1 ¹
		DSIH 6p805 (Geely, Ssangyong, Mahindra 6 sp)
	Honda ATF Z1	Honda DW-1 ¹
	Hyundai/Kia SP-II, SP-III, JWS 3314, JWS 3317	Hyundai/Kia SP-IV ¹ , SPH-IV ¹ , SP-IV RR ¹ , SPIV-M ¹ / SP4-M ¹
		Hyundai NWS-9638 ¹
	JASO 1A	JASO 1A-LV ¹
	Kia Red-1	
	Mazda ATF F-1, ATF M-III, ATF M-V	
	Mitsubishi Diaqueen J2	Mitsubishi Diaqueen J3 ¹ / Diaqueen ATF PA ¹
	Mitsubishi SP-II, SP-III	Mitsubishi SP-IV ¹
	Nissan 402, Nissan Matic D, J, K	Nissan Matic S ¹ , W ¹
	Subaru ATF, ATF-HP	
	Suzuki 3314, 3317	
	Toyota T, T-II, T-III, T-IV ²	Toyota WS (JWS 3324) ¹

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Application	High Viscosity Specification/Vehicle	Low Viscosity Specification/Vehicle
Passenger Car - European OEM	Audi G 052 162, G 052 990, G 055 025	Audi G 055 005 ¹ , G 055 162 ¹ , G 060 162 ¹
	BMW 7045E (3 Series), 8072B (BMW 5 Series), LA 2634, LT 71141	BMW 83 22 0 142 516 ¹ , 83 22 2 152 426 ¹
	Mercedes-Benz MB 236.10 (NAG 1 / Shell 3403), MB 236.1, 236.2, 236.3, 236.5, 236.6, 236.7, 236.9, 236.11, 236.81	Mercedes-Benz 236.12 ¹ , 236.14 ¹ , 236.15 ¹ , 236.41 ¹
	Peugeot Societe Anonyme (PSA) AL-4	
	Renault DP-0	
	Saab 3309	Saab 93 165 147 ¹
	Volvo 4 speed (P/N 1161621), Volvo P/N 1161540/11616402	Volvo 6 speed MY 2011-2013 (P/N 31256774 or 31256675) ¹
	VW G 052 162, G 052 990, G 055 025	VW G 052 540 ¹ , G 055 005 ¹ , G 055 162 ¹ , G 060 162 ¹
	ZF TE-ML 09, 11 (3/4/5 speed)	ZF 6 speed (S671 090 255) ¹

DURADRIVE™ MV Synthetic ATF is not recommended for DCT and CVT transmissions or where a non-friction modified fluid is recommended (e.g. Ford Type F). Always consult the vehicle's owner manual for specific transmission fluid recommendations.

For a full listing of suitable for use applications including transfer case and power steering applications, please consult Tech Data IM-8043E or a Technical Service Advisor.

¹ DURADRIVE MV Synthetic ATF is a high viscosity formulation and does not meet the viscosity profiles of these low viscosity specifications. Field testing results have demonstrated proof of no harm but product will not provide the potential fuel economy benefits of the low viscosity genuine oils.

² Except AWTF80-SC transmissions or MY 2008-2010 V70

DURADRIVE™ LOW VISCOSITY MV SYNTHETIC ATF

DURADRIVE Low Viscosity MV Synthetic ATF is a full synthetic low viscosity formulation that offers true multi-vehicle performance with improved fuel efficiency. This ATF provides the frictional properties, wear protection and viscometrics needed by most newer North American, Asian, and European automatic transmissions. The superior oxidation stability coupled with greater low temperature properties extends the transmission life by reducing sludge and deposits formation at high temperatures while protecting from wear at cold temperatures.

DURADRIVE Low Viscosity MV Synthetic ATF is approved for DEXRON®-VI (J-60185) and Ford MERCON® LV (MLV161104). It is suitable for use in a wide range of North American, Asian and European automatic transmissions where the following OEM specifications are recommended:

Application	High Viscosity Specification/Vehicle	Low Viscosity Specification/Vehicle
Passenger Car - North American OEM	Chrysler ATFs (incl. ATF+3®) ¹	Chrysler/Dodge/Jeep 68043742AA, 05127382AA, 68171866A
	Chrysler/Dodge MOPAR AS 68 RC and AS 69 RC	Chrysler/Dodge/Jeep 68157995AA, 68157995AB, 68218925AA
	(T-IV), JWS 3309 ¹	
	Ford MERCON® ¹	Ford MERCON® LV (SF only) approved (MLV161104)
	Ford FNR5 ¹	
	Ford WSS M2C 922A1, 924A (XT-8-QAW) JWS 3309 ¹	
	GM TASA, DEXRON®-II (IID, IIE) -III (IIIF, IIIG, IIIH) ¹	GM DEXRON®-VI (SF only) approved (J-60185)
	Saturn T-IV (JWS 3309) ¹	
Passenger Car - Asian OEM	Aisin Warner JWS 3309 (T-IV) ¹	Aisin Warner JWS 3324 (WS)
	Daewoo LT 71141 ¹	Aisin Warner AW-1
	Daihatsu AMMIX ATF D-II, ATF D-III SP ¹	
	FUSO ATF-II, ATF-SPIII, ATF-A4 ¹	
	Hino Blue Ribbon ATF ¹	
	Honda ATF Z1 (all except CVTs)/ Acura ATF Z1 ¹	Honda DW-1
		Honda Type 3.0
		Honda Type 3.1
	Hyundai/Kia SP-II, SP-III, JWS 3314, JWS 3317 ¹	Hyundai/Kia SP-IV, SP-IV RR, SP-IV M/ SP4-M
	Hyundai/Kia 040000C90SG ¹	Hyundai/Kia NWS-9638
	ISUZU BESCO ATF-II, ATF-III, ATF SP ¹	
	ISUZU SCS Fluid ¹	
	JASO 1A, 2A ¹	JASO 1A-LV
	Kia Red-1 ¹	
	Lexus JWS 3309 ¹	
	Mazda ATF S-1, ATF N-1, ATF D-II, ATF F-1, ATF M-III, ATF M-V, ATF 3317 ¹	Mazda ATF FZ
	Mitsubishi Diaqueen J2, SK ¹	Mitsubishi Diaqueen J3 / Diaqueen ATF PA

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Application	High Viscosity Specification/Vehicle	Low Viscosity Specification/Vehicle
Passenger Car - Asian OEM	Mitsubishi Diaqueen SP-II, SP-III ¹	Mitsubishi SP-IV
	Nissan 402, Nissan Matic C, D, J, K ¹	Nissan Matic S
	Subaru ATF, ATF-HP, DEXRON®-II, ATF 5AT ¹	
	Suzuki 3314, 3317, JWS 3309, AT OIL 5D06, ATF 2326, ATF 2384K ¹	
	Ssang Yong DSIH 5M-66 ¹	
	Toyota ATF D-II, D-III, T-III, T-IV (JWS 3309) ¹	Toyota ATF WS (JWS 3324)
Passenger Car - European OEM	Audi G 052 162, G 052 990, G 055 025 ¹	Audi G 060 162, G 055 540, G 055 005
	Audi 5HP LT71141 (ZF 5 HP 18FL/19FL/24A) ¹	
	BMW 7045E (3 Series), 8072B (5 Series), LA 2634, LT 71141 (ZF 5HP 18FL/19FL/24A) ¹	
	BMW JWS 3309 (T-IV) ¹	
	BMW ZF 5HP18FL, 5HP24, 5HP30 ¹	
	FIAT T-IV type (JWS 3309) ¹	
	Jaguar ATF 3403, ATF 3403-M115, LT71141, ZF 5HP24, JLM20238, JLM20292, K17 ¹	Jaguar Fluid 8432
	Mercedes-Benz MB 236.10 (NAG 1 / Shell 3403) ¹	Jaguar Fluid 02JDE 26444
	Mercedes-Benz; MB 236.1, 236.2, 236.3, 236.5, 236.6, 236.7, 236.8, 236.9 ¹	Land Rover Fluid LR023288
	Peugeot Societe Anonyme (PSA) ZF 4HP20 ¹	Mercedes-Benz: MB 236.14, 236.15, 236.17
	Porsche ZF 5HP19FL, ZF 5HP20, LT71141, ATF 3403-M115, T-IV (JWS 3309) ¹	
	Renault DPO/AL4, Matic D2, Samsung SATF-D ¹	
	Saab T-IV (JWS 3309), 96 160 393 ¹	Saab 93 165 147
	Texaco N402 (JATCO), ETL-7045E (BMW 7045E), ETL-8072B (BMW 5 Series) ¹	
	Vickers M2950-S, I-286-S ¹	
	Volvo 4 speed (P/N 1161621) ¹	Volvo 6 speed MY 2011-2013 (P/N 31256774/ 31256675)
	Volvo P/N 1161540/1161640 ¹	
	VW G 052 162, G 052 990, G 055 025, TL 521 62 ¹	VW G 060 162, G 055 540, G 055 005
	VW 5HP (18FL /19FL/ 24A/ 30), ZF 5HP 30 ¹	
	ZF - all 3 & 4 speed transmissions ¹	ZF - 6 speed transmissions
	ZF - 5 speed transmissions ¹	ZF - 8 speed transmissions
	ZF TE-ML 05L, TE-ML 09, 11A, 11B, TE-ML 21L ¹	ZF - 9 speed transmissions

- Suitable for Use (SFU) = Supporting data is available to demonstrate acceptable performance (not OEM approved).

¹ DURADRIVE™ Low Viscosity MV Synthetic ATF is a low viscosity formulation and does not meet the viscosity profiles of these high viscosity specifications.

- NOT recommended for CVT* and DCT transmissions or when a non-friction modified fluid is recommended (e.g. Ford Type F). Also not recommended for applications requiring Ford MERCON® SP.

* Some e-CVT designs require the use of Automatic Transmission Fluids; therefore, DURADRIVE Low Viscosity MV Synthetic ATF is suitable for use where recommended for the appropriate ATF Specification/Vehicle.

- Always consult the vehicle owner's manual for specific transmission fluid recommendations.

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Typical characteristics are shown below:

		DURADRIVE™ MV	DURADRIVE Low Viscosity MV
		Synthetic ATF	Synthetic ATF
Viscosity	cSt @ 40°C	36.1	29.2
	cSt @ 100°C	7.4	5.9
Viscosity Index		178	153
Brookfield Viscosity cP @ - 20°C		1,210	953
	cP @ -30°C	2,697	2,752
	cP @ - 40°C	11,538	8,773
Pour Point, °C/°F		-54/-65	-51/-60
Flash Point, COC, °C/°F		206/403	218/424
Color		Red	Red

DURADRIVE CVT MV SYNTHETIC TRANSMISSION FLUID

DURADRIVE CVT MV Synthetic is a full synthetic high viscosity Continuously Variable Transmission (CVT) Fluid that offers true multi-vehicle performance. It is specially formulated to provide stable and precise friction balance for belt and chain CVTs while delivering strong anti-shudder durability over a long fluid life. DURADRIVE CVT MV Synthetic provides the frictional properties, wear protection and viscometrics needed by most major Asian, North American and European continuously variable transmissions. DURADRIVE CVT MV Synthetic benefits include excellent oxidation and shear stability, outstanding wear protection, strong and long lasting foaming control and reliable low temperature fluidity. It is suitable for use in a wide range of Asian, North American and European continuously variable transmissions with belt/pulley or chain/pulley arrangements where the following OEM specifications are recommended:

Application	High Viscosity Specification/Vehicle	Low Viscosity Specification/Vehicle
Passenger Car - North American OEM	Chrysler (FCA) CVTF+4®	
	Ford MERCON® C (WSS-M2C 933-A)	
	Ford WSS M2C 928-A	
	GM DEX CVT, GM CVT	
Passenger Car - Asian OEM	Daihatsu AMMIX CVTF-DC	Daihatsu AMMIX CVTF-DFE¹
	Honda HMMF (without wet clutch)	Honda HCF-2¹
	Hyundai/Kia SP CVT-1	
	Mazda CVTF 3320	
	Mitsubishi DiaQueen CVTF J1	Mitsubishi DiaQueen CVTF J4¹



Application	High Viscosity Specification/Vehicle	Low Viscosity Specification/Vehicle
Passenger Car - Asian OEM		Mitsubishi Diamond ATF SP III ¹
	Nissan NS-1, NS-2	Nissan NS-3 ¹
	Subaru e-CVTF, i-CVTF, i-CVT FG	
	Subaru Lineartronic CV-30, CVTF-II	
	Subaru High torque CVTF	
	Suzuki CVT Fluid Green1	Suzuki CVT Fluid Green2 ¹
	Suzuki CVTF 3320	
		Toyota FE ¹
Passenger Car - European OEM	Toyota TC	Toyota WS (for e-CVT only) ¹
	Audi TL 52180 (G 052 180)	
	Audi TL 52516 (G 052 516)	
	BMW EZL 799A	
	Mercedes-Benz MB 236.20	
	VW TL 52180 (G 052 180)	
	VW TL 52516 (G 052 516)	

- Suitable for Use (SFU) = Supporting data is available to demonstrate acceptable performance (not OEM approved).

¹ DURADRIVE™ CVT MV Synthetic is a high viscosity formulation and does not meet the viscosity profiles of these low viscosity specifications.

- DURADRIVE CVT MV Synthetic is not suitable for use on e-CVT designs where the use of planetary stepped automatic transmission fluid is recommended.
- DURADRIVE CVT MV Synthetic is not recommended for conventional stepped automatic transmissions or dual-clutch transmissions (DCT).
- DURADRIVE CVT MV Synthetic is not recommended when Honda Z1 is recommended.

Typical characteristics are shown below:

DURADRIVE CVT MV Synthetic		
Viscosity	cSt @ 40°C	35.9
	cSt @ 100°C	7.2
Viscosity Index		172
Brookfield Viscosity	cP @ - 20°C	1,120
	cP @ -30°C	3,130
	cP @ - 40°C	11,200
Pour Point, °C/°F		-51/-60
Flash Point, COC, °C/°F		217/423
Color		Green

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DURADRIVE™ DCT MV SYNTHETIC TRANSMISSION FLUID

DURADRIVE DCT MV Synthetic is a full synthetic transmission fluid for wet dual or double clutch transmissions. This fluid is specifically designed for these demanding transmissions where the frictional properties, load-carrying capacity and corrosion protection are critical to the transmission performance.

DURADRIVE DCT MV Synthetic provides excellent wear protection, extended anti-shudder durability and reliable low temperature fluidity ensuring the transmission is protected over the life of the fluid. DURADRIVE DCT MV Synthetic is suitable for use where the following OEM specifications are recommended:

Application	Specification/Vehicle SFU Claim
Passenger Car - North American OEM	Chrysler BOT 341 (Power shift 6-speed)
	Ford WSS-M2C936-A
Passenger Car - Asian OEM	BYD TL 52182 (G 052 182)
	FAW TL 52182 (G 052 182)
	Hyundai/Kia API GL-4 SAE 70W DCTF
	Mitsubishi Dia-Queen SSTF-I (MZ320065)
	Nissan WSS M2C936 A (GTRT00P)
Passenger Car - European OEM	SAIC TL 52182 (G 052 182)
	Audi TL 52182 (G 052 182)
	Audi TL 52529 (G 052 529)
	BMW 83 22 2 148 578
	BMW 83 22 2 148 579
	BMW 83 22 0 440 214
	BMW 83 22 2 147 477
	Citroën 9734.S2
	Mercedes-Benz MB 236.21 (001 989 85 03)
	Mercedes-Benz MB 236.22 (000 989 61 04)
	Mercedes-Benz MB 236.24 (002 989 04 03)
	Mercedes-Benz MB 236.25 (001 989 86 03)
	Mercedes-Benz MB 239.21 (000 989 20 02)
	Peugeot 9734.S2
	Porsche (oil No 999.917.080.00)
	Porsche (oil 971.917.080.01)
	Renault BOT 450 (6-speed)
	Seat TL 52182 (G 052 182)
	Skoda TL 52182 (G 052 182)
	VW TL 52182 (G 052 182)
	VW TL 52529 (G 052 529)
	VW TL 55529 (G 055 529)
	Volvo 1161838, 1161839

- Suitable for Use (SFU) = Supporting data is available to demonstrate acceptable performance (not OEM approved).
- DURADRIVE DCT MV Synthetic is not recommended for manual transmissions, conventional stepped automatic transmissions, continuously variable transmissions (CVT) or e-CVT.



Typical characteristics are shown below:

DURADRIVE™ DCT MV Synthetic		
Viscosity	cSt @ 40°C	37.0
	cSt @ 100°C	7.2
Viscosity Index		161
Brookfield Viscosity	cP @ - 20°C	1530
	cP @ -30°C	4180
	cP @ - 40°C	15,620
Pour Point, °C/°F		-51/-60
Flash Point, COC, °C/°F		206/403
Color		Amber

DURADRIVE™ HD SYNTHETIC 668 ATF

DURADRIVE HD Synthetic 668 ATF is fully approved for on-highway Allison transmissions. DuraDrive HD Synthetic 668 is the first fluid to complete Allison's rigorous validation program, receive license approval, and be awarded Allison's global factory fill program. DuraDrive HD Synthetic 668 meets and exceeds the TES 668™ specification and is backwards compatible for every Allison transmission that currently requires approved TES 295® ATF*. Approved for: 1000/2000 Series transmissions, 3000 and 4000 Series transmissions, hybrid H 40/50 EP™ and eGen Flex drive units. Suitable for use for Voith H55.6335.xx (standard drain, 60K km) and ZF TE-ML 14A (standard drain).

*TES 668™ fluids are not recommended for Allison TC10® transmissions.

DURADRIVE HD LONG DRAIN ATF

DURADRIVE Heavy-Duty (HD) Long Drain ATF offers excellent wear protection, oxidation control and friction durability demonstrated through extensive rig testing and field trial. DURADRIVE HD Long Drain ATF is recommended for use in heavy duty fleets for extended 120,000 km (72,000 mile) and up to 180,000 km (108,000 miles). Approved by MAN, Mercedes-Benz, Volvo and ZF.

DURADRIVE HD SYNTHETIC BLEND ATF

DuraDrive HD Synthetic Blend ATF is specially formulated to perform under the demanding severe service operating conditions found in heavy-duty transmission systems. It is designed for use in commercial applications where Severe Duty and Extended Drain Interval fluids are specified.

DURADRIVE HD Synthetic Blend ATF is suitable for use in heavy-duty fleets for up to 50,000 miles in severe service and 100,000 miles in normal service. Approved for Voith and ZF extended drain applications. Also suitable for use where ZF TE-ML 16L, Caterpillar TO-2 (obsolete), Mercedes-Benz MB 236.1/.5/.6/.7, MAN 339 Typ Z2 & V2, Volvo STD 1273,41 - transmission oil 97341 (AT101), or MERCON® V is recommended.

Typical characteristics are shown below:

		DURADRIVE HD LONG DRAIN ATF	DURADRIVE HD SYNTHETIC 668	DURADRIVE HD SYNTHETIC BLEND ATF
Viscosity	cSt @ 40°C	38	34	34
	cSt @ 100°C	7.2	7.0	7.8
Viscosity Index		154	169	208
Brookfield Viscosity, cP @ -40°C		14,800	11,120	9,700
Pour Point, °C/°F		-45/-49	-57/-71	-45/-49
Flash Point, COC, °C/°F		243/469	217/423	189/372
Color		Red	Red	Red

* TES 668™, 1000-4000 Series, H 40/50 EP™, eGen Flex and TES 295® are trademarks of Allison Transmission, Inc.



OEM Specification	DuraDrive™ HD Synthetic 668	DuraDrive HD Long Drain ATF	DuraDrive HD Synthetic Blend ATF
	This ATF is suitable for use in heavy-duty fleets for extended oil drain intervals. Refer to the OEM oil drain interval recommendations for your application and service type.	This ATF is suitable for use in heavy-duty fleets for extended oil drain intervals. Refer to the OEM oil drain interval recommendations for your application and service type.	This ATF is suitable for use in heavy-duty fleets for standard and extended oil drain intervals. Refer to the OEM oil drain interval recommendations for your application and service type.
Allison TES 668™	Approved (AN668-10012020)	–	
Allison C-4 (legacy)	–	–	C-4 29493700
Voith H55.6335.xx (standard drain, 60K km)	SFU	–	Approved
Voith H55.6336.xx (extended drain, 120K km)	–	–	Approved
Voith 150.014524.xx (maximum drain, 180K km) xx- VTI-DIWA Service Bulletins 013 and 118	–	Approved*	–
ZF TE-ML 14A (standard drain)	SFU	–	–
ZF TE-ML 14B (extended drain)	–	–	Approved (ZF004790)
ZF TE-ML 03D, 04D, 17C	–	–	Approved (ZF004790)
ZF TE-ML 16L	–	–	SFU
ZF TE-ML 14C, 20C (extended drain)	–	Approved (ZF004791)	–
ZF TE-ML 04D, 16M, 16S, 25C		Approved (ZF004791)	
MAN 339 Typ V2, Z2	–	–	SFU
MAN 339 Typ Z3, Z12	–	Approved (TUC 1463/19)	–
Mercedes-Benz MB 236.1/ .5/ .6/ .7	–	–	SFU
Mercedes-Benz MB 236.9	–	Approved	–
Volvo STD 1273.41 - transmission oil 97341 (AT101)	Approved (#97341-086)	Approved (#97341-079)	SFU
Caterpillar TO-2 (obsolete)	–	–	SFU
Ford MERCON® V	–	–	SFU
GM DEXRON®-III(H), -III(G), -II(E), or -II	–	–	SFU

They can also be used as a hydraulic or power steering fluids.

SFU = Suitable for use.

* Including DIWA NXT and DIWA Rail NXT transmissions.

TES 295® and TES 668™ are trademarks of Allison Transmission, Inc.

DEXRON® is a registered trademark of General Motors LLC. MERCON® is a registered trademark of Ford Motor Company.

AUTOMOTIVE GEAR OILS

Automotive gear oils protect gears, bearings and cross-shafts from premature failure, ensure reliable equipment operation and increase transmission and differential service life. Automotive gear oils achieve this by performing the following five vital functions:

- **Reducing friction and wear**

An oil film of a certain thickness must be maintained between gear teeth at all times to prevent metal-to-metal contact between gear surfaces under extreme pressure conditions. Hypoid gear drives are especially tough systems to lubricate, since the gear contact motion severely shears the oil with sliding as well as rolling motions and the gears are severely shock loaded.

- **Providing oxidation stability**

A gear oil should resist thermal degradation and sludging so that harmful viscosity increase is minimized over time.

- **Cooling the gear surfaces**

Gear components are prevented from destructive over-heating, by circulating oil through the gear mesh zones, where frictional heat is generated.

- **Inhibiting rust and corrosion**

A gear oil must be non-corrosive to bronze, and protect steel surfaces against rust, especially when water contamination is present.

- **Maintaining long clutch life and preventing seal leaks**

Clutches used in wet brakes and manual transmissions can become “glazed” and lose their function, if gear oils decompose at high temperatures. Gear oils must, therefore, be thermally stable. Undesirable decomposition products can also coat seals with carbon, causing leakage.



GEAR OIL CLASSIFICATION SYSTEMS

SAE VISCOSITY GRADE

Gear lubricants must flow freely when the axle is cold, yet have sufficient thickness or viscosity to separate the lubricated parts at normal operating temperatures.

The SAE classification for axle and transmission lubricant viscosity is indicated in the table below. Each viscosity grade has distinct criteria for low and high temperature performance.

AXLE AND MANUAL TRANSMISSION LUBRICANT VISCOSITY CLASSIFICATION SAE J306 (February 2019)			
SAE Viscosity Grade	Max. Temperature for Absolute Viscosity of 150,000 cP (°C) ⁽¹⁾	Kin. Viscosity @ 100°C, cSt ⁽²⁾	
		Minimum ⁽³⁾	Maximum
70W	-55	3.8	—
75W	-40	3.8	—
80W	-26	8.5	—
85W	-12	11.0	—
65	—	3.8	<5.0
70	—	5.0	<6.5
75	—	6.5	<8.5
80	—	8.5	<11.0
85	—	11.0	<13.5
90	—	13.5	<18.5
110	—	18.5	<24.0
140	—	24.0	<32.5
190	—	32.5	<41.0
250	—	41.0	—

NOTE – 1cP = 1 mPa.s; 1 cSt = 1mm²/s

1. Using ASTM D2983.

2. Using ASTM D445.

3. Limit must also be met after testing in CEC L-45-A-99, Method C (20 hours).

SAE viscosity selection should be based on the minimum and maximum service temperatures. Today's most commonly used gear lubricants are multi-grades (e.g. 75W-90, 80W-90 and 85W-140). These fluids meet both the low and high temperature requirements for the combined grades. For example, an 80W-90 oil must have the low temperature fluidity of an 80W as well as the viscosity of a 90 grade at higher temperatures.

API SERVICE DESIGNATIONS

Automotive gear lubricant performance is defined by the type of service it can be expected to perform satisfactorily. The API service designations were developed for manufacturers and end-users to assist them in selecting manual transmission or gear lubricants for a variety of operating conditions.

The API service designations range from GL-1 to GL-5 and describe gear lubricants in terms of general type, severity of service and application. The following table lists these designations.

The most commonly specified and available type of automotive gear lubricant in North America is API GL-5 and for manual transmission applications API MT-1. In Europe and other parts of the world where manual transmissions are more prevalent, API GL-4/MT-1 oils are used as frequently as API GL-5.

API SERVICE CLASSIFICATION		
Classifications	Type	Typical Application
GL-1 (inactive)	Straight mineral oil (inactive)	Automotive manual transmissions
GL-2 (inactive)	Usually contains fatty materials (inactive)	Worm gear drives, industrial gear oils
GL-3 (inactive)	Contains mild EP additive (inactive)	Manual transmissions and spiral bevel final drives
GL-4	Equivalent to obsolete MIL-L-2105 Specification. Usually satisfied by 50% GL-5 additive level or stand alone optimized chemistry	Manual transmissions, spiral bevel and hypoid gears where moderate service prevails. Often used in systems that contain yellow metal.
GL-5	Part of SAE J2360 Specification (formerly MIL-PRF-2105E). Primary field service recommendation of most passenger cars and truck builders worldwide	Used for moderate and severe service in hypoid and all other types of gears. Also may be used in manual transmissions. Not for use in systems that contain yellow metal
GL-6	(Obsolete.)	Severe service involving high-offset hypoid gears.
MT-1	Part of SAE J2360 Specification. Formulated to protect against thermal degradation, wear and oil seal degradation	Non-synchronized manual transmissions, used in buses and trucks. System needs are dependent on chemistry used.

Each automobile manufacturer has a set of unique test requirements for rear axle factory-fill and manual transmission fluids. An SAE J2360 lubricant is a good starting point for the majority of these requirements and is often recommended on axle oils for service-fill. API MT-1 and sometimes API GL-4 lubricants are a good starting point for the majority of these requirements in manual transmissions and can be recommended for service fill.

NOTE – SAE J2360 is equivalent to API GL-5 + MT-1



LIMITED SLIP DIFFERENTIALS

In conventional differentials the same torque is applied to both wheels, regardless of traction conditions. Thus, if one wheel is on a surface with low enough traction for the applied torque to exceed the traction, that wheel will break loose and spin until it is revolving at twice the speed of the ring gear and the other wheel has stopped turning. All the power will then be delivered to the spinning wheel and no power will be transmitted to the wheel with traction. Limited slip or torque biasing, and locking type differentials have been developed to overcome this.

Limited slip differentials found on passenger cars all operate on the same principle. Clutches are inserted between the side gears and the case. When the clutches are engaged they lock the side gears to the case and prevent the differential action. Either stacked plate or cone type clutches are used for this purpose.

Torque biasing or locking differentials are used in on-road vehicles and in off-highway equipment. Some locking differentials lock and unlock automatically, while others are arranged so the operator can lock them when full traction is needed at both driving wheels.

DEXRON® LS GEAR OIL 75W-90

Petro-Canada Lubricants DEXRON® LS (Limited Slip) Gear Oil 75W-90 is a synthetic extreme pressure automotive axle lubricant formulated for General Motors vehicles. DEXRON® LS Gear Oil 75W-90 provides excellent long-lasting wear protection to extend equipment life and reduce downtime and maintenance costs, providing year-round performance. This premium synthetic gear oil is designed with added friction modifiers to perform in limited-slip differentials[†] and is an API GL-5 quality product that meets GM requirements for 9986290 (or GMW16445).

DEXRON® GEAR OIL 75W-90

DEXRON® Gear Oil 75W90 is particularly suited for applications requiring a synthetic gear lubricant that meets General Motors 9986285 (or GMW16433).

		DEXRON® LS GEAR OIL 75W-90	DEXRON® GEAR OIL 75W-90
Viscosity	cSt @ 40°C	83.8	88.5
	cSt @ 100°C	14.4	15.2
Viscosity Index		179	182
Brookfield Viscosity, cP @ - 40°C		38,142	41,391
Pour Point, °C/°F		<-57/<-71	<-57/<-71
Flash Point, COC, °C/°F		183 / 361	187 / 369

Petro-Canada Lubricants also offers a non-LS API GL-5 gear oil - DEXRON® Gear Oil 75W-90 formulated for GM vehicles. Please speak to a company representative to learn more.

DEXRON® is a registered trademark of General Motors LLC.

[†]DEXRON® Limited Slip (LS) Gear Oil is primarily for use in axles in cars and trucks with plate type GM LS differentials.

TRAXON™ GEAR OIL

TRAXON is Petro-Canada Lubricants premium multi-grade line of automotive and commercial hypoid gear lubricants. TRAXON gear oils are specially formulated to provide excellent shear stability and long oil life for outstanding long-lasting protection to help extend equipment life and reduce downtime and maintenance costs.

TRAXON gear oils are designed for use in most manual transmissions (excluding synchromesh manual transmissions), differentials, hypoid gears, power take-off units and final drives found on passenger cars, trucks, and off-highway vehicles used in construction, agriculture, forestry and mining operations. Consult owner's manual for type and grade needed.

Most TRAXON gear oils meet API GL-5 and MT-1 requirements and are designed to meet or exceed the SAE J2360 global standard.

TRAXON gear oils are suitable for most oil-lubricated universal joints, wheel bearings, planetary gear sets, steering gears as well as certain industrial gear reducers requiring GL-3 (inactive), GL-4, or GL-5 oils.

Due to specific lubrication requirements TRAXON gear oil and specialized manual transmission fluids (such as TRAXON Synthetic MTF 75W-80 and TRAXON Synthetic CD-50)* must NOT be used in:

- Automatic Transmissions
- Powershift Transmissions
- Hydrostatic drives and systems that include the lubrication of wet clutches and brakes
- Manual Transaxles on front wheel drive vehicles where an automatic transmission fluid or engine oil is specified
- Spicer Manual Transmissions where single grade engine oils are specified
- Not for use in specific manual transmissions calling for the use of an API GL-4 rated oil only and a GL-4/MT-1 oil is not acceptable*.

*Exception – TRAXON Synthetic CD-50 and TRAXON E Synthetic MTF 75W-80 are suitable for use where API GL-4 and/or API MT-1 are called for.



TRAXON™ SYNTHETIC 75W-85 – ULTIMATE FUEL EFFICIENCY

TRAXON Synthetic 75W-85 offers equipment the same remarkable performance as TRAXON Synthetic 75W-90 with gains in efficiency due to a reduced viscous drag at elevated temperatures.

- TRAXON Synthetic 75W-85 has better torque efficiency vs. GL-5 80W-90 (from 20°C/68°F to 45°C/113°F at moderate loads) for reduced friction and lubricant drag and a smoother, more efficient operating performance, which may lead to lower fuel consumption
- TRAXON Synthetic 75W-85 has better efficiency vs. GL-5 80W-90s and 75W-90 (at static high temperature operation 79.3°C/175°F s at low to moderate loads and speeds) for reduced friction and lubricant drag and a smoother, more efficient operating performance, which may lead to lower fuel consumption
- Approved against the SAE J2360 Global Standard (formerly MIL-PRF-2105E) (PRI QPL GL-1013)
- Meets API GL-5, API MT-1 and Meritor 0-94 credentials. Suitable for use where John Deere JDM J11E and Volvo 1273,12 (97312) fluids are called for

TRAXON SYNTHETIC 75W-90 – ULTIMATE ALL SEASON PROTECTION

TRAXON Synthetic 75W-90 offers your equipment the same remarkable performance package as TRAXON XL Synthetic Blend plus it also provides outstanding protection in extreme cold weather conditions.

- Shear stability ensures retention of viscosity to protect equipment against metal-to-metal contact and wear, especially at higher temperatures
- Excellent resistance to degradation and sludging for longer oil life with fewer change-outs and better protection of gears
- Excellent protection in extreme cold weather conditions which means easier start-ups and cold weather shifting
- Better torque efficiency vs. GL-5 80W-90 (from 20°C/68°F to 45°C/113°F at moderate loads) for reduced friction and lubricant drag and a smoother, more efficient operating performance which may lead to lower fuel consumption
- Meets API GL-5, MT-1, Meritor 0-94, and Scania STO 1:0 (axle and gearboxes/MT)
- Approved against the SAE J2360 Global Standard (formerly MIL-PRF-2105E) (PRI QPL GL-0841), ZF TE-ML Class 05A,16B,17B,21A (ZF 002212), MACK GO-J, MAN 342 Typ M1 (obsolete) and Typ M2, and Meritor (globally listed in their TP 9539 extended drain listing under 0-76-Q and 0-95)

**TRAXON™ XL SYNTHETIC BLEND 75W-90 –
PREMIUM PROTECTION**

TRAXON XL Synthetic Blend 75W-90 provides the same great long-lasting protection as TRAXON 80W-90 plus better low temperature protection and more efficient operating performance which could ultimately lead to lower fuel consumption.

- Shear stability ensures retention of viscosity to protect equipment against metal-to-metal contact and wear, especially at higher temperatures
- Excellent resistance to degradation and sludging for longer oil life with fewer change-outs and better protection of gears
- Excellent protection for cold weather conditions which means better gear protection at low temperatures and easier start-ups and cold weather shifting
- Better torque efficiency vs. GL-5 80W-90s (from 20°C/68°F to 45°C/113°F at moderate loads) for reduced friction and lubricant drag and a smoother, more efficient operating performance which may lead to lower fuel consumption
- Meets API GL-5, MT-1, Scania STO 1:0 (axle and gearbox/MT) and Meritor 0-94 and 0-76-E (obsolete)
- Approved against the SAE J2360 Global Standard (formerly MIL-PRF-2105E) (PRI QPL GL-0796 and GL-0951), Mack GO-J specifications

Typical characteristics are shown below:

		Synthetic		XL Synthetic Blend
		75W-85	75W-90	75W-90
Viscosity	cSt @ 40°C	77.7	96.7	103
	cSt @ 100°C	12.3	15.5	16.7
Viscosity Index		156	171	170
Flash Point, COC, °C/°F		193/379	202/396	171/361
Pour Point, °C/°F		-45/-54	-48/-54	-45/-54
Brookfield Viscosity, cP @ °C/°F		69,000 @ -40/-40	89,700 @ -40/-40	124,800 @ -40/-40
Phosphorus, % Wt		0.12	0.13	0.12
Boron, % Wt		0.030	0.028	0.029



Petro-Canada Lubricants TRAXON™ line includes SAE 140 grade oils for situations where tough, high-load, high operating temperatures are encountered and where an SAE 140 GL-5 gear oil is required.

TRAXON 80W-90 – HIGH PERFORMANCE PROTECTION

TRAXON 80W-90 provides outstanding long-lasting protection for reduced downtime and maintenance costs.

- Outstanding shear stability which ensures retention of viscosity to protect equipment against metal-to-metal contact and wear, especially at higher temperatures
- Resists degradation and sludging for longer oil life with fewer change-outs and better protection of gears
- Meets API GL-5, MT-1, Scania STO 1:0 (axles and gear boxes/MT) and Meritor 0-76-D (obsolete) and 0-94
- Approved against the SAE J2360 Global Standard (formerly MIL-PRF-2105E), PRI GL 0794 and 0919, Mack GO-J, MAN 342 Typ M1 (obsolete) and Typ M2, ZF TE-ML lubricant class 05A, 12M, 16B, 19B, 21A (ZF000764 and ZF003389)

TRAXON 85W-140 – HIGH PERFORMANCE PROTECTION

- Outstanding shear stability and anti-wear EP additives protect equipment in tough, high-load, high operating temperature conditions for extended equipment life and reduced maintenance costs
- Excellent resistance to degradation and sludging for long fluid life to reduce maintenance costs and increase uptime
- Meets API GL-5, MT-1, Scania STO 1:0 (axles) and Meritor 0-76-A (obsolete) and 0-94
- Approved against the SAE J2360 Global Standard (formerly MIL-PRF-2105E), (PRI GL 795 and 0920), Mack GO-J, ZF TE-ML lubricant class 05A, 12M, 16D, and 21A (ZF000778 and ZF003390) specifications

Typical characteristics are shown below:

	TRAXON		TRAXON XL Synthetic Blend
	80W-90	85W-140	80W-140
Viscosity cSt @ 40°C	137	355	253
	cSt @ 100°C	15.1	26.1
Viscosity Index	108	97	133
Flash Point, COC, °C/°F	211/426	217/433	195/379
Pour Point, °C/°F	-33/-33	-24/-17	-36/-33
Brookfield Viscosity, cP @ °C/°F	79,950 @ -26/-15	47,760 @ -12/10	84,600 @ -26/-15
Phosphorus, % Wt	0.10	0.10	0.10
Boron, % Wt	0.024	0.024	0.025

**TRAXON™ XL SYNTHETIC BLEND 80W-140 –
PREMIUM PROTECTION**

- Excellent shear stability which ensures retention of viscosity to protect equipment against metal-to-metal contact and wear, especially in tough, high-load, extreme high operating temperature conditions
- Exceptional resistance to degradation and sludging vs. GL-5 85W-140 oils for longer lasting oil life which helps reduce maintenance costs and increases uptime
- Better torque efficiency vs. mineral based GL-5 85W-140 oils (20°C/68°F to 45°C/113°F at moderate loads) for reduced friction and lubricant drag and a smoother, more efficient operating performance which may lead to lower fuel consumption
- Meets API GL-5, MT-1, Scania STO 1:0 (axle), and Meritor 0-76-B (obsolete) and 0-94
- Approved against SAE J2360 Global Standard (formally MIL-PRF-2105E) (PRI GL 0914), Mack GO-J, ZF TE-ML lubricant class 05A, 12M, 16D, and 21A (ZF002287)

TRAXON E SYNTHETIC

TRAXON E Synthetic is Petro-Canada Lubricants line of lubricants formulated to meet the “Genuine Roadranger” extended drain and warranty performance requirements set by Eaton Corporation (for transmissions) and Dana CVSD Corporation (for axles). The line consists of the following viscosity grades:

TRAXON E SYNTHETIC 75W-90 AND 80W-140

- Contain extreme pressure additives and are specially formulated to operate under a variety of load conditions and protect gears and bearings against rust, corrosion and oxidation
- Exceptional resistance to oxidation for long lubricant life which extends drain intervals between change-outs for maximized oil life and less downtime
- High viscosity indices and good low temperature flow properties provide superior protection over a wide range of temperatures for increased productivity
- Since early 2015, TRAXON E Synthetic 75W-90 has demonstrated up to 1.5%* fuel efficiency benefits over the previous formulation
- Meets API GL-5, API MT-1, SAE J2360 (MIL-PRF-2105E), International TMS 6816 / Navistar MPAPS B-6816 Type I, Meritor 0-76-N (75W-90), and Meritor 0-76-B & 0-80 (80W-140) requirements as well as Navistar MPAPS B-6821 and is approved under Meritor's TP-9539 extended drain warranty listing for categories
- Genuine Eaton Roadranger Lubricants are approved against Mack GO-J Plus (75W-90), Mack GO-J (80W-140) and approved against Dana-CVSD SHAES256 Rev. E (75W-90) and SHAES429 Rev. A (75W-90 AND 80W-140)

Typical characteristics are shown on next page:



TRAXON™ E Synthetic		
	75W-90	80W-140
Viscosity, cSt @ 40°C	103	284
cSt @ 100°C	14.9	29.1
Viscosity Index	152	146
Flash Point, COC, °C/°F	210/410	228/442
Pour Point, °C/°F	-42/-44	-33/-27
Brookfield Viscosity, cP @ -18°C/0°F	5,850	–
cP @ -26°C/-15°F	–	59,200
cP @ -40°C/-40°F	92,400	–
Phosphorus, wt%	0.15	0.13
Boron., wt%	0.02	0.02

TRAXON MANUAL TRANSMISSION FLUIDS

There are two main types of manual transmissions (MTs): synchronized and non-synchronized. Non-synchronized transmissions are more common in North America commercial and off-highway vehicle applications, where as synchronization is commonly found in passenger car and light duty trucks.

Now entering the market is a hybrid in the commercial trucking industry called an Automated Manual Transmission (AMT) driven by better fuel economy targets, increasing the driver availability pool and safer operations by elimination of the manual clutch.

The focus on driver comfort and premium fluids has improved the designs of today's transmissions across the below criteria:

- Shift
- Feel
- Fill-for-life capability (passenger car/light truck) including: Extended Drain Intervals (800,000 km/500,000 miles for commercial and off-highway applications)
- High thermal stability
- Durability including:
 - synchronizer friction material compatibility
 - Corrosion protection
 - High shear stability
- Improved fuel economy and efficiency

All of these have led to advancements in design and the use of a wide range of synchronizer materials or hardware design.

These changes in transmission design have led to advancements in transmission lubricant technology highlighting the importance of using a dedicated manual transmission fluid (MTF) that is matched to the frictional properties of these more complex materials.

TRAXON™ SYNTHETIC MTF 75W-80

TRAXON Synthetic MTF 75W-80 is a premium performance fuel efficient commercial vehicle manual transmission fluid/gear oil especially formulated for modern synchronized automated manual transmissions designed to deliver extended drain capability, long component life and optimal gear shifting.

TRAXON Synthetic MTF 75W-80 is also suitable for transaxles, manual gearboxes, transfer boxes and final drives where an API GL-4 lubricant is specified.

It is suitable for use for Volvo STD 1273,07-97307 and for Volvo I-Shift and Mack mDrive synchronized automated manual transmission applications and can be used in a range of existing and new vehicles using ZF transmissions, including those fitted with ZF-Intarders. Models include ASTronic, TC Tronic, Ecolite, Ecomid and Ecospilt.

This transmission fluid is also intended for manual gearboxes of the G7/8, S, SR, SPO, AT and VT series designed by Volvo GTT which are used in normal applications up to an extended maximum 400,000 Km (250,000 mi) oil drain interval.

This product also meets or exceeds the performance requirements for:

- API GL-4 and MT-1
- DAF (See DAF SMF&L 201240 for suitability)
- IVECO (See ZF approvals for specific applicability)
- Approval for MAN 341 Typ Z4. Suitable where Z1 (obsolete), Z2 and Z3 (obsolete) Z5 (400,000km / 250,000 mile ODI) is called for
- Renault (Note Technique B0032/2 Annex 3)
- Suitable for use for EATON Europe (300,000 km/3 year) (obsolete)
- Suitable for use where Volvo STD 1273,05 (97305) and XXW-80 are called for
- Approved against ZF TE-ML - 01L, 02L, 13 (where stipulates ZF TE-ML 02L), 16K (ZF002286)
- Suitable for use against Bosch TE-ML 08

Typical characteristics are shown below:

TRAXON Synthetic MTF 75W-80		
Viscosity,	cSt @ 40°C	54.8
	cSt @ 100°C	9.6
Viscosity Index		160
Flash Point, COC, °C/°F		227/440
Pour Point, °C/°F		-42/-44
Brookfield Viscosity, cP @ -40°C/-40°F		49,800
Phosphorus, wt%		0.06
Boron., wt%		0.07



TRAXON™ E SYNTHETIC MTF

- Provides superior year-round manual transmission fluid performance where a non-EP transmission lubricant is required
- Contains an anti-wear additive, as well as rust, oxidation and corrosion inhibitors to protect vital transmission parts in severe heat, oxidation and shear conditions
- TRAXON E Synthetic MTF has demonstrated up to 1.6%** fuel efficiency benefits over the older Eaton PS-164 Rev 7 ("CD-50" type) fluid technology
- Long lubricant life provides extended drain capabilities for less change-outs and reduced maintenance
- Meets API MT-1 and International TMS 6816 / Navistar MPAPS B-6816 Type II requirements
- Approved against Eaton PS-386 and MACK TO-A Plus
- Approved for use in Eaton transmissions such as UltraShift Plus, Fuller Advantage Series (FAS), FR and RT Series
- Meets all criterion of Meritor's up-dated 0-81 manual transmission / transfer case specifications that includes two different viscosity grades (SAE 50 and SAE 40) and two different applications (Manual transmission and transfer case)

Typical characteristics are shown below:

TRAXON E Synthetic MTF		
Viscosity,	cSt @ 40°C	95.1
	cSt @ 100°C	14.8
Viscosity Index		163
Flash Point, COC, °C/°F		238/460
Pour Point, °C/°F		-42/-44
Brookfield Viscosity, cP @ -40°C/-40°F		51,900
Phosphorus, wt%		0.11
Boron., wt%		0.03

TRAXON™ RECOMMENDED APPLICATIONS

Products	TRAXON 80W-90	TRAXON 85W-140	TRAXON XL Synthetic Blend 75W-90	TRAXON XL Synthetic Blend 80W-140
API GL-4				
API GL-5	✓	✓	✓	✓
API MT-1	✓	✓	✓	✓
Bosch TE-ML 08				
CNH MAT 1316	•	•		
CNH MAT 3511		•		•
Dana CVSD SHAES 256 Rev E (EATON TCMT0020-EN U.S Listed)				
Dana CVSD SHAES 429 Rev A* (EATON TCMT0020-EN U.S Listed)				
Detroit Diesel DFS93K219.01				
Eaton PS-164 Rev 7 (obsolete)				
Eaton PS-386 ** (TCMT0020-EN U.S Listed)				
Ford M2C-94A / M2C -197A	•		•	
Ford M2C-200B and M2C-201A			•	
International TMS 6816 / Navistar MPAPS B-6816 Type I				
International TMS 6816 / Navistar MPAPS B-6816 Type II				
Iveco 18-1807 MGS-1				
John Deere JDM J11E	•	•	•	•
Navistar MPAPS B-6821				
Mack GO-J	★	★	★	★
Mack GO-J Plus				
Mack TO-A Plus				
MAN 342 Typ M1 (obsolete)	★	•		•
MAN 342 Typ M2	★			•
MAN 341 Typ Z4***				
Meritor 0-76-A (obsolete)		✓		
Meritor 0-76-B (obsolete)				✓
Meritor 0-76-D (obsolete)	✓			
Meritor 0-76-E (obsolete)			✓	
Meritor 0-76-Q (obsolete)				
Meritor 0-76-N (obsolete)				
Meritor 0-76-R (obsolete)				
Meritor 0-80 (obsolete)				
Meritor 0-81				
Meritor 0-94	✓	✓	✓	✓
Meritor 0-95				
SAE J2360 ****	★ PRI GL 0794 and 0919	★ PRI GL 0795 and 0920	★ PRI GL 0796 and 0951	★ PRI GL 0891
Scania ST0 1:0 (axles)		✓		✓
Scania ST0 1:0 (axles and gearboxes/MT)	✓		✓	
Volvo Std 1273,05 - 97305				
Volvo Std 1273,07 - 97307				
Volvo Std 1273,10 - 97310	•	•	•	•
Volvo Std 1273,12 - 97312				
Volvo Std 1273, (15- 18 & 19) - 973 (15,18 and 19)				
Voith Retarder Class B				
ZF TE-ML - 01L, 02L, 13 (where stipulates ZF TE-ML 02L), 16K				
ZF - Freedom Line (ZF-AS Tronic) - Applications				
ZF -Ecolite, Ecomid, Etronic - Applications				
ZF TE-ML - 17B	★ (ZF000764 and ZF003389)			
ZF TE-ML - 05A, 12M, 16B, 19B, 21A	★ (ZF000764 and ZF003389)			
ZF TE-ML - 05A, 12M, 16D, 21A		★ (ZF000778 and ZF003390)		★ (ZF002287)
ZF TE-ML - 05A, 16B, 21A				

* Products meeting these specifications are required as part of the Eaton "Genuine Roadranger" extended drain and warranty performance requirements set by Eaton Corporation (for transmissions) and Dana CVSD Corporation (for axles).



TRAXON™ Synthetic 75W-85	TRAXON Synthetic 75W-90	TRAXON E Synthetic 75W-90	TRAXON E Synthetic 80W-140	TRAXON E Synthetic MTF	TRAXON Synthetic CD-50	TRAXON Synthetic MTF 75W-80
					✓	✓
✓	✓	✓	✓			
✓	✓	✓	✓	✓	✓	✓
						•
	•					
		★				
		★	★			
		✓				
					•	
				★		
	•					
		✓				
				✓	•	
•	•					•
		✓	✓			
	★		★			
		★				
	★	•	•	★	•	
	★					
						★
			✓			
	✓	✓				
	•					
		★				
			•			
			•			
				★	•	
✓	✓	✓	✓			
	★	★	★			
★ PRI GL 1013	★ PRI GL 0841	✓	✓			
	✓					
					•	•
					•	•
•	•					
•	•					
					•	
						•
						★ (ZF002286)
						✓
						✓
	★ (ZF002212)					
	★ (ZF002212)					

** For use in Eaton transmissions such as UltraShift Plus, Fuller Advantage Series (FAS), FR and RT Series.

*** Approval from MAN North America only. **** SAE J2360 global standard (formerly MIL-PRF-2105E).

TRAXON™ SYNTHETIC CD-50

TRAXON Synthetic CD-50 is a premium performance fuel efficient commercial vehicle manual transmission fluid recommended for use in Heavy-Duty Manual Transmissions, such as those manufactured by Eaton and Meritor.

This product also meets or exceeds the performance requirements for:

- API GL-4 and MT-1
- Proof of performance in the field included extreme multi-year fleet testing of >100 truck transmissions where drain intervals were greater than 800,000 km/500,000 miles* and had excellent end of inspection results

Typical characteristics are shown below:

TRAXON Synthetic CD-50	
Viscosity, cSt @ 40°C	105.9
cSt @ 100°C	17.1
Viscosity Index	177
Flash Point, COC, °C/°F	219/426
Pour Point, °C/°F	-42/-44
Brookfield Viscosity, cP @ -40°C/-40°F	132,300
Phosphorus, wt%	0.03
Boron., wt%	0.02

* Results may vary due to, but not limited to operating severity. Extending drain intervals should always be undertaken in conjunction with an oil analysis program.



DURATRAN™ – UNIVERSAL TRACTOR TRANSMISSION OIL (THF, UTTO)

The DURATRAN THF/UTTO line of heavy-duty transmission-hydraulic fluids is designed for use in farm tractors, mining and construction equipment with a common oil system for transmission, differential, hydraulic, power take-off, wet brake and power-steering mechanisms.

Compared to competitive tractor fluids, DURATRAN fluids offer:

- **Outstanding resistance to breakdown caused by oxidation and high temperatures**

Formulated with high performance base oils and special oxidation inhibitors, DURATRAN fluids strongly resist sludge and varnish build-up, as well as fluid thickening to extend fluid change intervals considerably, past the OEM recommendations.

- **Controlled Frictional Properties**

DURATRAN fluids have excellent shear stability and the correct balance of lubricity and friction for the optimal operation of brakes, clutches and power-take off mechanisms. This helps prevent brake noise and brake chatter.

- **Protection against wear**

DURATRAN fluids exceed existing John Deere Extreme Pressure (EP) and Final Drive Gear Wear test requirements and perform well in the demanding Eaton/Vickers hydraulic pump wear test. These features provide excellent wear protection to bearings and gears under demanding, shock-loaded operating conditions.

- **Exceptional Low Temperature Performance**

Formulated with high performance base oils, DURATRAN fluids demonstrate exceptional low temperature fluidity, which allows easier cold weather start-up of all equipment, even at very low temperatures. DURATRAN XL Synthetic Blend and DURATRAN Synthetic may be used at temperatures down to -41°C/-42°F.

Typical characteristics are shown below:

DURATRAN				
		DURATRAN	XL Synthetic Blend	Synthetic
Viscosity	cSt @ 40°C	55.2	40.0	46.4
	cSt @ 100°C	9.4	8.45	9.9
Viscosity Index		153	193	206
Brookfield Viscosity,	cP @ - 20°C	2,670	1,120	1,310
	cP @ - 35°C	17,300	–	–
	cP @ - 40°C	61,200	13,750	14,430
Pour Point, °C/°F		-45/-49	-51/-58	-48/-53
Flash Point, COC, °C/°F		241/462	219/426	213/437
Base Number (D2896), mg KOH/g		10.2	10.3	10.3

DURATRAN™ fluids are recommended where the following specifications are called for:

Agricultural Equipment	
John Deere	DURATRAN JDM J20C, DURATRAN XL Synthetic Blend JDM J20D, DURATRAN Synthetic JDM J20C and JDM J20D
CNH (Case I.H., J.I. Case New Holland Group)	DURATRAN - MAT3540, MS-1209/MAT 3505, MS-1210/JIC-145/MAT 3506, MS-1230/CNH MAT 3509, ESN-M2C134-D/MAT 3525, MS-1207, MS-1206, MS-1205, MS-1204/JIC-185, B-6, B-5, JIC-144, JIC-143, FNHA-2-C-201.00, ESN-M2C134-A/B/C, ESN-M2C86-B/C, ESN-M2C53-A, ESN-M2C48-B
	DURATRAN XL Synthetic Blend - MS-1209/MAT 3505, MS-1210/JIC-145/MAT 3506, MS-1230/CNH MAT 3509, ESN-M2C134-D/MAT 3525, MS-1207, MS-1206, MS-1205, MS-1204/JIC-185, B-6, B-5, JIC-144, JIC-143, FNHA-2-C-200.00, ESN-M2C134-A/B/C, ESN-M2C53-A, ESN-M2C48-B
	DURATRAN Synthetic - MS-1209/MAT 3505, MS-1210/JIC145/MAT 3506, MS-1230/CNH MAT 3509, ESN-M2C134-D/MAT 3525 MS-1207, MS-1206, MS-1205, MS-1204/JIC-185, B-6, B-5, JIC-144, JIC-143, FNHA-2-C-201.00, FNHA-2-C-201.00A (134-D), FNHA-2-C-200.00, ESN-M2C134-A/B/C, ESN-M2C86-B/C ESN-M2C53-A, ESNM2C48-B
White Farm (Oliver)	Q-1826, Hydraulic Transmission Fluid (HTF), Q-1802, Q-1766B, Q-1722, Q-1705
Massey-Ferguson	M-1145* (DURATRAN, DURATRAN Synthetic), M-1141, M-1135, M-1143, M-1129-A, M-1127-A/B, M-1110

(*Note: For UTTO applications only. Do not use in engine application where Super Tractor Oil Universal (STOU) are recommended.)

(*Note: Many Tractor OEM's have since been consolidated to one Brand. Specifications have been noted to be the last known specification published for specific Tractor brand names. Check with your OEM supplier for the latest lubricant specification required for your equipment or your OEM Manual.)

AGCO / Deutz-Allis / Allis. Power Fluid 821XL, 272843, 257541, 246634 GIMA MF CMS M1145 (DURATRAN, DURATRAN Synthetic (Approved)), GIMA MF CMS M1141 (DURATRAN, DURATRAN XL Synthetic Blend, DURATRAN Synthetic)

Kubota UDT, Kubota UDT² (DURATRAN XL Synthetic Blend, DURATRAN Synthetic); Steiger (SEMS 17001); Versatile (ESN-M2C134-D); Landini (Tractor II Hydraulic Fluid); Hesston-Fiat (Oliofiat Tutela Multi-F); Volvo WB101 – 97303.(VCE 1273,03) (DURATRAN (Approved), DURATRAN Synthetic (Approved)); Valtra G2-98 DURATRAN and DURATRAN Synthetic.

ZF Transmissions: DURATRAN TE-ML 03E, 05F, 06K, 21F (axles). DURATRAN Synthetic TE-ML 03E, 05F, 21F (axles), Komatsu KES 07.866 (DURATRAN, DURATRAN Synthetic)

Mahindra as an Agriculture OEM - All three DURATRAN products

Kioti - DURATRAN XL Synthetic Blend (Approved)

Voith Heavy Industrial

Hitachi Heavy Industrial

AECON/ Miller

Heist / Kalmar / Kessler / Fantuzzi

DANA-OHTM-UTTO-LV (DURATRAN Synthetic - Approved)



- **Transmissions and Differentials**

API GL-4 (Manual Transmissions, Spiral Bevel Axles, and Hypoid gears in moderate service). Allison Type C-4 and C-3 Fluids (Obsolete). Caterpillar TO-2 (Obsolete). Sundstrand Hydrostatic Transmission Fluid. Dresser Construction Equipment Division - Transmission/Hydraulic Fluid. Clark Lift Truck Transmission Fluid TA12, TA18, HR 500 (DURATRAN XL, DURATRAN Synthetic), HR 600 (DURATRAN, DURATRAN Synthetic)

- **Hydraulic Pumps**

Parker / Abex / Denison: HF 0/1/2. Eaton / E-FDGN-TB002-E. Dynamatic Limited (DANFOSS-Plessey-Sundstrand)

PRODURO™ TO-4+ – TRANSMISSION DRIVE TRAIN OIL (TDTO)

PRODURO TO-4+ products are a line of Transmission and Drive Train Oils (TDTO) formulated to meet or exceed Caterpillar's TO-4 requirements for transmission and drive line fluids.

PRODURO TO-4+ oils are available in six grades: SAE 10W, 30, 50, 60, XL Synthetic Blend LoTemp and Synthetic All Season. The last two products are formulated with special base oils which confer multigrade pumpability equivalent to SAE 0W-20 and SAE 5W-30 respectively. They have been fully tested and comply with the performance requirements of Caterpillar TO-4, API GL-3 (Inactive) and the obsolete categories of Allison C-4 (transmission), API CD (Diesel Engine), Caterpillar TO-2 and Eaton/Vickers (M-2950/I-280-S). They are recommended for use in hydraulics, manual transmissions and drive lines, where a TO-4 oil is recommended. Other OEMs include Komatsu's KES 07.868.1, Komatsu-Dresser, Dana Power shift, Tremac and Euclid Specifications.

Typical characteristics are shown below:

PRODURO TO-4+						
SAE Grade	10W	30	50	60	XL Synthetic Blend LoTemp	Synthetic All Season
Viscosity cSt @ 40°C	35.4	88.5	213.9	368.9	35.1	55.8
cSt @ 100°C	6.3	11.0	18.3	26.4	7.4	10.7
Viscosity Index	128	110	96	96	184	187
HT/HS @ 150°C	2.2	3.5	5.0	6.5	2.7	3.7
Flash Point, COC, °C/°F	239/462	259/498	257/487	253/487	209/408	222/432
Pour Point, °C/°F	-33/-27	-27/-17	-30/-17	-24/-6	-51/-60	-48/-54
Cold Crank Viscosity, cP @ °C/°F	5,219@ -25/-13	10,433@ -20/-4	11,800@ -10/14	12,909@ -5/23	4,403@ -35/-31	6,530@ -30/-22
Brookfield cP @ °C/°F Viscosity,	48,100@ -35/-31	28,006@ -26/-15	33,780@ -15/5	36,960@ -10/14	10,140@ -40/-40	14,720@ -35/-31
Performance Level	Caterpillar TO-4 (June 05) ZF TE-ML 03C — Komatsu KES 07.868.1	Caterpillar TO-4 (June 05) ZF TE-ML 03C and 07F — Komatsu KES 07.868.1	Caterpillar TO-4 (June 05) — Komatsu KES 07.868.1	Caterpillar TO-4 (June 05) — Komatsu KES 07.868.1	Caterpillar TO-4 (June 05) — Komatsu KES 07.868.1	Caterpillar TO-4 (June 05) ZF TE-ML 03C — Komatsu KES 07.868.1



Generic Operating Temperature Range Based on Viscometrics (TO-4)

Application	PROUDURO™ TO-4+ Product		
Hydrostatic Transmissions	10W 30 XL Synthetic Blend Lo Temp Synthetic All Season	-20°C to +40°C +5°C to +50°C -43°C to +40°C -34°C to +45°C	(-4°F to +104°F) (+41°F to +122°F) (-45°F to +104°F) (-29°F to +113°F)
Hydraulic	10W 30 XL Synthetic Blend Lo Temp Synthetic All Season	-25°C to +50°C -15°C to +50°C -43°C to +40°C -34°C to +50°C	(-13°F to +122°F) (+5°F to +122°F) (-45°F to +104°F) (-29°F to +122°F)
Powershift Transmissions	10W 30 50 XL Synthetic Blend Lo Temp Synthetic All Season	-21°C to +10°C -9°C to +35°C +5°C to +37°C -43°C to +10°C -34°C to +30°C	(-6°F to +50°F) (+16°F to +95°F) (+41°F to +99°F) (-45°F to +50°F) (-29°F to +86°F)
Final Drives On-Highway	10W 30 50 60 XL Synthetic Blend Lo Temp Synthetic All Season	-30°C to 0°C -25°C to +25°C -18°C to +50°C -11°C to +55°C -47°C to 0°C -37°C to +25°C	(-22°F to +32°F) (-13°F to +77°F) (0°F to +122°F) (+12°F to +131°F) (-53°F to +32°F) (-35°F to +77°F)
Final Drives Off-Highway	10W 30 50 60 XL Synthetic Blend Lo Temp Synthetic All Season	-30°C to -10°C -25°C to +15°C -18°C to +34°C -11°C to +55°C -47°C to 0°C -37°C to +15°C	(-22°F to +14°F) (-13°F to +59°F) (0°F to +93°F) (+12°F to +131°F) (-53°F to +32°F) (-35°F to +59°F)

From time to time, Caterpillar publishes revisions to lubricant recommendations for their various equipment. Users are encouraged to visit the CAT website to download the most recent version of these recommendations, document SEBU 6250.

PRODURO™ FD-1 60 – FINAL DRIVE AND AXLE LUBRICANT FOR CATERPILLAR EQUIPMENT

PRODURO FD-1 60 is Petro-Canada Lubricants primary recommendation for the final drives and axles of Caterpillar off-highway equipment, especially those that operate under severe conditions. PRODURO FD-1 60 provides improved gear and bearing life in final drives and axles and can be used in final drives and axles that previously specified TO-4 lubricants and do not contain friction material and/or wet brakes. The recommended drain interval for FD-1 60 is 4000 hours for off-highway trucks, final drive and rear axles instead of the 2000 hour interval typically recommended for TO-4 fluids. PRODURO FD-1 60 should not be used in compartments containing friction material unless an FD-1 type of product is specified. This product is not designed for use in engines, transmission hydraulic systems, or older Caterpillar (789 series haul trucks) final drive technology where ZDDP anti-wear additive technology is better suited.

Typical characteristics are shown below:

PRODURO FD-1 60	
SAE Grade	60
Viscosity cSt @ 40°C	360.6
cSt @ 100°C	26.5
Viscosity Index	98
Flash Point, COC, °C/°F	277/531
Pour Point, °C/°F	-24/-11
Brookfield Viscosity, cP @ °C/°F	33,720@-10/+14
Borderline Pumping Viscosity, cP @ °C/°F	2,490 (calculated) @+10/+50
Borderline Pumping Viscosity, cP @ °C/°F	79,699 @ -15/+5
Performance Level	Caterpillar FD-1 (Dec 01)



PRODURO™ FD-1 SYNTHETIC – FINAL DRIVE AND AXLE LUBRICANT FOR CATERPILLAR EQUIPMENT

PRODURO FD-1 Synthetic is Petro-Canada Lubricants primary recommendation for the final drives and axles of Caterpillar off-highway equipment, especially those that operate under colder temperatures with frequent heat cool cycles. PRODURO FD-1 Synthetic provides improved gear and bearing life in final drives and axles and can be used in final drives and axles that previously specified TO-4 lubricants. The recommended drain interval for FD-1 Synthetic is up to 6000 hours for off-highway trucks, final drive and rear axles instead of the 2000 hour interval typically recommended for TO-4 fluids. PRODURO FD-1 Synthetic should not be used in compartments containing friction material unless an FD-1 type of product is specified. This product is not designed for use in engines, transmission hydraulic systems, or older Caterpillar (789 series of haul trucks) final drive technology, where ZDDP anti-wear additive technology is better suited.

Typical characteristics are shown below:

PRODURO FD-1 SYNTHETIC	
SAE Grade	Multigrade
Viscosity cSt @ 40°C	286.5
cSt @ 100°C	31.8
Viscosity Index	152
Flash Point, COC, °C/°F	243/469
Pour Point, °C/°F	-39/-38
Brookfield Viscosity, cP @ °C/°F	126,000@-30/-22
Brookfield Viscosity, cP @ °C/°F	29,900@-20/-4
Borderline Pumping Viscosity, cP @ °C/°F	119,740@-30/-22
Performance Level	Caterpillar FD-1 Synthetic (Caterpillar FD-1 (Dec 01))

OTHER AUTOMOTIVE LUBRICANTS (2-STROKE)

Petro-Canada Lubricants small engine oil is designed to give excellent performance in air-cooled, two-strokes per cycle engines operating under all conditions. This oil is especially formulated for use in oil injection as well as conventional pre-mixed gasoline/oil lubricated two-stroke engines.

Petro-Canada Lubricants small engine oil contains high performance additives, which give excellent anti-scuff and anti-wear performance to ensure reliability, internal cleanliness and long engine life. The additive system used produces minimal spark plug, ring, piston and valve deposits allowing for good starting and continued efficient engine operation.

Petro-Canada Lubricants small engine oil also contains special rust inhibitors with a high film strength, which protect engines against rust during use and in storage.

Basic manufacturers' recommendations should be followed so as to obtain maximum protection during prolonged storage. Care should be taken not to mix two-stroke oils from different manufacturers.



SUPREME™ SYNTHETIC BLEND 2-STROKE SMALL ENGINE OIL

Petro-Canada SUPREME Synthetic Blend 2-Stroke Small Engine Oil is a premium synthetic blend, low ash, two-strokes per cycle engine oil for use in many conventional pre-mix fuel/oil, as well as oil injection lubricated engines.

Petro-Canada SUPREME Synthetic Blend 2-Stroke Small Engine Oil is certified against JASO FC and meets the requirements of ISO-L-EGC and API TC.

It is designed to lubricate air-cooled, 2-stroke engines in motorcycles, mopeds, snowmobiles, chain saws, generators, lawn mowers, weed trimmers and other landscaping equipment. It is suitable for use in oil injection and premixed lubricated engines at gasoline/oil ratios up to 100:1.

It is recommended for use in air-cooled, 2-stroke snowmobiles including those manufactured by (and more): Bombardier, Arctic Cat, Polaris and Yamaha.

It is recommended for use in 2-stroke lawn maintenance/ forestry equipment including those manufactured by:

- Dolmar
- Hitachi
- Husqvarna
- John Deere
- Kawasaki
- Lawn Boy
- Massey Ferguson
- Polaris
- Powermate (formerly Honda Coleman)
- Poulan
- Stihl
- Tecumseh
- Weedeater
- Woods
- Yamaha
- Yardman

It is recommended for use in 2-stroke small cc motorcycles and scooters including those manufactured by (and more):

- Yamaha
- Bombardier (BRP)
- Kawasaki
- TVS
- Honda

SUPREME Synthetic Blend 2-Stroke Small Engine Oil has the following features:

- Controls deposit formation, ring-sticking and prevents exhaust-port plugging
- Superior anti-wear and anti-scuff protection
- Minimizes spark plug fouling and engine preignition
- Provides excellent protection against rust and corrosion
- Mixes easily with gasoline and pumps readily down to -40 °C/°F
- Formulated for oil injection as well as premixed gasoline/oil lubricated engines
- Keeps smoke emissions low when used at recommended gasoline/oil ratios
- Dyed blue-green for easy detection of gasoline/oil mixtures

SUPREME Synthetic Blend 2-Stroke Small Engine Oil is suitable for use against API Classification TC, TISI, ISO-L-EGC, SAE Fluidity/Miscibility (F/M) Grade 4 and JASO FA, FB and is certified against JASO FC (PCL 694 and PCL 695).

Typical characteristics are shown below:

SUPREME™ Synthetic Blend 2-Stroke Small Engine Oil		
Viscosity	cSt @ 40°C	34.7
	cSt @ 100°C	6.8
Viscosity Index		158
Flash Point, COC, °C/°F		151/304
Pour Point, °C/°F		-51/-60
Brookfield Viscosity, cP @ °C		14,490@ -40
Sulphated Ash, % Wt		0.10
Color		Blue/Green
Suitable Performance Level		API TC SAE F/M Grade 4 JASO FA, FB and FC ISO-L-EGC TISI

QUICK MIX CHART						
Quantity of Oil per Container of Gasoline†						
Container Volume	5 L	10 L	25 L	1 Gal	2 Gal	5 Gal
Gasoline to Oil Ratio	mL of Oil	mL of Oil	mL of Oil	oz of Oil	oz of Oil	oz of Oil
16:1	315	625	1560	8.0	16.0	40.0
24:1	210	415	1040	5.5	10.5	26.5
32:1	155	315	780	4.0	8.0	20.0
50:1	100	200	500	2.5	5.0	13.0
100:1	50	100	250	1.5	2.5	6.5

†All units are measured by metric and US standards.

A black and white photograph of two men in a workshop or industrial setting. The man on the left is wearing a white button-down shirt and a dark baseball cap, looking towards the right. The man on the right is wearing a dark long-sleeved shirt and a dark baseball cap, looking towards the left. They appear to be in conversation. A large blue diagonal graphic element cuts across the image from the top left to the bottom right.

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INTRODUCTION

Businesses today place heavy demands on industrial plants and machinery. Equipment is expected to operate at temperatures between -50°C and 150°C (-58°F and 302°F) without losing production or increasing maintenance costs. Notwithstanding these extremes of temperature, machines today are operated under heavier loads, run at higher speeds, with smaller oil reservoirs and at longer lubricating intervals than ever before.

Proper lubrication is vital to any operation and is determined by the “Five Rights”:

- Right Type of Lubricant
- Right Quality
- Right Amount
- Right Place
- Right Time / Frequency

Your Original Equipment Manufacturer (OEM) together with a company representative or a technical services advisor can assist you in determining the “Five Rights” for your equipment or machinery.

VISCOSITY CLASSIFICATION OF INDUSTRIAL OILS

It was common practice in North America to define the viscosity of industrial lubricating oils in Saybolt Universal Seconds (SUS) at reference temperatures of 100°F and 210°F. However, there is now worldwide acceptance of the International Organization for Standardization's (ISO) system for viscosity measurement in centistokes (cSt) at 40°C and 100°C.

ADVANTAGES OF ISO VISCOSITY GRADES

- International acceptance benefits customers, manufacturers, and marketers.
- The number in the product name for most products represents the viscosity of an industrial oil, which is often the lubricant grade recommended by the equipment manufacturer.
- Conversion from one viscosity measurement to another is virtually eliminated.

Automotive engine and gear oils are not classified using the ISO measurement system. They continue to be described by the Society of Automotive Engineers (SAE) viscosity classifications (see Automotive Lubricants Section).

The table below shows the kinematic viscosity limits for each ISO Viscosity Grade. Each viscosity grade is 50% higher in viscosity than the preceding viscosity grade. These limits are set at a 10 percent tolerance level above and below the mid-point of a grade. Any product with a viscosity outside these tolerance levels is not a recognized ISO Viscosity Grade.



Viscosity System for Industrial Fluid Lubricants ^A – ASTM D2422 – 97 (2013)			
Viscosity System Grade Identification	Mid-Point Viscosity, cSt (mm ² /s) at 40.0°C	Kinematic Viscosity Limits, cSt (mm ² /s) at 40.0°C ^{B,C}	
		min	max
ISO VG 2	2.2	1.98	2.42
ISO VG 3	3.2	2.88	3.52
ISO VG 5	4.6	4.14	5.06
ISO VG 7	6.8	6.12	7.48
ISO VG 10	10	9.00	11.0
ISO VG 15	15	13.5	16.5
ISO VG 22	22	19.8	24.2
ISO VG 32	32	28.8	35.2
ISO VG 46	46	41.4	50.6
ISO VG 68	68	61.2	74.8
ISO VG 100	100	90.0	110
ISO VG 150	150	135	165
ISO VG 220	220	198	242
ISO VG 320	320	288	352
ISO VG 460	460	414	506
ISO VG 680	680	612	748
ISO VG 1000	1000	900	1100
ISO VG 1500	1500	1350	1650
ISO VG 2200	2200	1980	2420
ISO VG 3200	3200	2880	3520

A This system implies no evaluation of quality.

B This system is used in ISO 3448.

C If 40°C is not the temperature used when determining the viscosity (as is sometimes the case with very viscous fluids) then the related viscosity at 40°C shall be established by using Viscosity Temperature charts found in ASTM D341.

AGMA VISCOSITY GRADE REQUIREMENTS

The American Gear Manufacturers Association (AGMA) used to have a numbering system to define gear oil viscosity required for various gear lubrication applications. AGMA is currently using ISO viscosity grade classifications, but these AGMA Lubricant Numbers are still sometimes stamped on the manufacturer's metal name plate. ISO viscosity grades and former AGMA grades are cross-referenced in the table below.

Viscosity grade requirements				
American National Standard		ANSI/AGMA 9005-F16		
ISO viscosity grade	Mid-point viscosity at 40°C mm ² /s*	Kinematic viscosity limits at 40°C mm ² /s*		Former AGMA grade equivalent
		min	max	
ISO VG 32	32	28.8	35.2	0
ISO VG 46	46	41.4	50.6	1
ISO VG 68	68	61.2	74.8	2
ISO VG 100	100	90.0	110	3
ISO VG 150	150	135	165	4
ISO VG 220	220	198	242	5
ISO VG 320	320	288	352	6
ISO VG 460	460	414	506	7
ISO VG 680	680	612	748	8
ISO VG 1000	1000	900	1100	8A
ISO VG 1500	1500	1350	1650	9
ISO VG 2200	2200	1980	2420	10
ISO VG 3200	3200	2880	3520	11

NOTES:

* The preferred unit for kinematic viscosity is mm²/s, commonly referred to as centistoke (cSt).

- TURBOFLO™ R&O can be used where AGMA Inhibited (rust and oxidation inhibited) Gear Oils are required.
- ENDURATEX™ EP, ENDURATEX XL Synthetic Blend and ENDURATEX Synthetic EP oils can be used where AGMA Antiscuff (formerly known as Extreme Pressure or EP) Gear Lubricants are required.
- ENDURATEX Mild Worm Gear Oils, which contain special lubricity additives, can be used where AGMA Compounded Gear oils are required.
- Automotive gear oils, such as TRAXON™, are defined by the SAE for viscosity and the API for quality. These oils can be used in gear boxes but industrial gear oils formulated to meet former AGMA requirements cannot be used in automotive differentials or transmissions.
- SYNDURO™ SHB is suitable for many gear oil applications such as worm gears and helical gear boxes and has an excellent FZG Failure Load Stage of 12+. For those applications that are subjected to heavy loads or shock loading and require an AGMA Antiscuff type of fluid, ENDURATEX Synthetic EP is recommended.

VISCOSITY COMPARISONS

Viscosities designated by various organizations may be compared as shown in the Viscosity Equivalents table (next page). This is strictly a viscosity comparison and should not be construed as a quality level comparison.

ISO VG – Viscosity measurement in centistokes (cSt) at 40°C.

AGMA – Viscosity grades as formerly designated by the American Gear Manufacturers Association.

SAE – Society of Automotive Engineers viscosity measurement for automotive engine and gear oils e.g. SAE 30, SAE 90, etc.

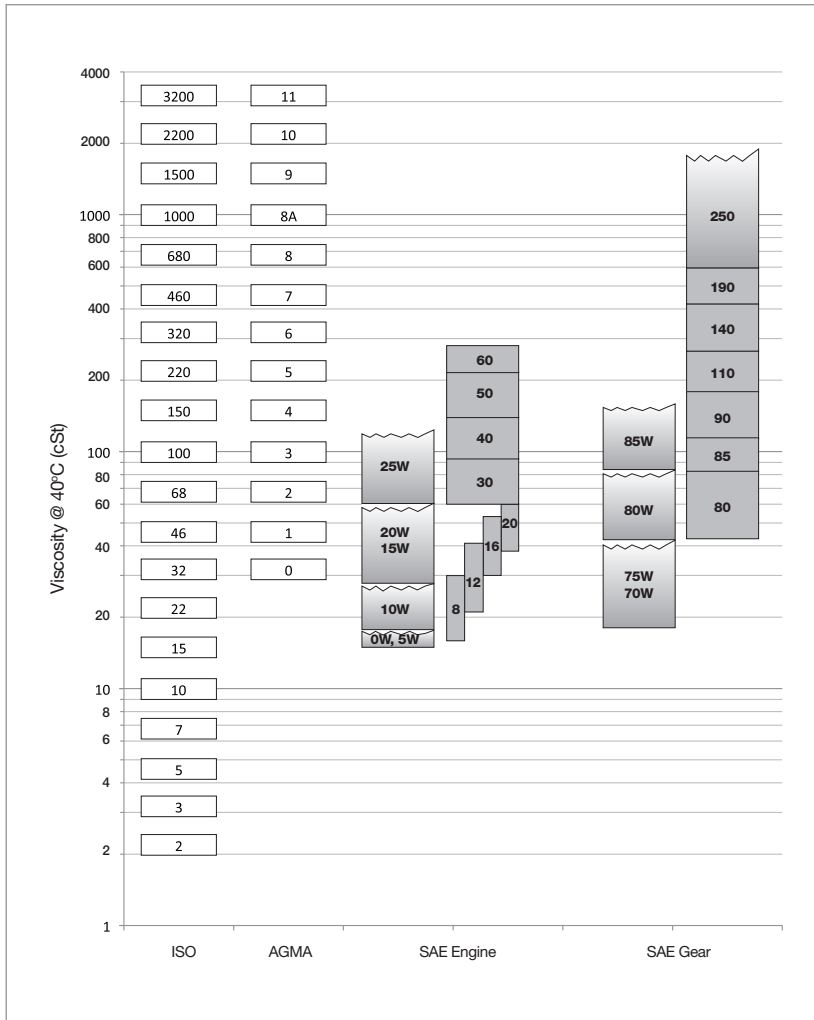
How to use the chart:

If a manufacturer requires an SAE 20 oil for a piece of equipment, go to the SAE viscosity column and follow across horizontally to the left to read an ISO VG of 46.



VISCOSITY EQUIVALENTS

Comparison of ISO/AGMA/SAE Viscosities at 40°C



NOTE:

- Read horizontally.
- Equivalence is in terms of viscosity at 40°C only.
- Viscosities of SAE engine oils based on a VI of 150, an estimated average of current Passenger Car Motor Oil and Heavy-Duty Engine Oil products.
- Viscosities of SAE gear oils based on a VI of 130, an estimated average of current Automotive Gear products.
- Viscosity limits are approximate: for precise data, consult ISO, AGMA and SAE specifications.
- SAE W grades are represented only in terms of approximate 40°C viscosity. For low temperature limits, consult SAE specifications.

COMPRESSOR FLUIDS

COMPRO™ – AIR COMPRESSOR FLUIDS

COMPRO Compressor Fluids are ashless air compressor fluids formulated to provide long and highly reliable service life in industrial air compressor applications. COMPRO Compressor Fluids are available in 32 and 68 viscosity grades (for additional grades see COMPRO XL-S). They are suitable for use in compressors that handle air, and inert gases such as nitrogen, argon, hydrogen, neon, helium, carbon dioxide, carbon monoxide and blast furnace gas.

COMPRO Compressor Fluids can be used in rotary screw compressors to a maximum of 2,000 hours at air discharge temperatures up to 85°C/185°F, in centrifugal compressors for up to two years at air discharge temperatures up to 50°C/122°F, and in reciprocating compressors for shorter duration. COMPRO 68 meets the requirements of DIN 51506 VDL.

Air compressors in continuous service or operating at elevated discharge temperatures should use COMPRO XL-S and COMPRO Synthetic for extended life.

COMPRO Compressor Fluid		
	32	68
Viscosity cSt @ 40°C	36.6	68
cSt @ 100°C	6.0	8.7
Viscosity Index	108	99
Flash Point, COC, °C/°F	230/446	238/460
Pour Point, °C/°F	-39/-38	-30/-22

NOTE 1: Do not use in breathing air apparatus or medical equipment. COMPRO air compressor fluids should **never** be used in any equipment compressing pure oxygen. **Please note that in the case of chemically active gases such as chlorine, oxygen and hydrogen chloride, no petroleum lubricant is recommended.**

NOTE 2: Consult Tech Bulletin "TB-1217 - Guidelines for Converting to COMPRO Compressor Fluids" before changing over to any of the COMPRO fluids.



COMPRO™ XL-S – AIR COMPRESSOR FLUIDS

COMPRO XL-S Compressor Fluids are formulated to extend compressor fluid life in rotary screw air compressors, with minimal carbon deposits or varnish formation.

COMPRO XL-S is particularly recommended for air compressors in continuous service operating at discharge air temperatures up to 85°C/185°F. Such rotary screw compressors may be run for up to one year (8,000 hours) in continuous operation. This is at least four times the life of conventional mineral oil based compressor fluids.

While particularly effective in rotary screw compressors, COMPRO XL-S can also be used in centrifugal compressors for up to three years at air discharge temperatures up to 50°C/122°F. COMPRO XL-S 68, 100 and 150 meet the requirements of DIN 51506 VDL, and can be used in reciprocating compressors for shorter duration.

Typical characteristics are shown below:

COMPRO XL-S					
	32	46	68	100	150
Viscosity cSt @ 40°C	37	47	71	101	147
cSt @ 100°C	6.0	7.2	11.6	14.0	16.1
Viscosity Index	107	114	157	141	115
Flash Point, COC, °C/°F	243/469	253/487	271/520	261/502	287/549
Pour Point, °C/°F	-42/-44	-42/-44	-36/-33	-36/-33	-24/-11
Ramsbottom Carbon, % Wt	0.04	0.05	0.05	0.06	0.09

Note: Do not use in breathing air apparatus or medical equipment. COMPRO XL-S rotary screw air compressor fluids should **never** be used in any equipment compressing pure oxygen. **Please note that in the case of chemically active gases such as chlorine, oxygen and hydrogen chloride, no petroleum lubricant is recommended.**

COMPRO™ SYNTHETIC – AIR COMPRESSOR FLUID

COMPRO Synthetic is a premium fluid that has been specifically developed for rotary screw air compressors operating in severe service environments, particularly those with high air-discharge temperatures up to 105°C/221°F. COMPRO Synthetic outperforms PAO synthetic based fluids at these high discharge temperatures - up to one year continuous service or 8,000 hours. (NOTE: This is a Polyalkylene Glycol / Ester blend and should never be mixed with mineral oils or Polyalphaolefin synthetics.)

Typical characteristics are shown below:

COMPRO Synthetic Compressor Fluid		
Viscosity	cSt @ 40°C	41
	cSt @ 100°C	7.6
Viscosity Index		157
Flash Point, COC, °C/°F		257/495
Pour Point, °C/°F		-51/-60

Note: Do not use in breathing air apparatus or medical equipment. COMPRO Synthetic air compressor fluid should **never** be used in any equipment compressing pure oxygen. **Please note that in the case of chemically active gases such as chlorine, oxygen and hydrogen chloride, COMPRO Synthetic must not be used.**

COMPRO E COMPRESSOR FLUID

COMPRO E Compressor Fluids are fully synthetic, high performance ester based lubricants formulated to provide superior protection in rotary screw, rotary vane, centrifugal, and reciprocating air compressors*.

COMPRO E Compressor Fluids are recommended for single and multistage air compressors, such as rotary vane compressors, rotary screw compressors, reciprocating compressors, and centrifugal compressors. Please note that not all viscosity grades are suitable for all compressor types; please follow compressor OEM recommendations and follow the operation manual of the specific brand and model of compressor. COMPRO E Compressor Fluids are ester based fluids that are compatible with mineral oil products.

COMPRO E Compressor Fluids are compatible with standard rubbers/elastomers used in most compressor components:

Recommended to use with Teflon, Viton, High Nitrile Rubber-Buna N (>36% nitrile content). Fair compatibility with Nitrile Rubber-Buna N (30%-36% nitrile content), Silicone Rubber, Ethylene-Propylene Terpolymer, Polyacrylate Rubber, and Epichlorohydrin. Not recommended to use with Natural Rubber, Neoprene, Nitrile Rubber, Butyl Rubber, and Styrene.



COMPRO™ E Compressor Fluids are compatible with the following standard paints and coating used in most compressor components:

Recommended to use with Epoxy, Baked Phenolic, Oil Resistant Alkyd, Cured (moisture) Urethane

Fair compatibility with Industrial Latex

Not recommended to use with Acrylic, Vinyl (PVC), Lacquer, Varnish, Latex (household type).

Note: COMPRO E Compressor Fluids should not be used in systems compressing wet or sour hydrocarbon gases. For these applications, Petro-Canada Lubricants Compressor Oil RP, SPX or NGS compressor fluid are recommended.

Note: Do not use in breathing air apparatus or medical equipment.

Note: COMPRO E Compressor Fluids must not be used in the compression of oxygen, or other chemically active gases such as chlorine or hydrogen chloride.

* Not all viscosity grades are suitable for all compressor types, please follow compressor OEM recommendations.

	Test Method	COMPRO E COMPRESSOR FLUID			
		46	68	100	150
Viscosity, cSt @ 40°C	ASTM D445	46	68	100	150
cSt @ 100°C	ASTM D445	8	10	13	18
Viscosity Index	ASTM D2270	138	138	121	128
Flash Point, COC, °C (°F)	ASTM D92	249 (480)	247 (477)	243 (469)	245 (473)
Pour Point, °C (°F)	ASTM D5950	-57 (-71)	-51 (-60)	-42 (-44)	-45 (-49)

The values quoted above are typical of normal production. They do not constitute a specification.

COMPRESSOR OIL RP NATURAL GAS COMPRESSOR OIL

Compressor Oil RP 268 and RP 460 are specially designed for the lubrication of cylinders and rod packings in natural gas reciprocating compressors having force-feed lubrication systems.

These compressor oils are formulated with an advanced, non-fatty additive package to provide excellent high temperature stability, very good lubricity and wear protection, as well as minimizing deposit formation. They are primarily recommended for use in compressing sour, wet or contaminated natural gas. The higher viscosity RP 460 is especially suited for use in higher pressure applications.

Compressor Oils RP 268 and RP 460 may also be used for the initial break-in (first 500 hours running) of compressor cylinders in sweet or dry gas service.

Typical characteristics are shown below:

Compressor Oil RP		
	268	460
Viscosity cSt @ 40°C	269	393
cSt @ 100°C	22.0	28.0
Viscosity Index	98	97
Flash Point, COC, °C/°F	278/532	297/567
Pour Point, °C/°F	-18/0	-12/10
Ramsbottom Carbon Residue, wt%	1.2	1.2



Note: In selecting a compressor oil it is important to know not only the equipment manufacturer and model, but also the gas being compressed and the discharge pressure. In the table below, various gases are categorized for the type of lubricant required.

Please note that in the case of chemically active gases such as chlorine, oxygen and hydrogen chloride no petroleum lubricant is recommended.

VARIOUS GASES	LUBRICANT
<ul style="list-style-type: none">• Inert – Argon, Carbon Dioxide, Carbon Monoxide, Hydrogen, Helium, Neon, Nitrogen, Blast Furnace Gas.	<ul style="list-style-type: none">• Same as for air.
<ul style="list-style-type: none">• Hydrocarbon Gases – Methane, Acetylene, Ethane, Propane, Butane, Coke Oven Gas.	<ul style="list-style-type: none">• Same as for natural gas.
<ul style="list-style-type: none">• Chemically Active – Chlorine, Oxygen, Hydrogen Chloride.	<ul style="list-style-type: none">• No petroleum lubricant.
<ul style="list-style-type: none">• Ammonia	<ul style="list-style-type: none">• REFLO 46A, 68A, REFLO 68 Synthetic, REFLO XL Synthetic Blend

REFLO™ – REFRIGERATION COMPRESSOR OILS

The REFLO line of refrigeration compressor fluids is developed for use in commercial refrigeration compressor systems.

REFLO CFC is formulated for use in systems using CFC (chlorinated fluorocarbon) refrigerants such as Freon, Genetron and Isotron. It is a highly refined naphthenic oil with excellent low temperature properties. It is not recommended in HFC (hydrofluorocarbons) systems such as R134a or R23.

REFLO CFC can be used in ammonia refrigeration systems. REFLO CFC can also be used at moderate temperatures with HCFC (hydrochlorinated fluorocarbon) refrigerants such as R-22, R-123, R-124, R-141b, R-142b, R-502 as well as Methyl Chloride and Carbon Dioxide (R-744).

REFLO 46A and 68A are formulated from pure paraffinic base stocks and continue to provide exceptional service in ammonia refrigeration systems. REFLO's lower solubility in ammonia can reduce carryover and help to improve system efficiency and performance through proper system maintenance. Its excellent thermal and oxidative stability can also help to extend fluid life.

REFLO XL Synthetic Blend is a refrigeration compressor fluid used in industrial ammonia refrigeration systems. REFLO XL Synthetic Blend is formulated to outperform straight API Group II, solvent refined paraffinic and naphthenic refrigeration oils by extending service life. It has good compatibility with seal materials; it contains a seal swell agent to reduce fluid leaks. REFLO XL Synthetic Blend is miscible with similar paraffinic mineral oil based products.

REFLO products meet the requirements of many refrigeration OEMs, including Sabroe, Grasso, Frick, Mycom, Frigoscandia, Gram, Vilter, Huppmann GMBH, J&E Hall, Howden, FES, and Dunham-Busch. Check with the Original Equipment Manufacturer, the technical data sheet and consult with a technical services representative for details.

Please refer to TB-1164 and TB-1197 for change-out and warranty advice.

Typical characteristics are shown below:

	REFLO CFC	REFLO 46A	REFLO 68A	REFLO XL Synthetic Blend
Viscosity cSt @ 40°C	60	46	58	59
cSt @ 100°C	6.5	6.9	7.9	8.5
Viscosity Index	48	106	101	115
Flash Point, COC, °C/°F	191/376	222/432	236/457	227/441
Pour Point, °C/°F	-39/-38	-42/-44	-42/-44	-45/-49
Floc Point, °C/°F	-50/-58	NA	NA	NA
Minimum recommended evaporator temperature, °C/°F	-36/-33	-39/-38	-39/-38	-42/-44

Food Industry Approvals

REFLO XL Synthetic Blend, REFLO 46A and REFLO 68A are NSF H2 registered.



REFLO™ SYNTHETIC

REFLO Synthetic 68A is formulated to lubricate ammonia refrigeration compressors used in large commercial operations such as cold stores, marine systems and food processing plants; specifically blast freezers that have very low temperature control, such as pharmaceuticals and microelectronics. REFLO Synthetic 68A can be used in ammonia refrigeration systems where evaporator temperatures are as low as -51°C/-60°F.

REFLO Synthetic 68A is miscible with mineral oils such as hydrotreated (HT) and solvent refined (SR) paraffinic oils.

REFLO Synthetic 68A is designed to have good compatibility with seal materials; it contains a seal swell agent to help reduce fluid leaks.

REFLO Synthetic 68A is compatible with elastomers made of materials such as NBR, SBR, CR, NR, MVQ and FKM (Viton).

Please refer to TB-1164 and TB-1197 for change-out and warranty advice.

Typical characteristics are shown below:

REFLO Synthetic 68A		
Viscosity	cSt @ 40°C	62
	cSt @ 100°C	8.9
Viscosity Index		119
Flash Point, COC, °C/°F		245/473
Pour Point, °C/°F		-54/-65
Minimum recommended evaporator temperature, °C/°F		-51/-60

COMPRESSION OF NATURAL GAS

A key concern in hydrocarbon applications is hydrocarbon gas dilution of the lubricant. This dilution can reduce the lubricant's working viscosity, which can be detrimental to equipment protection. That's why we consider the compressor operating conditions, and gas analysis results to assess the potential dilution of the lubricant for each application before making a product recommendation. Please contact a Technical Services Advisor, who can recommend an appropriate fluid for your application.

SPX 5000, 7100, 7000, 7220

SPX 5000, 7100, 7000 and 7220 are unique products specifically formulated for lubricating and cooling reciprocating and rotary screw compressors handling hydrocarbon gases, such as propane and natural gas. Unlike mineral oils, the SPX series PAG lubricants have a much lower gas solubility, which reduces dilution and the amount of decrease in viscosity and greatly improves separation of the lubricant from the hydrocarbon gases. These PAG based fluids are incompatible with all other oils; both mineral and synthetic based. Due to differences in base stock and additives between SPX 5000 and SPX 7000, these products should not be mixed. There are no compatibility issues but mixing will alter the characteristics and performance of the products. By contrast, SPX 7000 and SPX 7100 compressor lubricants are designed for use where heavier hydrocarbons or some natural gas liquids may be present alongside methane and ethane. SPX 7000 and SPX 7100 can be used for the compression of sour natural gas. SPX 5000 is intended for propane compression in refrigeration systems.

SPX 7000 and SPX 7220 are available for once-through rod packing and cylinder lubrication (not crankcase) in reciprocating compressors at high pressures.

SPX 7000 and SPX 7220 are recommended for:

- Compression of heavy hydrocarbon and water contaminated natural gas streams
- Compression of dry Natural gas with CO₂
- Compression of dry Natural gas with H₂S

SPX 7000 and 7100 are recommended for screw compressor applications such as:

- Compression of hydrocarbon mixtures containing butane and other hydrocarbon gases where the expected dilution by gases other than natural gas is greater than 10 wt%
- Sour natural gas and acid gas compression:
 - SPX 7100 and SPX 7000 will dissolve high levels of water at temperatures below 70°C / 158°F, helping to prevent corrosion during compressor shutdown
 - SPX 7100 is an ISO Viscosity Grade 100 and SPX 7000 is an ISO Viscosity Grade 150

SPX 5000 is a PAG recommended for use in screw and reciprocating compressor applications for:

- Compression of propane in refrigeration systems
- Compression of sweet, dry natural gas where <10% dilution is expected
- SPX 5000 is an ISO Viscosity Grade 150



Typical characteristics are shown below:

SPX					
		5000	7100	7000	7220
Viscosity	cSt @ 40°C	146	102	151	218
	cSt @ 100°C	23	21	29	41
Viscosity Index		185	226	235	242
Flash Point, COC, °C/°F		260/500	249/480	268/514	240/464
Pour Point, °C/°F		-34/-29	-51/-60	-45/-49	-42/-44
ISO Grade		150	100	150	220

NG COMPOIL AW

Petro-Canada Lubricants NG CompOil AW 150 and 220 are mineral oil compressor fluids specially designed for use in reciprocating compressors. These products are for sweet, mostly light natural gas service operating at low pressure and employ a non-detergent formulation.

NG CompOil AW can be used in natural gas compressor skids where the engine and compressor lube oil feeds are from separate tanks. This low pour point formulation is suitable for remote locations where climate control is not practical.

NG CompOil AW compressor oils are recommended for use in:

- Lubrication of cylinders / packings of reciprocating compressors in sweet, light natural gas service at low pressure. Both the ISO VG 150 as well as the ISO VG 220 product.
- Crankcase of natural gas reciprocating compressors where an R&O type oil with anti-wear is recommended. ISO VG 150 product only.

Typical characteristics are shown below:

NG CompOil AW			
	150	220	
Viscosity	cSt @ 40°C	141	218
	cSt @ 100°C	14.4	19.2
Viscosity Index		101	99
Flash Point, COC, °C/°F		277 / 531	291/556
Pour Point, °C/°F		-33 / -27	-30 / -22

NG SCREW COMPOIL

Petro-Canada Lubricants NG Screw Compressor Oil fluids are designed for use in flooded screw compressors in natural gas production and service and are intended for the compression of the lightest hydrocarbon gases at moderate discharge temperatures.

These mineral oil based fluids include select additive chemistry to help protect metal surfaces against corrosion and to provide excellent performance in harsh natural gas streams. The additive system is compatible with sour (H₂S) hydrocarbon gas systems.

NG Screw CompOil compressor fluids are used for flooded screw compressors in natural gas field booster service. Although these fluids are primarily intended for dry, light and clean natural gas service, at moderate temperatures and pressures, they can be used in select applications where water, H₂S and/or CO₂ contaminate the natural gas streams.

NG Screw CompOil fluids are specifically recommended for:

- Compression of the lightest hydrocarbon gases (methane and ethane) where the expected dilution is <10 wt%, and discharge temperatures are moderate (<99 °C / 210 °F)
- Compression of sour natural gas streams
- Available in ISO 100 and ISO 150 viscosity grades

For more difficult gas streams, where heavy hydrocarbons and/or high CO₂ are present, the SPX 7000 series of PAG screw compressor fluids may be a better fit.

Please contact a Technical Services Advisor, who can recommend an appropriate fluid for your application.

Typical characteristics are shown below:

NG Screw CompOil		
	100	150
Viscosity cSt @ 40°C	100	154
cSt @ 100°C	12	17
Viscosity Index	108	121
Flash Point, COC, °C/°F	243/469	263/505
Pour Point, °C/°F	-33/-27	-30/-22



LUMINOL™ ELECTRICAL INSULATING OILS

Petro-Canada Lubricants LUMINOL family of electrical insulating oils represents a breakthrough in electrical insulating oil technology. Unlike competitive products formulated with naphthenic mineral oils, LUMINOL uses ultra-pure, high quality base oils to deliver worry-free, corrosive sulfur-free performance in your transformer.

LUMINOL TRi is ideal for use in large power and distribution transformers as well as free-breathing units. LUMINOL LS is an electrical insulating oil for high voltage equipment in specialty applications. LUMINOL Di is ideal for use in smaller distribution transformers such as pad and pole mounted units. LUMINOL LV is an electrical insulating oil designed specifically for Siemens X-ray equipment. LUMINOL electrical insulating oils are suitable for commercial, industrial and institutional applications:

- LUMINOL TRi meets or exceeds the performance requirements of CAN / CSA-C50-14 (R2018) (Class A and B), ASTM D3487 standards, and DOBLE TOPS specifications.
- LUMINOL TRi meets the CSA-C50-14 (R2018) upgraded oxidation stability Special Requirements for Type IV fluids oil.
- LUMINOL TRi is designed for Type II and Type IV applications and meets IEC 60296 General specifications for fully inhibited high grade oil (Type A).
- LUMINOL TRi is approved for applications requiring Ontario Hydro M-104.
- LUMINOL LS is designed for Type II applications and meets or exceeds the performance requirements of CAN / CSA-C50-14 (R2018) (Class A and B), ASTM D3487 standards.
- LUMINOL Di meets the performance requirements of CAN / CSA-C50-14 (R2018) Class B and ASTM D3487. It is designed for Type II applications.

Typical characteristics are shown below:

	LUMINOL™ TRI	LUMINOL LS	LUMINOL DI
Viscosity cSt @ 40°C	9.2	9.1	9.35
cSt @ 0°C	53	48.4	55.5
cSt @ -40°C	1,230	1,223	4,082
Flash Point, COC, °C/°F	170/338	171/340	171/340
Pour Point, °C/°F	-60/-76	-60/-76	-48/-54
Dielectric breakdown voltage, after treatment - 60Hz, 2mm gap (ASTM D1816), kV	65	62	68
Power Factor @ 60Hz, 100°C	0.001	0.001	0.001
Interfacial Tension, 25°C, mN/m	48	48	46
Rotary Pressure Vessel Oxidation Test (ASTM D2112), minutes	600	592	451
Gassing Tendency (ASTM D2300), µL/min	-10	+11.7	+23.6
Oxid. Stability, wt% Sludge (IEC 61125 C, 500 h)	<0.02	—	—
Oxid. Stability, Neut # mg KOH/g (IEC 61125 C, 500 h)	<0.02	—	—
Oxid. Stability, Power Factor @ 90°C (IEC 61125 C, 500 h)	<0.001	—	—



INCIDENTAL FOOD CONTACT (H1) LUBRICANTS

Petro-Canada Lubricants PURITY™ FG fluids and lubricants are advanced products formulated to meet the tough demands of food and beverage processing operations while maintaining food grade purity.

PURITY FG products are fortified with specially selected additives to meet the application requirements such as protecting against wear, shock loading, and corrosion. These products are designed to be highly resistant to the harsh conditions found in food and beverage processing operations, which can include high pressure water spray, causing water contamination as well as exposure to fats, acids, cleaning and sanitizing solutions. For the majority of PURITY FG products, a key component is 99.9% pure, crystal clear base oils.

PURITY FG EP Gear Fluids, PURITY FG Compressor Fluids and PURITY FG-X AW Hydraulic Fluid 46 are formulated with SynFX™, an advanced additive technology designed to deliver synthetic-like performance for enhanced low temperature properties, long lasting protection and increased service life.

All PURITY FG Synthetic products are formulated with synthetic base stocks to provide the same outstanding lubrication performance over an even wider range of operating temperatures.

All PURITY FG products have been formulated to excel under harsh conditions, while meeting food industry safety standards and can be integrated in HACCP (Hazard Analysis Critical Control Point) Plans and GMP (Good Manufacturing Practice) Programs.

Please refer to the Food Industry Registrations/Credentials chart on 360 Marketing Support (LUB3152) or contact your local representative.

PURITY™ FG CHAIN FLUIDS

PURITY FG Chain Fluids are formulated to lubricate all types of drive and conveyor chains as well as bearings found on food processing machinery. They may be applied by brush or drip feed as well as by centralized lubrication systems.

They can be applied at temperatures up to 200°C (392°F); however, equipment should be re-oiled more frequently at temperatures above 150°C (302°F).

These advanced food grade fluids include special tackifiers to ensure strong adhesion to metal surfaces and resistance to dripping, throw-off, and water spray loss.

Typical characteristics are shown below:

PURITY FG Chain Fluid		
	Light	Heavy
Viscosity cSt @ 40°C	151	370
	cSt @ 100°C	20
Viscosity Index	150	175
Flash Point, COC, °C/°F	230/446	240/464
Pour Point, °C/°F	-12/10	-12/10
4 Ball Wear Scar Diam., mm	0.41	0.39

PURITY FG COMPRESSOR FLUIDS

PURITY FG Compressor Fluids are formulated with SynFX™, an advanced additive technology designed to deliver synthetic-like performance for long lasting protection and increased service life. Typical applications include the lubrication of air compressors and vacuum pumps used for producing, manufacturing, and preparing food and food packaging.

PURITY FG Compressor Fluids resist thermal and oxidative breakdown extending fluid life and reducing varnish build up on compressor parts.

PURITY FG Compressor Fluids are recommended for use in rotary screw compressors for up to 4,000 hours at a maximum air discharge temperature of 85°C (185°F).

Note: Do not use in breathing air apparatus or medical equipment.

Typical characteristics are shown below:

PURITY FG Compressor Fluids		
	46	100
Viscosity cSt @ 40°C	44	105
	cSt @ 100°C	6.6
Viscosity Index	99	101
Flash Point, COC, °C/°F	240/464	280/536
Pour Point, °C/°F	-45/-49	-33/-27
Oxidation stability RPVOT, minutes	2061	2894



PURITY™ FG SYNTHETIC FLUIDS

PURITY FG Synthetic Fluids are synthetic PAO based products formulated with specially selected additives to protect against wear, oxidation, rust and corrosion. Tough enough to handle wet food processing environments and wide temperatures, PURITY FG Synthetic Fluids can be used in compressor, vacuum pump, pneumatic and hydraulic applications, as well as in low temperature applications such as freezers. PURITY FG Synthetic Fluid 46 is listed by injection molding machine OEM Husky.

Note: Do not use in breathing air apparatus or medical equipment.

Typical characteristics are shown below:

PURITY FG Synthetic Fluids		
	46	100
Viscosity cSt @ 40°C	46	102
cSt @ 100°C	7.7	14.2
Viscosity Index	136	144
Flash Point, COC, °C/°F	262/503	262/504
Pour Point, °C/°F	-60/-76	-57/-70

PURITY FG SYNTHETIC BARRIER FLUID

Petro-Canada Lubricants PURITY FG Synthetic Barrier Fluids are advanced food grade barrier fluids formulated to deliver exceptional performance, by resisting degradation and deposit formation, and are also suitable for service in non-food grade industrial applications. These barrier fluids start clean and remain clean in the most demanding conditions.

PURITY FG Synthetic Barrier Fluid is a PAO based product formulated with specific additives to deliver exceptional protection against oxidation, corrosion, and wear. This NSF H1 registered product is designed to provide lubrication and cooling for mechanical seals to help maximize seal life.

The ideal barrier fluid for mechanical seals that contain process fluids flowing at temperatures above 60°C (140°F), is a very low viscosity Polyalphaolefin (PAO) based fluid with highly stable additives at minimal concentrations. This makes PURITY FG Synthetic Barrier Fluids the ideal candidates for barrier fluid service.

PURITY™ FG Synthetic Barrier Fluid

	ASTM Test Method	5	32
Density, kg/L @ 15 °C	D4052	0.7992	0.8297
Viscosity cSt @ 40°C	D445	5.1	30.7
cSt @ 100°C	D445	1.7	5.8
Flash Point, COC, °C / °F	D92	149 / 300	259 / 498
Pour Point, °C / °F	D5950	-63 / -81	-66 / -89
Rust A	D665	Pass	Pass
Rust B	D665	Pass	Pass
Copper Strip Corrosion Test, 3 hours @ 100°C / 212°F	D130	1a	1b
Foaming Characteristics, Sequence 1, Vol. mL after blow/settling	D892	30/0	10/0
Initial Boiling Point, °C / °F	D7500	173 / 343	372 / 702
RPVOT, min	D2272	1331	1608
Acid Number, (mg KOH/g)	D664	0.6	0.35
Colour	D1500	< 0.5	< 0.5

The values quoted above are typical of normal production. They do not constitute a specification.

PURITY FG CORRCUT-E FLUID

PURITY FG Corrcut-E Fluid is an advanced food grade lubricant formulated to improve slitter blade life on slitter scorer systems. This product helps to provide optimal performance, less maintenance and longer service life for cutting blades. It effectively removes starch from the blades which means sharper blades for cleaner cuts and longer blade life. This product can be utilized on most major OEM slitter scorer systems both below the line and above the line lubrication.

PURITY FG Corrcut-E Fluid

	15
Viscosity cSt @ 40°C	22.2
cSt @ 100°C	4.5
Flash Point, COC, °C/°F	213/415
Pour Point, °C/°F	-36/-32



PURITY™ FG GREASES – ALUMINUM COMPLEX

PURITY FG, NSF H1 registered greases are advanced food grade lubricants specially formulated to deliver exceptional performance under the highly demanding conditions of food processing operations. They can be used in a wide range of general manufacturing machinery including sleeve and anti-friction bearings, slides and guides found in food processing machinery. PURITY FG greases exhibit good low temperature pumpability and excellent resistance to water wash-out and spray loss. In addition, they have excellent anti-wear, extreme pressure properties, and protect against rust and corrosion. **PURITY FG2** and **PURITY FG1** are recommended for the greasing systems in canning fillers found in the beverage industry.

PURITY FG1 and **00** are also preferred for centralized greasing systems.

Please refer to the Food Industry Registrations/Credentials chart on 360 Marketing Support (LUB3152) or contact your local representative.

Typical characteristics are shown below:

PURITY FG Greases			
	FG2	FG1	FG00
Soap Type	Aluminum Complex	Aluminum Complex	Aluminum Complex
NLGI Grade	2	1	00
Color	White	White	White
Worked Penetration @ 25°C	283	328	420
Dropping Point, °C/°F	277/531	266/511	211/412
Base Oil Viscosity cSt @ 40°C	182	172	182
cSt @ 100°C	17	16	17
Weld Point, kg	500	400	620
Operating Temperature Range min, °C/°F	-20/-4	-25/-13	-35/-31
Operating Temperature Range max, °C/°F	160/320	160/320	120/248

PURITY™ FG2 WITH MICROL™ MAX† GREASE

PURITY FG2 with MICROL™ MAX grease is a specially formulated lubricant that inhibits the growth of microbes that can cause lubricant degradation. PURITY FG2 with MICROL™ MAX is an NSF H1 registered lubricant formulated with a U.S. EPA registered antimicrobial product preservative.

PURITY FG2 with MICROL™ MAX exhibits good low temperature pumpability and excellent resistance to water washout and water spray loss. It also has excellent antiwear and extreme pressure properties and protects against rust and corrosion.

Typical characteristics are shown below:

PURITY FG2 WITH MICROL™ MAX†	
NLGI Grade	2
Soap Type	Aluminum Complex
Color	Cream
Worked Penetration @ 25°C	292
Dropping Point, °C/°F	287/549
Base Oil Viscosity cSt @ 40°C	182
cSt @ 100°C	17
Weld Point, kg	315
Operating Temperature Range	-20°C (-4°F) to 160°C (320°F)
Antimicrobial Protection Temperature Range	-20°C (-4°F) to 160°C (320°F)

†MICROL™ MAX is an antimicrobial product preservative.



PURITY™ FG2 EXTREME GREASE

PURITY FG2 Extreme grease is a high viscosity, semi synthetic, heavy-duty NSF H1 registered food grade grease specifically formulated for low to medium speed, heavily loaded industrial bearings operating under severe conditions. PURITY FG2 Extreme exhibits excellent protection in applications subjected to high temperature, high pressure, and heavy loads. PURITY FG2 Extreme is best suited for applications under 1000 rpm.

Typical characteristics are shown below:

PURITY FG2 Extreme	
Soap Type	Aluminum Complex
NLGI Grade	2
Color	White
Worked Penetration @ 25°C	276
Dropping Point, °C/°F	264/507
Base Oil Viscosity cSt @ 40°C	469
cSt @ 100°C	33.2
Weld Point, kg	400
Operating Temperature Range	-20°C (-4°F) to 160°C (320°F)

PURITY FG2 CLEAR GREASE

PURITY FG2 Clear grease is an advanced colorless lubricant specially formulated to deliver superior performance under the highly demanding conditions of food processing operations when compared to other clear food grade greases. PURITY FG2 Clear grease is NSF H1 registered and designed for use in anti-friction bearings, slides, and guides through food processing and industrial plants. It is specifically formulated for beverage production machinery such as canning and bottling equipment.

Typical characteristics are shown below:

PURITY FG2 Clear	
Soap Type	Aluminum Complex
NLGI Grade	2
Color	Clear
Worked Penetration @ 25°C	293
Dropping Point, °C/°F	277/531
Base Oil Viscosity cSt @ 40°C	185
cSt @ 100°C	18
Weld Point, kg	200
Operating Temperature Range	-20°C (-4°F) to 160°C (320°F)

PURITY™ FG GREASES – CALCIUM SULPHONATE COMPLEX

PURITY FG2 Synthetic and **PURITY FG2 Synthetic Heavy 220** are specially formulated to provide outstanding lubrication in food processing applications running under heavier loads or subject to high and low temperature extremes. They are NSF H1 registered and recommended as multipurpose lubricants across all food processing applications such as freezers, high temperature applications including ovens, multi service bearings, canning, bottling equipment, animal feed pellet mills, and mixers.

PURITY FG2 Synthetic is particularly recommended for use in low temperature applications. PURITY FG2 Synthetic Heavy 220 is most suitable for use under heavy loads, higher temperatures, and where greases need to stay in place.

PURITY FG2 MULTI PURPOSE

Petro-Canada Lubricants PURITY FG2 MULTI PURPOSE is a H1 food grade lubricant specially formulated for tough food processing applications where high loads can be challenging. This advanced formula contains a patented thickener complex to provide outstanding wear and extreme pressure protection, with excellent mechanical stability in the presence of heat and water to keep surfaces well lubricated.

Ideal for wide operating temperatures, rust prevention and enhanced resistance to water washout, PURITY FG2 MULTI PURPOSE is a solution for all types of food processing and general industrial applications.

PURITY FG2 MULTI PURPOSE has been designed to meet the highest food industry safety standards and can be easily integrated into Hazard Analysis and Critical Control Point (HACCP) plans and Good Manufacturing Practice (GMP) programs.

	PURITY FG Multipurpose	PURITY FG2 Synthetic	PURITY FG2 Synthetic Heavy 220
NLGI Grade	2	2	2
Soap Type	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex
Color	Tan	Tan	Tan
Worked Penetration @ 25°C	280	294	268
Dropping Point, °C/°F	>309/>588	>304/579	>304/579
Base Oil Viscosity cSt @ 40°C	105	50.0	220
cSt @ 100°C	11.3	7.8	24.0
Weld Point, kg	620	500	400
Operating Temperature Range	-25°C (-13°F) to 160°C (320°F)	-40°C (-40°F) to 200°C (392°F)	-25°C (-13°F) to 200°C (392°F)



PURITY™ FG EP GEAR FLUIDS

PURITY FG EP Gear Fluids are formulated with SynFX™, an advanced additive technology designed to deliver synthetic-like performance. These products provide long lasting protection and can be used on enclosed gear drives (worm, helical, bevel and spur) operating under normal or heavy shock-loading conditions in food processing machinery. They can also be used in bearings and chain drives, providing long service life and clean operation. PURITY FG EP Gear fluids are suitable for yellow metals.

Typical characteristics are shown below:

PURITY FG EP Gear Fluid					
	100	150	220	320	460
Viscosity cSt @ 40°C	105	145	225	320	460
cSt @ 100°C	12	14.6	19.7	23.8	29.8
Viscosity Index	103	101	100	99	99
Flash Point, COC, °C/°F	264/507	240/464	204/399	184/363	198/388
Pour Point, °C/°F	-39/-38	-39/-38	-36/-33	-39/-38	-39/-38

PURITY™ FG SYNTHETIC EP GEAR FLUIDS

PURITY FG Synthetic EP Gear Fluids are specially formulated to provide outstanding lubrication in food processing applications running under heavier loads or subject to high or low temperature extremes. Typical applications include enclosed gear drives (worm, helical, bevel and spur), plain and anti-friction bearings, and chain drives used in food processing machinery.

The ISO VG 220 grade can also be used as a blower lobe lubricant. PURITY FG Synthetic EP Gear Fluids are fortified with specially selected additives to provide outstanding resistance to oxidation and protection from wear and shock loading. These fluids are suitable for yellow metals.

PURITY FG Synthetic EP Gear Fluid		
	220	460
Viscosity cSt @ 40°C	221	446
cSt @ 100°C	25.8	43.5
Viscosity Index	148	151
Flash Point, COC, °C/°F	281/538	253/487
Pour Point, °C/°F	-45/-49	-42/-44

PURITY FG PAG GEAR OILS

PURITY FG PAG Gear Oils are advanced gear lubricants formulated to deliver exceptional performance and resist degradation for service in both food grade and non-food grade industrial applications.

PURITY FG PAG Gear Oils are synthetic polyalkylene glycol (PAG) based lubricants formulated with specially selected additives to protect against wear, oxidation, rust and corrosion. PURITY FG PAG Gear Oils exhibit high viscosity indices for a wide range of applications and the inherent properties of polyalkylene glycol base fluids help improve lubricity. These synthetic fluids are tough enough to handle food processing applications, and severe, heavy-duty industrial applications over wide temperatures, and are suitable for industrial applications and gearboxes.

**PURITY™ FG PAG Gear Oil**

	Test Method	150	220	460
Density, kg/L @ 15°C	D4052	1.053	1.076	1.076
Viscosity cSt @ 40°C	D445	151	220	459
cSt @ 100°C	D445	28.3	38.4	77.3
Viscosity Index	D2270	227	226	251
Flash Point, COC, °C (°F)	D92	268 (514)	263 (505)	265 (509)
Pour Point, °C (°F)	D5950	-40 (-40)	-38 (-36)	-35 (-31)
Oxidation Stability, Time to oxidation, min	D2272	673	678	670
4-Ball Wear, mm scar diameter (40kg, 1200 rpm, 1 h, 75°C)	D4172	0.45	0.45	0.38
4-Ball Weld, Kg	D2783	126	160	160

The values quoted above are typical of normal production. They do not constitute a specification.

PURITY FG HEAT TRANSFER FLUID

PURITY FG Heat Transfer Fluid is a food grade NSF HT-1 registered heat transfer fluid formulated for use in non-pressurized, liquid phase, closed heat transfer systems operating with bulk temperatures up to 326°C (619°F). This thermally stable fluid is fortified with specially selected additives to provide outstanding protection from oxidative breakdown.

Typical applications include central cooking facilities, drying, edible oil deodorizing and heating of deep frying oils. PURITY FG Heat Transfer Fluid is also used in the equipment for manufacture of plastic bottles, films and containers for the packaging of food products.

Typical characteristics are shown below:

PURITY FG Heat Transfer Fluid

Viscosity cSt @ 40°C	37.1
cSt @ 100°C	5.9
Viscosity Index	98
Flash Point, COC, °C/°F	237/459
Pour Point, °C/°F	-18/0
Autoignition Temperature, °C/°F	354/669
Max Bulk Temperature, °C/°F	326/619

For details on the complete line of Heat Transfer Fluids, see CALFLO on page 166.

PURITY™ FG SEAMER-E FLUID

PURITY FG Seamer-E Fluid is an advanced food grade, mineral oil based, water emulsifying fluid that is formulated for use in high-speed continuous lubrication seaming units where contamination of the oil with water and sugar may occur. It is designed to lubricate the main turrets, bearings, chains and gears for smooth and reliable equipment performance.

PURITY FG Seamer-E Fluid is suitable for use in Pneumatic Scale Angelus series such as 61/62H, 80/81L, 100/101L, 120/121L, 140S, 180S and 12M.

Typical characteristics are shown below:

PURITY FG Seamer-E Fluid		
Viscosity	cSt @ 40°C	155
	cSt @ 100°C	14.5
Viscosity Index		91
Flash Point, COC, °C/°F		240/464
Pour Point, °C/°F		-26/-21
Four-Ball Wear (mm) (40kg, 1200 rpm, 1 hr., 75°C)		0.37
4-Ball EP Weld Load, kg		126

PURITY FG AW HYDRAULIC FLUIDS

PURITY FG AW Hydraulic Fluids are advanced food grade lubricants specially formulated to deliver exceptional, long lasting protection in hydraulic systems used in food processing and pharmaceutical operations. They provide excellent performance in high pressure systems including applications operating at more than 1000 psi (7000 kPa). They may also be used to lubricate anti-friction bearings in general circulating systems, and in inline (air line) oilers in pneumatic systems commonly found in food packaging applications. PURITY FG AW 32 is approved for use in high pressure processing applications by OEM JBT Avure.

Typical characteristics are shown below:

PURITY FG AW Hydraulic Fluid					
		32	46	68	100
Viscosity	cSt @ 40°C	30	45	63	102
cSt @ 100°C		5.2	6.8	8.4	11.5
Viscosity Index		101	102	102	99
Flash Point, COC, °C/°F		225/437	245/473	253/487	267/513
Pour Point, °C/°F		-18/0	-18/0	-18/0	-15/5
Four-Ball Wear (mm) (40kg, 1200 rpm, 1 hr., 75°C)		0.46	0.48	0.49	0.44
Oxidation Resistance, RPVOT (minutes)		844	885	888	888
FZG, load stage fail		>12	>12	>12	>12



PURITY™ FG-X AW HYDRAULIC FLUID

PURITY FG-X AW Hydraulic Fluid 46 is an advanced food grade lubricant that is formulated with SynFX™, an advanced additive technology designed to deliver synthetic-like performance and enhanced protection. This product resists oxidative breakdown from air exposure, high temperatures and water contamination that can lead to longer fluid and equipment life.

Typical characteristics are shown below:

PURITY FG-X AW Hydraulic Fluid 46		
Viscosity	cSt @ 40°C	47
	cSt @ 100°C	6.9
Viscosity Index		102
Flash Point, COC, °C/°F		240/464
Pour Point, °C/°F		-48/-54
Four-Ball Wear (mm) (40kg, 1200 rpm, 1 hr., 75°C)		0.45
Oxidation Resistance, RPVOT (minutes)		1147

PURITY™ FG AEROSOL SPRAYS

PURITY FG line of aerosol sprays are advanced multipurpose food grade lubricants packaged in aerosol cans. All sprays are packaged with an application tube to provide a convenient way to lubricate specific areas or difficult to reach locations. Its unique spray valve allows the product to be sprayed even when the can is held upside down. PURITY FG aerosol spray lubricants also meet food industry standards and can be integrated in HACCP (Hazard Analysis Critical Control Point) Plans and GMP (Good Manufacturing Practice) Programs.

Please refer to the Food Industry Registrations/Credentials chart on 360 Marketing Support (LUB3152) or contact your local representative.

PURITY FG SPRAY

PURITY FG Spray contains special tackifiers to reduce drips and 'fling off' from moving parts. PURITY FG Spray dispenses lubricant in a single direction streamline spray pattern. Typical applications include chains, rails, guides, slides, pivots, cables, linkages, gears, hinges and small bearings.

PURITY FG SILICONE SPRAY

PURITY FG Silicone Spray is a silicone-based lubricant that forms a non-hardening film to resist moisture and help prevent corrosion around heavy water wash-up areas. It can be used in many metal to non-metal applications.

PURITY FG PENETRATING OIL SPRAY

PURITY FG Penetrating Oil Spray is a general purpose penetrating oil that can be used to help loosen rust and scale around fasteners to ease the disassembly of mechanical equipment and fittings. It is a silicone free formula to allow for easy clean up of treated surfaces to be repainted.

Typical characteristics are shown below:

PURITY				
Characteristics	Method	FG Spray	FG Silicone Spray	FG Penetrating Oil
Net weight (g)		290	284	312
NSF registration		H1	H1	H1
PROPERTIES WITHOUT PROPELLANT				
Color	Visual	Colorless	Colorless	Colorless
Viscosity @ 40°C (cSt)	ASTM D445	151	N/A	39
Four Ball Wear, scar diam, mm	ASTM D4172	0.4	N/A	N/A
Four Ball Wear, scar diam, mm	ASTM D2266	N/A	N/A	N/A

*MICROL™ MAX is an antimicrobial product preservative.



PURITY™ FG TROLLEY FLUID

PURITY FG Trolley Fluid is formulated to lubricate hook and trolley systems in meat processing operations. It can also be used as a low viscosity lubricating fluid for chains and conveyors, and as a rust protective oil. PURITY FG Trolley Fluid is fortified with specially selected additives to provide outstanding resistance to wear and corrosion, and to prevent oil drips. PURITY FG Trolley Fluid can also be utilized as a light chain oil in either a drip or atomized application.

Typical characteristics are shown below:

PURITY FG Trolley Fluid	
	46
Viscosity cSt @ 40°C	44
cSt @ 100°C	7.3
Viscosity Index	131
Flash Point, COC, °C/°F	215/419
Pour Point, °C/°F	-15/5
Four-Ball Wear scar diameter, mm	0.45

PURITY FG WO WHITE MINERAL OILS

PURITY FG WO White Mineral Oils are ultra pure, food grade white mineral oils specially formulated for the food processing industry. Blended with vitamin E as a stabilizer for extended shelf life, PURITY FG WO White Mineral Oils are ideally suited for applications that include direct and indirect food contact in production, packaging, and processing operations. PURITY FG WO White Mineral Oils are commonly used in food production facilities for equipment wipe down. These products are NSF 3H and H1 registered for use as a release agent on hard surfaces to prevent food from adhering during processing and general incidental contact use.

Typical characteristics are shown below:

PURITY FG WO WHITE MINERAL OILS						
	10	15	35	40	68	90
Viscosity, cSt @ 40°C	13	15	36	40	68	103
cSt @ 100°C	3.1	3.4	5.8	6.2	8.9	11.8
Viscosity Index	100	98	105	100	100	104
Density, kg/L @ 15°C	0.846	0.850	0.866	0.865	0.867	0.872
Flash Point, COC, °C/°F	190/374	198/388	220/428	240/464	255/491	266/510
Pour Point, °C/°F	-24/-11	-18/0	-18/0	-18/0	-18/0	-15/5
Color, Saybolt	+30	+30	+30	+30	+30	+30

**CALFLO™, PETRO-THERM™ AND PURITY™
FG HEAT TRANSFER FLUIDS**

CALFLO is a line of specialty heat transfer fluids produced from Petro-Canada Lubricants 99.9% pure base oils and proprietary additive technology. CALFLO Synthetic is based on PAO chemistry and specially selected additives. These fluids provide high temperature performance without raising the same adverse environmental or health and safety concerns caused by chemical aromatic fluids. The CALFLO family of advanced fluids is recommended for use in non-pressurized, liquid phase, closed heat transfer systems. For use in open systems, please contact a representative.

There are several formulations to meet a wide range of applications:

- CALFLO HTF is a premium high temperature heat transfer fluid recommended for systems operating with bulk temperatures up to 326°C/619°F. Typical applications include power generation, metal processing and chemical manufacturing.
- CALFLO AF is a highly efficient heat transfer fluid recommended for systems requiring a greater resistance to oxidation, operating with bulk temperatures up to 316°C/600°F. Typical applications include plastic extrusion, injection moulding and rubber manufacturing operations. Also used in shingle manufacturing, and lumber drying kilns.
- CALFLO LT is a synthetic blend heat transfer fluid suitable over a wide temperature range from 5°C/40°F to 288°C/550°F. Excellent low temperature pumpability allows cold start-up in ambient temperatures as low as -40°C/-40°F.
- CALFLO Synthetic is a synthetic heat transfer fluid that delivers outstanding protection and is formulated virtually free of impurities and aromatic compounds that can be hazardous to workplace health and safety. CALFLO Synthetic's breakthrough chemistry balances low temperature fluidity at extreme conditions down to -48°C/-54°F with outstanding oxidative stability and volatility control. CALFLO Synthetic can also be used as a mechanical seal barrier fluid in process pumps.
- PURITY FG Heat Transfer Fluid, formerly CALFLO FG, is a food grade HT-1 registered heat transfer fluid for the food processing industry with systems operating at bulk temperatures up to 326°C/619°F. More details on this fluid can be found on page 161.
- PETRO-THERM Heat Transfer Fluid is a general purpose fluid that provides economical service in various industrial processes. More details on this fluid can be found on page 167.

In addition to heat transfer fluids, Petro-Canada Lubricants offers two additional products for servicing heat transfer systems: CALFLO Cleaning Fluid and CALFLO Flushing Fluid. Details regarding the use of these fluids can be found on page 168 and page 169.

Typical characteristics are shown on the next page:



	CALFLO™ Heat Transfer Fluid				PURITY™ FG
	HTF	AF	LT	Synthetic	HTF
Viscosity cSt @ 40°C	35.2	32.3	7.5	5.3	37.1
	cSt @ 100°C	5.7	5.4	2.2	1.8
Viscosity Index	100	99	103	N/A	98
Flash Point, COC, °C/°F	231/448	217/423	176/349	163/325	237/459
Pour Point, °C/°F	-18/0	-39/-38	<-57/<-71	<-51/<-60	-18/0
Autoignition Temp, °C/°F	350/662	343/649	235/455	226/438	354/669
Max Bulk Temp, °C/°F	326/619	316/600	288/550	N/A	326/619

PETRO-THERM™ HEAT TRANSFER FLUID

PETRO-THERM is a general purpose heat transfer fluid developed for use in non-pressurized, liquid phase, closed heat transfer systems operating with bulk temperatures up to 315°C (599°F). It is specifically formulated to provide economical service in a variety of industrial applications while resisting oxidative and thermal degradation. Please contact Technical Services.

PETRO-THERM is particularly suitable for use in asphalt plants, marine applications, wood processing, dry kilns, institutional laundry and heating, and general processing.

Typical characteristics are shown below:

PETRO-THERM		
Viscosity	cSt @ 40°C	35.8
	cSt @ 100°C	5.7
Viscosity Index		97
Flash Point, COC, °C/°F		225/437
Pour Point, °C/°F		-18/0
Autoignition Temp, °C/°F		351/664

For applications where specialty heat transfer fluids are required, see CALFLO on page 166.

CALFLO™ CLEANING FLUID FOR HEAT TRANSFER SYSTEMS

CALFLO Cleaning Fluid is specially designed to help clean dirty or heavily carbonized systems which have been operating on overextended, contaminated or degraded heat transfer fluids. The cleaning action of this fluid is based on its solvency and the fluid should therefore be used in its pure, undiluted state.

This fluid is recommended for use in closed heat transfer systems and should not be used in systems operating in food processing plants. The upper operating limit for CALFLO Cleaning Fluid is 100°C (212°F) and therefore should not be placed into an existing system while in operation warmer than this temperature.

CALFLO Cleaning Fluid is NSF registered HT1 suitable for use in food processing facilities where there is a possibility of incidental food contact. Once all the cleaning fluid has been drained, CALFLO Flushing Fluid should be used to help remove residual fluids and loose contaminants prior to recharging the system with new heat transfer fluid. PURITY™ FG WO White Mineral Oil should be used in food processing facilities as the flushing fluid. Please refer to Tech Bulletin (TB-1158) for detailed instructions on how to clean heat transfer systems.

Typical characteristics are shown below:

CALFLO Cleaning fluid	
Density, kg/L @ 15°C	0.853
Color, ASTM	<2
Flash Point, COC, °C/°F	155/311
Viscosity cSt @ 40°C	7.93
cSt @ 100°C	2.2
Pour Point, °C/°F	-15/5
GC Distillation, 10% °C/°F	286/547
GC Distillation, 90% °C/°F	379/714



CALFLO™ FLUSHING FLUID

CALFLO Flushing Fluid is a clear fluid designed for flushing out dirty oil-circulating systems including those operating on heat transfer fluids. This fluid is also recommended to flush debris and water from pressure tests and contaminants from welding and construction in newly commissioned heat transfer systems. While it will not remove hard baked-on carbon, nor will it dissolve heavy sludge residues left by highly degraded fluids, it is effective in removing trapped residual fluids and in displacing system contaminants such as water, loose solids and debris. For heavily contaminated systems, CALFLO Cleaning Fluid should be used first. It operates effectively as a mechanical flushing agent for heat transfer systems changing over to CALFLO or PETRO-THERM™ Heat Transfer Fluids from other non-compatible materials. It is completely compatible with hydrocarbon based lubricants and with all grades of CALFLO or PETRO-THERM. For systems that will subsequently operate on a low viscosity fluid, please consult Technical Services. For systems in food processing plants where an HT-1 approved fluid will be used, flush with PURITY™ FG WO White Mineral Oils found on page 165.

Typical characteristics are listed below:

CALFLO FLUSHING FLUID	
Density, kg/L @ 15°C	0.864
Flash Point, COC, °C/°F	216/421
Viscosity cSt @ 40°C	35.6
cSt @ 100°C	5.70
Pour Point, °C/°F	-18/0

HYDREX™ AW – HYDRAULIC FLUIDS

HYDREX AW are premium performance, long-life, anti-wear hydraulic fluids. HYDREX AW fluids are primarily recommended for heavy-duty hydraulic systems that operate in industrial plants, and may also be used outdoors in mobile equipment if the ambient temperature range is suitable. HYDREX AW fluids have excellent thermal stability and oxidation life, which extend drain intervals and protect against corrosion and varnish formation. They also minimize harmful sludge build up in the reservoir that can lead to shortened oil life and equipment wear. Rust preventative properties minimize the possibility of corrosion occurring and excellent water separability and hydrolytic stability allow the oil to be used for longer periods which reduces equipment maintenance and downtime.

HYDREX AW fluids are approved against the following hydraulic equipment manufacturers' specifications: Bosch Rexroth Fluid Rating List RDE 90245 (AW 32, 46, 68), Denison HF-0, HF-1 and HF-2 (AW 32, 46, 68), Eaton E-FDGN-TB002-E, Engel (AW 46), Arburg (AW 46), and Marlen Hydraulic Power Unit (AW 68).

HYDREX AW fluids are suitable for use in equipment manufactured by Eaton, Denison, Bosch Rexroth, Komatsu, Sauer-Danfoss, Racine, Oilgear, Hydreco, Dynex and others.

HYDREX AW 46 is designed to provide optimum performance in injection moulding equipment manufactured by: Husky, Krauss-Maffei, Battenfeld, Demag, Soplar and Netstal.

HYDREX AW (22, 32, 46, 68, and 100) meets the following specifications: DIN 51524 Part 2 HLP, ASTM D6158 HM, and ISO 11158 HM as well as Fives Cincinnati P-68 (AW 32), P-70 (AW 46) and P-69 (AW 68). HYDREX AW fluids are suitable for use where below specifications are required: JCMAS HK (AW 32, 46), AIST 126 and 127 (AW 32, 46, 68), Voith 3625-006072, 3625-006073 and 3625-008426 (AW 32), Voith 3625-006208 and 3625-006209 (AW 46), and Voith 3625-006101 (AW 100). HYDREX™ AW fluids are NSF H2 registered (no allowable food contact).

Typical characteristics are shown below:

HYDREX AW						
	22	32	46	68	80	100
Viscosity cSt @ 40°C	22.0	31.5	46.4	67.4	79.4	101
cSt @ 100°C	4.4	5.5	6.9	8.9	9.9	11.6
Viscosity Index	110	110	104	106	104	102
Flash Point, COC, °C/°F	196/385	206/403	236/457	242/468	258/496	266/511
Pour Point, °C/°F	-45/-49	-43/-45	-39/-38	-33/-27	-31/-24	-29/-20
Oxidation Stability (D943), hours to 2.0 AN	6500+	6500+	6500+	6500+	6500+	6500+



HYDREX™ MV – WIDE TEMPERATURE RANGE HYDRAULIC FLUIDS

HYDREX MV are premium performance, energy efficient, long-life, anti-wear hydraulic fluids designed for use over wide temperature ranges. HYDREX MV fluids are recommended for heavy-duty hydraulic applications operating at high pressure and with wide ranges of temperature. They are ideally suited for piston, gear and vane hydraulic pumps used in industrial, marine, woodlands, mining and other mobile hydraulic systems. These fluids offer minimal fluid friction at low start-up temperatures and maintain optimum viscosity at high operating temperatures. Combined with their shear stable high viscosity index, this energy efficient formulation helps your bottom line.

HYDREX MV fluids¹ are approved against the following hydraulic equipment manufacturers' specifications: Eaton E-FDGN-TB002-E, Denison HF-0, HF-1 and HF-2 (MV 32, 46, and 68), and HYDREX MV 32, 46 and 68 have also been successfully evaluated against Bosch Rexroth requirements. HYDREX MV fluids¹ are suitable for use in equipment manufactured by Eaton, Denison, Bosch Rexroth, Komatsu, Sauer-Danfoss, Oilgear, Hydreco, Dynex and others.

HYDREX MV¹ meets the following specifications: ISO 11158 HV, DIN 51524 Part 3 HVLP, ASTM D6158 HV, as well as Fives Cincinnati P-68 (AW 32), P-70 (AW 46) and P-69 (AW 68). HYDREX MV 46 also meets the requirements of JCMAS HK and Komatsu HPV35+35 pump test. HYDREX MV 32 is suitable for use where JCMAS HK is required. HYDREX MV 46 and 68 are suitable for use where AIST 126 and 127 are required. All HYDREX MV fluids are NSF H2 registered (no allowable food contact).

HYDREX™ MV Arctic 15 is a premium, high performance hydraulic fluid designed for extremely cold temperature operations, particularly in arctic climates, allowing hydraulic systems to start at temperatures of -50°C (-58°F) under no-load conditions. It is also readily biodegradable as measured by OECD 301B and recommended for use in emergency shut-down valves or other critical low temperature heavy-duty hydraulic systems that are required to respond quickly and reliably.

Typical characteristics are shown below:

HYDREX						
		MV Arctic 15	MV 22	MV 32	MV 46	MV 68
Viscosity	cSt @ 40°C	13.6	22.2	31.9	45.4	68.2
	cSt @ 100°C	5.2	5.0	6.2	8.1	10.5
Viscosity Index		391	160	147	153	142
Flash Point, COC, °C/°F		132/270	222/432	236/457	256/493	230/446
Pour Point, °C/°F		-57/-71	-54/-65	-51/-60	-48/-54	-42/-44
Oxidation Stability (D943), hours to 2.0 AN		5000+	7000+	7000+	7000+	7000+
Min. Start-up Temperature ¹ , °C/°F		<-50/-58	-44/-47	-37/-35	-31/-24	-24/-11
Operating Temp. Range ² Mobile Equipment	°C	-45 to 45	-22 to 64	-17 to 76	-13 to 86	-5 to 96
	°F	-49 to 113	-8 to 147	1 to 169	9 to 187	23 to 205
Industrial Machinery	°C	-45 to 32	-22 to 55	-17 to 66	-13 to 76	-5 to 86
	°F	-45 to 90	-8 to 131	1 to 151	9 to 169	23 to 187

¹ Start-up is defined as the temperature at which the oil dynamic viscosity reaches 10,000 cP.

² Operating temperature limits are determined by the equipment manufacturer. Petro-Canada Lubricants has chosen to define the upper operating temperature to be the after-shear oil kinematic viscosity of 10 cSt for mobile equipment and 13 cSt for industrial machinery, while the lower operating temperature to be the fresh oil dynamic viscosity of 750 cP for both mobile and industrial machinery.

These ranges are only an approximation and the operator should always check the viscosity requirements as specified by their equipment manufacturer. Mobile equipment typically refers to machinery that encompasses a transmission and braking system to allow and prohibit movement. Industrial machinery is typically stationary, with hard piping and auxiliary components in place.



HYDREX™ XV – ALL SEASON HYDRAULIC FLUID

HYDREX XV All Season is an advanced formula, long life, energy efficient anti-wear hydraulic fluid designed for all season use in heavy-duty hydraulic systems for increased productivity in very hot or cold temperatures.

HYDREX XV is recommended for year-round use in equipment that has to be started at temperatures as low as -34°C (-29°F) and it will continue to perform well at operating temperatures as high as 90°C (194°F). HYDREX XV gives excellent results in a wide range of industrial machinery and mobile equipment used in such industries as forestry, construction, mining, injection molding, public utility and marine operations. Its very high viscosity index, energy efficient formulation helps maximize productivity.

HYDREX XV helps eliminate the need to change hydraulic oil seasonally. HYDREX XV is approved against the following hydraulic equipment manufacturers' specifications: Eaton E-FDGN-TB002-E and Denison HF-0, HF-1 and HF-2. HYDREX XV is suitable for use in equipment manufactured by Eaton, Denison, Komatsu, Sauer-Danfoss, Bosch Rexroth, Oilgear, Hydreco, Dynex and others.

HYDREX XV meets the following specifications: ISO 11158 HV, DIN 51524 Part 3 HVL, and ASTM D6158 HV, JCMAS HK and the requirements of Rexroth A2F10 pump test. HYDREX XV is suitable for use where AIST 126 and 127 are required.

Typical characteristics are shown below:

HYDREX XV		
Viscosity	cSt @ 40°C	47.9
	cSt @ 100°C	9.7
Viscosity Index		192
Flash Point, COC, °C/°F		227/441
Pour Point, °C/°F		-48/-54
Oxidation Stability (D943), hours to 2.0 AN		10,000+
Min. Start-up Temperature ¹ , °C/°F		-34/-29
Operating Temperature Range ² , Mobile Equipment	°C	-14 to 90
	°F	7 to 194
Industrial Machinery	°C	-14 to 78
	°F	7 to 172

1 Start-up is defined as the temperature at which the oil dynamic viscosity reaches 10,000 cP.

2 Operating temperature limits are determined by the equipment manufacturer. Petro-Canada Lubricants has chosen to define the upper operating temperature to be the after-shear oil kinematic viscosity of 10 cSt for mobile equipment and 13 cSt for industrial machinery, while the lower operating temperature to be the fresh oil dynamic viscosity of 750 cP for both mobile and industrial machinery.

These ranges are only an approximation and the operator should always check the viscosity requirements as specified by their equipment manufacturer. Mobile equipment typically refers to machinery that encompasses a transmission and braking system to allow and prohibit movement. Industrial machinery is typically stationary, with hard piping and auxiliary components in place.

HYDREX™ EXTREME – WIDE TEMPERATURE HYDRAULIC FLUID

HYDREX EXTREME is a high performance multi-grade hydraulic fluid designed for extremely wide temperature protection. Its excellent oxidation stability helps to extend drains and reduce sludge build-up and varnish deposits.

HYDREX EXTREME is also zinc-free, inherently biodegradable and contains no heavy metals. Its anti-wear, energy efficient formula helps your bottom line.

HYDREX EXTREME is recommended for vane, gear and axial piston hydraulic pumps over an extremely wide range of operating temperatures. It is suitable for applications where systems must be started up at very low temperatures but have significantly higher temperatures during operation. It is also suitable for use in bucket trucks operating around power lines or in bucket truck hydraulic systems requiring extreme low temperature pumpability.

HYDREX EXTREME is suitable for use in Liebherr cranes where extreme cold temperatures occur.

Typical characteristics are shown below:

HYDREX EXTREME		
Density, kg/L @ 15°C (60°F)		0.852
Viscosity,	cSt @ 40°C	33.6 (165)
	cSt @ 100°C	13.0 (71)
	cP @ -45°C (-49°F)	2985
Viscosity Index		404
Flash Point, COC, °C (°F)		141 (285)
Pour Point, °C (°F)		-54 (-65)
Oxidation Stability (D943), hours to 2.0 AN		8000+
Start-up Temperature ¹ , °C (°F)		-48 (-54)
Operating Temp. Range ² , Mobile Equipment	°C	-35 to 76
	°F	-31 to 169
Industrial Machinery	°C	-35 to 60
	°F	-31 to 140

¹ Start-up is defined as the temperature at which the oil dynamic viscosity reaches 10,000 cP.

² Operating temperature limits are determined by the equipment manufacturer. Petro-Canada Lubricants has chosen to define the upper operating temperature to be the after-shear oil kinematic viscosity of 10 cSt for mobile equipment and 13 cSt for industrial machinery, while the lower operating temperature to be the fresh oil dynamic viscosity of 750 cP for both mobile and industrial machinery.

These ranges are only an approximation and the operator should always check the viscosity requirements as specified by their equipment manufacturer. Mobile equipment typically refers to machinery that encompasses a transmission and braking system to allow and prohibit movement. Industrial machinery is typically stationary, with hard piping and auxiliary components in place.



HYDREX™ DT – DETERGENT HYDRAULIC FLUID

HYDREX DT is a special anti-wear detergent/dispersant hydraulic fluid containing the same anti-wear and anti-oxidant chemistry as HYDREX AW. HYDREX DT also contains detergent/dispersant additives to help keep systems clean by helping to prevent deposit formation. This fluid is intended for use in hydraulic systems that are prone to contamination.

Typical characteristics are shown below:

HYDREX DT 46		
Viscosity	cSt @ 40°C	46.3
	cSt @ 100°C	6.9
Viscosity Index		104
Flash Point, COC, °C/°F		237/459
Pour Point, °C/°F		-38/-36
Oxidation Stability (D943), hours to 2.0 AN		3000+

ENVIRON™ AW HYDRAULIC FLUIDS

Petro-Canada Lubricants ENVIRON AW monograde inherently biodegradable hydraulic fluids are designed for use in mobile and stationary heavy-duty hydraulic systems and are particularly suited for hydraulic applications in environmentally sensitive locations.

ENVIRON AW is free of heavy metals, non-toxic, inherently biodegradable and recyclable. ENVIRON AW is formulated to provide excellent anti-wear protection for extended equipment life. Its exceptional oxidation stability provides long oil life for fewer change-outs and helps prevent sludge and varnish deposits.

ENVIRON AW fluids are approved against the following hydraulic equipment manufacturers' specifications: Eaton Brochure 03-401-2010 Rev 1, Denison HF-0, HF-1 and HF-2, Engel (AW 46), and Krauss Maffei (AW 46). They are also NSF H2 registered (no allowable food contact).

ENVIRON AW is suitable for use in equipment manufactured by Eaton, Denison, Bosch-Rexroth, Sauer-Danfoss, Racine, Oilgear, Hydreco, Dynex and others.

ENVIRON AW 32, 46, and 68 meet the requirements of DIN 51524 Part 2 HLP and ISO 11158 HM and ASTM D6158 HM. ENVIRON AW is suitable for use where Bosch-Rexroth RE 90220 is required.

Typical characteristics are shown below:

ENVIRON AW			
	32	46	68
Viscosity cSt @ 40°C	31.7	45.4	69.3
cSt @ 100°C	5.7	6.8	9.1
Viscosity Index	121	104	106
Flash Point, COC, °C/°F	216/421	233/451	242/468
Pour Point, °C/°F	-42/-44	-33/-27	-33/-27
Oxidation Stability (D943), hours to 2.0 AN	10,000+	10,000+	10,000+

ENVIRON MV WIDE TEMPERATURE HYDRAULIC FLUIDS

Petro-Canada Lubricants ENVIRON MV multigrade inherently biodegradable hydraulic fluids are designed for year-round use in mobile and stationary heavy-duty hydraulic systems operating in wide extremes of temperature, particularly in environmentally sensitive locations. ENVIRON MV is free of heavy metals, non-toxic, inherently biodegradable and recyclable. Its energy conserving formula helps maintain optimum pump protection in an efficient manner over a wide range of temperatures.

ENVIRON MV fluids are approved against the following hydraulic equipment manufacturers' specifications: Denison HF-0, HF-1 and HF-2, Eaton Brochure 03-401-2010 Rev 1 and Arburg (MV 46). They are also NSF H2 registered (no allowable food contact).



ENVIRON™ MV are suitable for use in equipment manufactured by Eaton, Denison, Sauer-Danfoss, Bosch-Rexroth, Racine, Oilgear, Hydreco, Dynex and others. ENVIRON MV 32 and 46 meet the requirements of DIN 51524 Part 3 HVLP, ISO 11158 HV and ASTM D6158 HV, and are suitable for use where Bosch-Rexroth RE 90220 is required.

ENVIRON MV is formulated to provide excellent anti-wear protection for extended equipment life. Its exceptional oxidation stability provides long oil life for fewer change-outs and helps prevent sludge and varnish deposits.

Typical characteristics are shown below:

ENVIRON MV		
	32	46
Viscosity	cSt @ 40°C	33.8
		45.0
	cSt @ 100°C	6.7
		8.2
Viscosity Index	160	158
Flash Point, COC, °C/°F	239/462	247/477
Pour Point, °C/°F	-48/-54	-48/-54
Oxidation Stability (D943), hours to 2.0 AN	10,000+	10,000+
Min. Start-up Temperature ¹ , °C/°F	-36/-33	-33/-27
Operating Temp. Range ²		
Mobile Equipment	°C	-15 to 76
	°F	-10 to 84
Industrial Machinery	°C	5 to 169
	°F	14 to 183
	°C	-15 to 66
	°F	-10 to 74
	°C	5 to 151
	°F	14 to 165

¹ Start-up is defined as the temperature at which the oil dynamic viscosity reaches 10,000 cP.

² Operating temperature limits are determined by the equipment manufacturer. Petro-Canada Lubricants has chosen to define the upper operating temperature to be the after-shear oil kinematic viscosity of 10 cSt for mobile equipment and 13 cSt for industrial machinery, while the lower operating temperature to be the fresh oil dynamic viscosity of 750 cP for both mobile and industrial machinery.

These ranges are only an approximation and the operator should always check the viscosity requirements as specified by their equipment manufacturer. Mobile equipment typically refers to machinery that encompasses a transmission and braking system to allow and prohibit movement. Industrial machinery is typically stationary, with hard piping and auxiliary components in place.

ENVIRON™ MV R HYDRAULIC FLUIDS

Petro-Canada Lubricants ENVIRON MV R are readily biodegradable, non-toxic hydraulic fluids and therefore, particularly suited for hydraulic applications in environmentally sensitive locations. ENVIRON MV R hydraulic fluids are premium multigrade anti-wear hydraulic fluids designed for year-round use in both mobile and stationary heavy-duty hydraulic systems operating in wide extremes of temperatures.

ENVIRON MV R hydraulic fluids are formulated for both indoor and outdoor use in piston, gear and vane hydraulic pumps found in industrial plant and mobile equipment used in environmentally sensitive areas and is well suited for hydraulic systems in hydroelectric dam operations.

ENVIRON MV R 32 and 46 are approved for use against the following hydraulic equipment manufacturers' specifications: Denison HF-0, HF-1 and HF-2, Eaton Brochure 03-401-2010 Rev 1. In addition, ENVIRON MV R is recommended for use in equipment manufactured by: Eaton, Denison, Bosch-Rexroth, Sauer-Danfoss, Racine, Oilgear, Hydreco, Dynex and others.

ENVIRON MV R fluids meet DIN 51524 Part 3 HVL, ISO 11158 HV and ASTM D6158 HV, and are suitable for use where Bosch-Rexroth RE 90220 is required.

ENVIRON MV R fluids meet the WGK (German Water Hazard Classification) of 1.

ENVIRON MV R does not contain zinc-based antiwear additives so it can be used in hydraulic pumps with silver bearings, such as Lucas pumps because it will not displace the silver in these bearings.

Typical characteristics are shown on the next page:



	Test Method	ENVIRON™ MV R	
		ISO 32	ISO 46
Start-up Temperature ¹ , °C/°F	—	-36/-33	-33/-27
Operating Range ² , °C/°F	Mobile Equipment	-15 to 76 / 5 to 169	-10 to 84 / 14 to 183
	Industrial Equipment	-15 to 66 / 5 to 151	-10 to 74 / 14 to 165
Density @ 15°C, kg/l	D4052	0.841	0.848
Flash Point, COC, °C/°F	D92	213/415	229/444
Kinematic Viscosity	cSt @ 40°C	32.45	43.99
	cSt @ 100°C	6.62	8.17
Viscosity Index	D2270	165	162
Pour Point, °C/°F	D5950	-51/-60	-48/-54
Rust Prevention, Procedures A & B, 24 h	D665	Pass	Pass
Copper Corrosion 3hr @ 100°C / 212°F	D130	1b	1b
Air Release @ 50°C / 122°F, Minutes	D3427	3.0	3.0
Denison Hybrid Pump Test, T6H20C	TP-30533	Pass	Pass
Water Separability @ 54°C / 129°F oil-water-emulsion (minutes)	D1401	40-40-0 (10)	40-40-0 (10)
Oxidation Stability, Hours to 2.0 AN	D943	10,000+	10,000+
Dielectric Breakdown Voltage, kV	D877	56	55
Biodegradability, %	OECD 301B	>70	>70
Aquatic Acute Toxicity ³	EC50 (Algae), ppm (mg/L)	OECD 201	>9,000
	EC50 (Daphnia), ppm (mg/L)	OECD 202	>10,000
	LC50 (Trout), ppm (mg/L)	OECD 203	>1,000

The values quoted above are typical of normal production. They do not constitute a specification.

¹ Start-up is defined as the temperature at which the oil dynamic viscosity reaches 10,000 cP.

² Operating temperature limits are determined by the equipment manufacturer. Petro-Canada Lubricants has chosen to define the upper operating temperature to be the after-shear oil viscosity of 10 cSt for mobile equipment and 13 cSt for industrial machinery, while the lower operating temperature to be the fresh oil viscosity of 750 cP for both mobile and industrial machinery. These ranges are only an approximation and the operator should always check the viscosity requirements as specified by their equipment manufacturer. Mobile equipment typically refers to machinery that encompasses a transmission and braking system to allow and prohibit movement. Industrial machinery is typically stationary, with hard piping and auxilliary components in place.

³ According to GHS, a substance is "not environmentally toxic" if LC50 and EC50 values for OECD 201, 202 and 203 are >100 mg/L.

ENDURATEX™ EP & ENDURATEX XL SYNTHETIC BLEND

ENDURATEX EP Gear Oils are designed to lubricate enclosed gear drives operating in normal, heavy or shock-loaded conditions, as well as all types of heavy or shock-loaded bearings. They deliver sustained anti-wear and extreme-pressure protection to all industrial gear drives and bearings.

ENDURATEX EP Gear Oils are noncorrosive to bronze gears, copper lines and bearing materials at low to moderate operating temperatures (up to 90°C/194°F).

ENDURATEX XL Synthetic Blend 68/150 and 68/220 are multi-grade EP gear oils designed to eliminate seasonal change-outs and provide equipment protection all year long. These multigrades complete the line, by extending AGMA EP viscosities over an extended temperature range. The 68/220 supports winter requirements (68 grade) and summer requirements (220 grade). The 68/150 delivers excellent low temperature properties versus leading all season competitive products for easier cold start-ups and better equipment protection.

ENDURATEX EP Gear Oils are suitable for use in most industrial gear sets that require a high quality EP lubricant.

ENDURATEX EP Gear Oils are typically suitable for use in situations requiring DIN 51517 Part 3, ISO 12925 – Type 1 CKC, AGMA 9005-F16, and AIST 224 (formerly US Steel 224) specifications.

The following products meet the specifications for ISO 12925-1 CKD:

- ENDURATEX Synthetic EP (Please refer to page 181)
- ENDURATEX XL Synthetic Blend 68/150 and 68/220
- ENDURATEX EP 32, 68, 100, 150 and 220

Fives Cincinnati (formerly MAG-IAS) Approval

ENDURATEX EP 150	P-77	ENDURATEX EP 220	P-74
ENDURATEX EP 320	P-59	ENDURATEX EP 460	P-35

ENDURATEX EP 460 is approved for Caterpillar Global Mining LLC (formerly Bucyrus International Inc.) Dragline enclosed gearcase lubricant (SD4721 Part A).



Typical characteristics are shown below:

								XL Syn BL	XL Syn BL
	68	100	150	220	320	460	680	68/150	68/220
Former AGMA Number	2	3	4	5	6	7	8	3	4
Density, kg/L @ 15°C/60°F	0.864	0.872	0.882	0.890	0.899	0.903	0.912	0.868	0.870
Color, ASTM	<1.0	<1.0	2.5	3.0	4.0	<5.0	>8.0	<1.0	1.0
Viscosity cSt @ 40°C cSt @ 100°C	68.0 9.1	101 11.3	150 15.0	220 19.4	325 25.2	452 30.4	688 37.0	101 14.5	150 22.3
Viscosity Index	109	97	100	99	100	97	88	147	176
Flash Point, COC, °C/°F	240/ 464	240/ 464	269/ 516	275/ 527	287/ 549	276/ 529	297/ 567	250/ 482	251/ 484
Pour Point, °C/°F	-39/-38	-33/-27	-33/-27	-27/-17	-21/-6	-15/5	-9/16	-39/-38	-33/-27
FZG Failure Load Stage	12+	12+	12+	12+	12+	12+	12+	12+	12+
Oxidation Stability % Viscosity Increase 312 hours, 121°C / 250°F	2.7	3.7	3.8	4.9	7.3	7.9	17	3.5	3.5

ENDURATEX™ MILD WORM GEAR (WG) OILS

ENDURATEX Mild WG Oils are Non-EP lubricants recommended for service in some enclosed worm gear reducers and industrial machinery. ENDURATEX Mild WG Oils are also suited for lubrication of reciprocating steam cylinders.

Typical characteristics are shown below:

ENDURATEX Mild WG Oils		
	460	680
Viscosity cSt @ 40°C	444	669
cSt @ 100°C	28.6	36.5
Viscosity Index	91	89
Flash Point, COC, °C/°F	311/592	313/595
Pour Point, °C/°F	-3/27	0/32

ENDURATEX™ SYNTHETIC OHV 680

ENDURATEX Synthetic OHV (Off-Highway Vehicle) 680 is a premium performance, extreme pressure lubricant. It is designed to work in high temperature conditions and maintain exceptional lubricant film strength. Formulated using PAO and ester-based technology, this product is capable of withstanding severe load conditions, helping to reduce wear so that component life is maximized. It is approved by General Electric for the lubrication of both DC and AC motorized wheel gearbox applications in off-highway haul trucks.

ENDURATEX Synthetic OHV 680 is also suitable for use in stationary gearbox applications requiring an ISO 680 viscosity grade.

Typical characteristics are shown below:

ENDURATEX Synthetic OHV 680	
Density, kg/L at 15°C	0.8607
Color, ASTM	<1.0
Viscosity, cSt at 40°C	707
cSt at 100°C	64.4
Viscosity Index	161
Pour Point, °C/°F	-36/-33
Temperature required for 150,000 cP, °C/°F	-23/-9
Flash Point, COC, °C/°F	280/536
Rust, Procedure B, 4 h, at 60 °C	Pass
Copper Corrosion, 3h @ 100°C	1a
Timken OK Load, kg/lb	45/99
Four Ball EP weld, kg/lb	250/550



ENDURATEX™ SYNTHETIC EP

ENDURATEX Synthetic EP gear lubricants are premium performance, extreme pressure lubricants designed for enclosed industrial gears and bearings operating under severe load conditions for all-season use. They deliver excellent wear properties and outstanding extreme temperature performance for extended component and fluid life. ENDURATEX Synthetic EP enhances gear box performance over a wide temperature range. The high viscosity index of ENDURATEX Synthetic EP products means that they retain their viscosity at high operating conditions. This often allows the use of a lower ISO grade than with conventional gear oils. ENDURATEX Synthetic EP gear lubricants meet the requirements of Flender Gear Units Revision 16, AIST 224 (formerly US Steel 224), DIN 51517-3, David Brown S1.53.101 Type E, Fives Cincinnati (formerly MAG IAS), Eickhoff Gear, Jahnel Kestermann and qualify as premium synthetic EP gear lubricants. ENDURATEX Synthetic EP oils can be used where AGMA antiscuff/antiwear Extreme Pressure (EP) Gear lubricants are required.

ENDURATEX Synthetic EP oils (ISO 150, 220, 320 and 460) are listed on Flender Gear Units and Geared Motors T7300 Approved Lubricants List and are suitable for use in GE787/GE788 drive systems.

Typical characteristics are shown below:

ENDURATEX Synthetic EP				
	150	220	320	460
AGMA No.	4EP	5EP	6EP	7EP
Viscosity cSt @ 40°C	150	226	331	466
cSt @ 100°C	19.5	26.2	35.5	46.3
Viscosity Index	148	148	153	155
Temp for 150,000 cP, °C/°F	-41/-42	-36/-33	-32/-26	-24/-11
Flash Point, COC, °C/°F	232/450	235/455	237/459	237/459
Pour Point, °C/°F	-54/-65	-48/-54	-42/-44	-39/-38
Timken OK Load, kg/lb	>48/106	>48/106	>48/106	>48/106
FZG Failure Load Stage	>12	>12	>12	>12

HARNEX™ 320 WIND TURBINE GEAR OIL

HARNEX 320 is a premium synthetic gear lubricant designed to provide exceptional anti-wear/EP performance, outstanding protection against micropitting and corrosion in wind turbine applications. The product uses synthetic PAO base oils, known for their excellent viscosity index and low pour point properties.

HARNEX 320 has Moventas approval for wind turbine gearboxes and also GE service fill approval for 1.x and 2.x platforms with Winergy gearboxes.

HARNEX 320 meets the technical requirements of Shanghai Electric, and is approved for use in any gear box on a Shanghai Electric wind turbine. Please contact a Technical Services Advisor for additional information.

In addition, HARNEX 320 meets the following industry requirements: AGMA 9005-F16, DIN 51517-3 (CLP 320).

Typical characteristics are shown below:

HARNEX 320	
Density @ 15 °C	0.862
Viscosity cSt @ 40°C	323
cSt @ 100°C	34.9
Viscosity Index	153
Flash Point, COC, °C/°F	237/459
Pour Point, °C/°F	-42/-44
Temperature for 150,000 cP, °C/°F	-32/-26
Rust Test (Synthetic Sea Water)	Pass
Timken OK, kg	>48
4 Ball Weld, kg	250
4 Ball Wear @ 40 kg, 1200 rpm, 75°C, 1 h	0.33
FZG Scuffing Test A/8.3/90 Fail	12+
FZG Scuffing Test A/16.6/90 Fail	12+
FZG Micropitting Test @ 60°C Fail	10
FZG Micropitting Test @ 90°C Fail	10
FAG FE8 Test (Stages 1,2,3,4)	Pass

Note 1: Users should refer to Tech Bulletin TB-1257 for detailed changeout procedure and TB-1263 for the list of recommended lubricants for wind turbines.

Note 2: Contact a Technical Services Advisor for used oil condemning limits of HARNEX 320.



SYNDURO™ SHB SYNTHETIC MULTI-FUNCTIONAL LUBRICANTS

SYNDURO SHB Fluids are a family of synthetic multi-functional lubricants designed to deliver excellent component protection for equipment operating at high speed or mild Extreme Pressure (EP) loads over a wide temperature range during extended service intervals. They have the added advantage of excellent low-temperature fluidity during start-ups, or during outdoor winter exposure.

They are especially suitable for a wide range of gear, bearing and compressor applications in the forestry, mining, marine and heavy-duty industries where low seasonal start-up temperatures and/or high operating temperatures prevail. SYNDURO SHB 32, 46 and 68 can also be used in rotary screw air compressors at air discharge temperatures up to 93°C/200°F, or as synthetic hydraulic fluids. SYNDURO SHB 220 can be used in the timing gears of most dry rotary blowers. SYNDURO SHB 460 can be used in moderately loaded worm gearboxes. SYNDURO SHB 46 meets Voith Doc. 3625-008377 and is therefore suitable for lubrication of the Vorecon variable speed planetary gear type RWE11F6. SYNDURO SHB Fluids offer the potential to consolidate lubricants over many different applications and a wide range of operating conditions. For those applications that are subjected to heavy loads or shock loading and require an AGMA 9005-F16 (antiscuff) type of fluid, Petro-Canada Lubricants ENDURATEX™ Synthetic EP series or ENDURATEX Synthetic OHV 680 is recommended.

Typical characteristics are shown below:

SYNDURO SHB							
	32	46	68	100	150	220	460
Viscosity cSt @ 40°C	33	47	68	101	148	219	452
cSt @ 100°C	6.2	8.3	11.1	15.3	20.3	27.4	46.9
Viscosity Index	142	151	155	157	159	160	162
Flash Point, COC, °C/°F	237/459	254/488	235/455	231/448	237/459	243/469	266/511
Pour Point, °C/°F	<-60/-76	<-60/-76	-54/-65	-54/-65	-45/-49	-42/-44	-39/-38
Oxidation Stability, 24h, 200°C (TAN increase)	0.4	0.4	0.5	0.5	0.5	0.5	0.7
FZG Failure Load Stage	12+	12+	12+	12+	12+	12+	12+

Note: These oils should NEVER be used in equipment compressing pure oxygen or other chemically active gases such as chlorine or hydrogen chloride. DO NOT USE in breathing air apparatus or medical equipment.

OTHER INDUSTRIAL LUBRICANTS

ACCUFLO™ TK – MACHINE TOOL LUBRICANTS

ACCUFLO TK Oils are specially formulated to lubricate the slideways of machine tools and maintain smooth, uninterrupted operation. They may be applied to linear and rotating guideways, table elevating slideways on milling machines, lead-screw-and-nut systems, feed gears, milling heads, and lathe saddles.

ACCUFLO TK Oils eliminate “stick-slip” or chatter on machine tables and contain inhibitors to protect ferrous and copper components against corrosion. Their unique zinc-free formulations provide excellent film strength, lubrication properties and machine table accuracy. They are highly tacky to resist removal by synthetic coolants and soluble oils. This cuts the consumption of lubricant and the generation of tramp oil which, in turn, improves coolant management.

ACCUFLO TK 68 is recommended for horizontal slides and moderately loaded machine tools, while ACCUFLO TK 220 is recommended for vertical slides or heavy-duty machine tools such as planers and boring mills.

ACCUFLO TK 68 and 220 are GM LS2 approved, meet ISO-L-G standards, and are approved against Fives (formerly Cincinnati Machine) specifications P-47 and P-50 respectively. ACCUFLO TK 68 is approved for use in Bijur systems and passes Bijur's filtration test #2107.

Typical characteristics are shown below:

ACCUFLO TK		
	68	220
Viscosity cSt @ 40°C	71	217
	cSt @ 100°C	9.9
Viscosity Index	122	21
Flash Point, COC, °C/°F	225/437	118
Pour Point, °C/°F	-33/-27	255/491
Stick-slip No.	-24/-11	0.76
Weld Point, kg / lb	200/441	0.78
		250/551



PC WAYLUBE – MACHINE TOOL LUBRICANT

PC WAYLUBE 68 is formulated for the lubrication of the slideways of modern machine tools. It meets the stick-slip ratio requirements of Fives (formerly Cincinnati Machine) P-47 specification and is GM LS2 approved.

Where greater oil adhesion is required, such as with vertical ways, we recommend Petro-Canada Lubricants ACCUFLO™ TK machine tool lubricants.

The visual appearance is lighter and is a more clear yellow liquid (<2.0 on the ASTM Color Scale).

Typical characteristics are shown below:

PC WAYLUBE 68		
Viscosity	cSt @ 40°C	68
	cSt @ 100°C	8.9
Viscosity Index		105
Flash Point, COC, °C/°F		233/451
Pour Point, °C/°F		-36/-32
Stick-slip No.		0.76
Weld Point, kg / lb		200/441

ARDEE™ – ROCK DRILL OILS

ARDEE oils are formulated to lubricate and cool the mechanisms of air-operated rock drills. They are ideal for use in equipment running in demanding situations with high air-flow rates, drill shock-loading, and high piston temperatures. There are six viscosity grades to meet temperatures ranging from -35°C / -31°F to 45°C / 113°F. ARDEE 32 is recommended for low temperatures and/or winter conditions. ARDEE 68 to 150 are recommended for underground operations, with the 150 grade being favored in SECAN drills and in mining operations targeting reduction of oil consumption and misting. ARDEE 220 is recommended for use in open pit operations using drills with a bore larger than 10 cm / 4 inches during the summer or under warmer conditions.

ARDEE 32 is recommended for use in plant air-line lubricators, especially where the air is water laden.

Typical characteristics are shown below:

ARDEE OILS						
	32	46	68	100	150	220
Viscosity cSt @ 40°C	31.9	45.0	71.7	96.4	149	207
cSt @ 100°C	6.0	7.4	9.9	11.5	15.0	19.0
Viscosity Index	137	129	119	107	101	103
Flash Point, COC, °C/°F	180/356	207/405	231/448	233/451	243/469	281/538
Pour Point, °C/°F	-48/-54	-42/-44	-42/-44	-33/-27	-30/-22	-24/-11
Timken OK Load, lb / kg	20/9	30/14	30/14	30/14	30/14	30/14
Weld Point, kg / lb	200/441	200/441	200/441	200/441	250/551	250/551



DURATAC™ OILS

Petro-Canada Lubricants DURATAC Oils are an economical, tacky, “once-through” line of lubricants for use in hand oiling of drive chains, log decks, and waste conveyors. They are also recommended for infeed and other sawmill chains, chain saw bars, and in lubricating leaky, slow-speed journal bearings. These products are formulated with a tackiness additive which helps to reduce dripping and throw-off during use.

DURATAC Chain Oil 32 is dyed red and formulated for use in the winter at low temperatures. DURATAC Chain Oil 150 is also dyed red and formulated for use in the summer.

Typical characteristics are shown below:

DURATAC CHAIN OILS				
	32	68	100	150
Texture	Stringy	Stringy	Stringy	Stringy
Viscosity cSt @ 40°C	32	68	100	150
cSt @ 100°C	6.3	10.4	13.4	16.8
Viscosity Index	151	140	133	120
Pour Point, °C/°F	-42/-44	-39/-38	-36/-33	-30/-22
Flash Point, COC, °C/°F	190/374	210/410	210/410	210/410
Color	Dark Red	Brown	Brown	Dark Red
Rust, Procedure A, 24 h	Pass	Pass	Pass	Pass
Four-ball Scar Diameter, mm 1200 rpm, 1 h, 15 kg, 75°C	0.25	0.25	0.25	0.25

PETRO-CANADA BAR & CHAIN OILS

PETRO-CANADA BAR & CHAIN OILS are designed specifically for use in chainsaws and timber harvesters.

PETRO-CANADA BAR & CHAIN 32 is formulated for use in late fall, winter, or early spring seasons due to its lower viscosity properties and pour point of -42°C (-44°F).

PETRO-CANADA BAR & CHAIN 150 is formulated for use in warmer seasons due to its high viscosity properties.

Because rapid chain wear can occur from insufficient lubrication, chain oiler reservoirs should be kept full and the oiler pump checked regularly.

Before installing a new chain, soak it first for a few hours in a clean container filled with PETRO-CANADA BAR & CHAIN OIL. This allows the lubricant to penetrate all the linkage points and prevent wear and rust.

PETRO-CANADA BAR & CHAIN OILS			
	Test Method	32	150
Texture	PCM 264	Stringy	Stringy
Colour	Visual	Dark Red	Dark Red
Kinematic Viscosity @ 40°C, cSt	D445	35	150
Kinematic Viscosity @ 100°C, cSt	D445	7.7	18.6
Viscosity Index	D2270	182	124
Flash Point, COC, °C	D92	171	231
Pour Point, °C	D5950	-42	-33

The values quoted above are typical of normal production. They do not constitute a specification.



PETROGLIDE™ – SAW GUIDE OIL

Petro-Canada Lubricants PETROGLIDE saw guide oils are specially designed for use with modern multi-blade gang saws and edgers to provide increased recovery rates and sawmill productivity.

PETROGLIDE's specially formulated additive package gives it the characteristics required for excellent saw guide lubrication. Its surface wetting, coupled with good water separability and tackiness, helps to hold it in place without causing excessive sawdust clumping. PETROGLIDE has excellent extreme pressure properties and Pitch Control additives to reduce friction and metal to metal contact, decreasing heat build-up and wear on both saw guides and blades. PETROGLIDE's blend of additives help to ensure a good cut, as well as a long saw guide and blade life. It also minimizes rusting throughout the operation cycle while reducing saw deviation and maximizing on-spec board production.

PETROGLIDE ELV is a low viscosity formulation designed to emulsify with water for enhanced cooling efficiency and helps reduce friction.

Typical characteristics are shown below:

PETROGLIDE			
	100	150	ELV
Viscosity cSt @ 40°C	108	172	42
cSt @ 100°C	14.1	17.7	6
Viscosity Index	131	113	92
Flash Point, COC, °C/°F	277/531	270/518	185/365
Pour Point, °C/°F	-36/-33	-33/-27	-27/-17
Four Ball EP Weld Load, kg	200	200	-

PETROGLIDE™ MC 32 – BANDSAW OIL

Petro-Canada Lubricants PETROGLIDE MC 32 is a premium quality bandsaw oil specially designed for mist lubricated bandsaws. Pitch control additives and rust inhibitor keep blades cleaner. Its tackiness and mist control are carefully balanced to effectively lubricate without excessive stray mist, which help to minimize oil usage and contribute to a cleaner environment.

PETROGLIDE MC 32 may also be used in oil/water saw lubrication and cooling systems which require a saw guide oil with an ISO 32 grade.

Typical characteristics are shown below:

PETROGLIDE MC 32		
Viscosity	cSt @ 40°C	32
	cSt @ 100°C	6.0
Viscosity Index		131
Flash Point, COC, °C/°F		195/383
Pour Point, °C/°F		-51/-60
Four Ball EP Weld Point, kg		200



SEPRO™ XL PAPER MACHINE OILS

Petro-Canada Lubricants' SEPRO XL PAPER MACHINE OILS are designed to offer reliable performance in both dry and wet ends of paper machine circulating systems. SEPRO XL paper machine oils are based on highly refined, high-quality base oils and a specially selected zinc-free additive chemistry. They provide outstanding anti-wear properties, excellent water separation as well as good oxidative and thermal stability for better and longer equipment protection against wear, rust and corrosion. SEPRO XL will help minimize unscheduled downtime and increase equipment life.

Petro-Canada Lubricants' SEPRO XL paper machine oils are suitable for use where the following paper machine OEM specifications are required: Voith VS 108 for dry and wet ends, Valmet RAU4L00659-06 for dry and wet ends, Valmet RAUAH02724-02 for zone-controlled rolls and SKF Specifications for Bearings in Dryer Sections of Paper Machines.

SEPRO XL			
	ASTM Test Method	150	220
Density @ 15°C, kg/L	ASTM D4052	0.876	0.881
Colour	ASTM D1500	2.5	< 4.0
Flash Point, COC, °C/°F	ASTM D92	272/522	282/540
Kinematic Viscosity @ 40°C, cSt	ASTM D445	152	222
Kinematic Viscosity @ 100°C, cSt	ASTM D445	15.2	19.4
Viscosity Index	ASTM D2270	101	100
Pour Point, °C /°F	ASTM D5950	-27/-17	-18/0
Water Separability at 82°C, minutes	ASTM D1401	10	10
Copper Corrosion	ASTM D130	1a	1a
Rust Test, Procedure A & B, 24 hours	ASTM D665	Pass	Pass
Air Release @ 75°C, minutes	ASTM D3427	7	10
Four-Ball Wear Test, scar diameter, mm 40 kg, 1 hour, 75°C, 1200 rpm	ASTM D4172	0.43	0.42
FZG Failure Load Stage	ASTM D5182	12+	12+

SUPER VAC FLUIDS – VACUUM PUMP FLUIDS

Super Vac Fluids are specially designed to cool, lubricate and provide a seal in piston and rotary-vane air vacuum pumps. Blended with high quality base oils and incorporating a unique additive system, Super Vac Fluids allow for extremely low vapour pressures which help to maximize vacuum efficiency. These fluids have exceptional resistance to high-temperature breakdown and deliver extended lubricant life under severe operating conditions when compared to straight base oil. They can be used at higher operating temperatures (100-130°C / 212-266°F) at reduced service life.

Besides handling air, Super Vac Fluids may also be used with the following gases: nitrogen, hydrogen, carbon dioxide, carbon monoxide, argon, neon and helium.

They should not be used in pumps handling aggressive vapours, such as nitric acid, sulfuric acid, chlorine, hydrogen sulfide or glacial acetic acid.

Food Industry Registration

Super Vac Fluids 15, 19, and 20 are NSF H2 registered and are acceptable for use in Canadian food processing facilities where no food contact is allowed.

Typical characteristics are shown below:

SUPER VAC FLUIDS			
	15	19	20
Viscosity cSt @ 40°C	38	55	103
cSt @ 100°C	6.2	7.6	11.4
Viscosity Index	108	100	97
Flash Point, COC, °C/°F	220/428	225/437	260/500
Pour Point, °C/°F	-18/0	-15/+5	-12/+10
Calculated Vapour Pressure, mBar @ 25°C	3x10 ⁻⁵	5x10 ⁻⁶	3x10 ⁻⁶



PROCESS OILS

INTRODUCTION

Petro-Canada Lubricants line of Process Oils are select blends of high quality paraffinic oils, designed for use by industry in a wide range of applications and finished products.

PARAFLEX™ HT

PARAFLEX HT Process Oils are carefully controlled blends of advanced paraffinic oils produced by removing undesirable polar and aromatic compounds from the product. Composed of saturated hydrocarbons, PARAFLEX HT Process Oils are typically crystal clear and have low toxicity.

PARAFLEX HT Process Oils are recommended for use as raw materials or production aids in a wide range of manufacturing of a wide range of chemical, elastomer and specialty products.

Typical characteristics are shown below:

PARAFLEX HT						
	3	4	5	9	10	15
Density, kg/L@ 15°C	0.844	0.827	0.853	0.830	0.855	0.848
Color, ASTM	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Viscosity cSt @ 40°C	3.7	3.9	5.6	9.4	10.0	15.4
cSt @ 100°C	1.4	1.4	1.8	2.6	2.5	3.5
Viscosity Index	—	—	—	102	83	100
Pour Point, °C/°F	-24/-11	-55/-67	-12/10	-39/-38	-21/-6	-24/-11
Aromatics, % Wt	2.2	<0.5	3.5	<0.5	<0.5	<0.5

PARAFLEX HT					
	22	32	46	68	100
Density, kg/L@ 15°C	0.845	0.860	0.862	0.866	0.870
Color, ASTM	<0.5	<0.5	<0.5	<0.5	<0.5
Viscosity cSt @ 40°C	21.5	34.7	45.9	66.9	102
cSt @ 100°C	4.3	5.7	6.8	8.8	11.5
Viscosity Index	108	105	104	103	99
Pour Point, °C/°F	-21/-6	-18/0	-18/0	-15/5	-15/5
Aromatics, % Wt	<0.5	<0.5	<0.5	<0.5	<0.5

STATIONARY GAS ENGINE OIL (SGEO)

SENTRON™ – STATIONARY GAS ENGINE OIL

SENTRON Stationary Gas Engine Oils (SGEOs) are premium performance, long life engine oils specifically designed to lubricate stationary gas engines and their integrated compressors, running at gas plants and pipeline compression stations, as well as in power generation, cogeneration, bio gas, landfill and sewage gas operations and in crude oil production operations.

SENTRON SGEOs are formulated with three different sulfated ash levels:

SENTRON ASHLESS 40	Ashless - less than 0.1% wt ash
SENTRON CG 40 PLUS, LD 3000, LD 5000, LD 8000, LD Synthetic Blend VTP 0W-30, VTP 10W-40, VLA 40	Low Ash - 0.1 to 0.6% wt ash
SENTRON CG 40, SP 30, SP 40, VTP 10W-40 Plus	Medium Ash - 0.6 to 1.0 % wt ash

ASHLESS

SENTRON ASHLESS 40

SENTRON ASHLESS 40 (0.05% wt ash) is recommended primarily for 2-stroke cycle stationary gas engines but may be used in certain 4-cycle gas engines. SENTRON ASHLESS 40 minimizes scavenge port, combustion chamber and spark plug deposits.

LOW ASH

SENTRON CG 40 PLUS

SENTRON CG 40 PLUS (0.52% wt ash) is a uniquely designed low ash formula for 4-cycle stationary gas engines running in biogas, sewage gas and landfill gas operations. It provides excellent control of deposits and offers protection against corrosion caused by high halogen levels produced by landfills. Unlike conventional landfill / biogas / sewer gas engine oils, SENTRON CG 40 PLUS is specifically designed to address current and future engines running in this severe contaminated gas application where higher BMEP engines are used.



SENTRON™ LD 3000

SENTRON LD 3000 (0.47% wt ash) is recommended for most 4-cycle and some 2-cycle stationary gas engines including Caterpillar, Waukesha and others in gas compression applications. It is suitable for use in engines fitted with catalytic converters. Can be used in any stationary application – compression, power gen, water pumping etc. SENTRON LD 3000 helps provide a high level of performance in high output turbocharged and naturally aspirated engines that prefer a low ash oil. It provides excellent control of engine deposits, even when there is a need for added high temperature deposit control. It is suitable for severe service applications including high output, turbocharged engines that encounter high exhaust gas temperatures.

SENTRON LD 5000

SENTRON LD 5000 (0.57% wt ash) is a low ash SAE 40 oil recommended for use in Caterpillar, Jenbacher, Waukesha, and many turbocharged or naturally aspirated, stoichiometric or lean burn engines that require a low ash stationary gas engine oil. It incorporates additives for the extra performance required for severe service applications, including high output, turbocharged engines that encounter high exhaust gas temperatures. SENTRON LD 5000 offers outstanding deposit control and excellent performance for up to 200%* longer drain intervals and exceptional overall engine protection for maximum reliability and savings. It can be used in biogas/digester gas applications if the fuel sources are pre-treated to minimize harmful acidic constituents.

*All data generated were on engines in gas compression service under >90% engine load using pipeline quality fuel and typical field conditions. Performance results may vary due to factors such as, but not limited to, engine optimization, load, fuel gas quality, proper maintenance, type of engine and application.

SENTRON LD 8000

SENTRON LD 8000 (0.52% wt ash) is a premium low ash SAE 40 lubricant, suitable for use in 4-cycle stationary gas engines operating on natural pipeline gas, pre-treated sewage/biogas and selective pre-treated process gases. It provides revolutionary extended drain intervals over the leading global conventional competitor.* SENTRON LD 8000 contains a specialized additive mix that provides greater TBN retention to help neutralize acids that can attack component surfaces. SENTRON LD 8000 prevents ash deposits which reduces wear. SENTRON LD 8000 combines a high degree of oxidative stability with nitration resistance.

*In Caterpillar G3500 TALE engines running in gas compression, with >90% loads and pipeline quality fuel. Performance results may vary due to factors such as, but not limited to, engine optimization, load, fuel gas quality, proper maintenance, type of engine and application.

SENTRON™ LD SYNTHETIC BLEND

SENTRON LD Synthetic Blend (0.53% wt ash) is an SAE 15W-40 multigrade extension of the SENTRON line, formulated as a synthetic blend to extend drain intervals and give better low temperature performance in comparison to mono-grade SAE 40 oils. SENTRON LD Synthetic Blend is specifically recommended for use in large bore engines prone to excessive combustion chamber deposits. It is suited for colder environments where start up temperatures fall as low as -20°C/-13°F.

SENTRON VTP 0W-30

SENTRON VTP 0W-30 (0.58% wt ash) is a low ash, synthetic blend stationary gas engine oil formulated specifically as an all season solution for small to mid-sized engines that are difficult to start in severe winter conditions. With a Pour Point of -45°C/-49°F, SENTRON VTP 0W-30 helps provide exceptional performance in extreme winter conditions, presenting opportunities for inventory consolidation. SENTRON VTP 0W-30 may also be suitable for use in engines equipped with certain on-road catalytic converters. Check with your Technical Services Advisor for suitability.

SENTRON VTP 10W-40

SENTRON VTP 10W-40 (0.59% wt ash) is specially formulated to meet the demands of small stationary natural gas engines for exceptional cleanliness of the engine through all seasons. It is recommended for use in gas fuelled engines that require high zinc additive for improved valve train wear protection while providing excellent cold start capability. SENTRON VTP 10W-40 is suitable for use in applications where Cummins CES 20074 is specified. SENTRON VTP 10W-40 may also be suitable for use in engines equipped with certain on-road catalytic converters. Check with your Technical Services Advisor for suitability.

SENTRON VLA 40

SENTRON VLA 40 (0.30% wt ash) is a "very" low ash stationary gas engine oil, specifically designed for 4-cycle stationary gas engines running at low loads (<60% MCR). Low load engines tend to have increased oil consumption rates, leading to excessive ash deposit accumulation. The very low ash content of 0.30% in SENTRON VLA 40 will provide optimal protection against deposit formation preventing excessive combustion chamber deposit buildup, reducing piston ring sticking/breaking and spark plug fouling. The decision to use this product is technical, check with your Technical Services Advisor for further information.



MEDIUM ASH

SENTRON™ CG 40

SENTRON CG 40 (0.93% wt ash) is a medium ash SAE 40 oil, that is specifically designed for 4-cycle stationary gas engines running in severe service, such as cogeneration, bio gas, digester and low halogen landfill or sewage gas operations. SENTRON CG 40 gives exceptional performance in turbocharged, lean-burn and naturally aspirated gas engines. SENTRON CG 40 may be suitable for use in engines equipped with certain catalytic converters. Check with your Technical Services Advisor for suitability.

SENTRON SP 40

SENTRON SP 40 (0.75% wt ash) is a premium performance stationary gas engine oil, specifically formulated for 4-cycle high BMEP stationary gas engines operating with steel pistons. This product offers significant reduction of combustion chamber deposits, outstanding top ring groove deposit control, excellent oxidation/nitration resistance and acid neutralization capability. This helps deliver a combination of extended oil life and outstanding engine durability.

SENTRON SP 30

SENTRON SP 30 (0.70% wt ash) is an advanced-performance SAE 30 mono-grade stationary gas engine oil that provides extended oil and component life in 4-cycle gas engines under varied operating conditions such as frequent start/stops, low as well as high operating temperatures. It is formulated with wax-free, very high viscosity index base oil and advanced additive technology to provide a performance that is unattainable with conventional gas engine oils including premium performance products. SENTRON SP 30's SAE 30 viscosity offers advantages over SAE 40 class oils including improved fuel efficiency, faster engine startup, and faster lubrication of critical hard to reach components such as valve guides after engine startup. SENTRON SP 30 is approved by MAN for M3271-2 and M3271-5 categories. Not all gas engines are designed to run with SAE 30 oils, please check with your Technical Services Advisor for suitability.

SENTRON VTP 10W-40 PLUS

SENTRON VTP 10W-40 PLUS (0.68% wt ash) is a premium quality mid ash SAE 10W-40 multi-grade natural gas engine oil specifically designed for stationary gas applications that need additional anti-wear characteristics (i.e. gasoline engines converted to natural gas) due to the valve train and/or for engines where extreme improved low temperature performance benefits are desired due to cyclic engine on-off cycles. Applications includes smaller remote well-head engines and gas line booster engines that are low emission. Not suitable for some engines with catalytic converters due to higher Zn/P Sulfur. Extended drains and excellent durability can be realized with SENTRON VTP 10W-40 PLUS. Check with your Technical Services Advisor for suitability.

Please refer to page 201 for a QR code to scan for SENTRON OEM approvals and product credentials for a listing of the recommended SENTRON products by Manufacturer.

TYPICAL PERFORMANCE DATA

PETRO-CANADA LUBRICANTS STATIONARY GAS ENGINE OILS							
PROPERTY	ASTM TEST METHOD	SENTRON™ ASHLESS 40	SENTRON CG 40 PLUS	SENTRON LD 3000	SENTRON LD 5000	SENTRON LD 8000	SENTRON SP 30
Ash Type	-	Ashless	Low Ash	Low Ash	Low Ash	Low Ash	Mid Ash
Sulphated Ash, % wt	D874	0.05	0.52	0.47	0.57	0.52	0.70
SAE Grade	-	40	40	40	40	40	30
Flash Point, COC, °C/°F	D92	276/529	283/541	273/523	272/522	277/531	241/466
Kinematic Viscosity cSt @ 40°C cSt @ 100°C	D445	125 13.7	119 13.4	124 13.7	124 13.4	121 13.3	74 10.7
Pour Point, °C/°F	D5950	-27/-17	-27/-17	-27/-17	-30/-22	-27/-17	-42/-44
Total Acid Number (TAN)*	D664	0.70	1.53	0.86	1.10	0.86	0.66
Base Number	D2896	1.6	4.5	3.9	4.9	4.6	6.5
PROPERTY	SENTRON SP 40	SENTRON VLA 40	SENTRON LD SYNTHETIC BLEND	SENTRON VTP 0W-30	SENTRON VTP 10W-40	SENTRON VTP 10W-40 PLUS	SENTRON CG 40
Ash Type	Mid Ash	Low Ash	Low Ash	Low Ash	Low Ash	Medium Ash	Medium Ash
Sulphated Ash, % wt	0.75	0.30	0.53	0.58	0.59	0.68	0.93
SAE Grade	40	40	15W-40	0W-30	10W-40	10W-40	40
Flash Point, COC, °C/°F	269/516	263/505	247/477	239/462	245/473	231/448	273/523
Kinematic Viscosity cSt @ 40°C cSt @ 100°C	124 13.3	116 13.0	106 15.6	62 11.2	101 15.1	104 14.9	123 13.6
Pour Point, °C/°F	-33/-27	-24/-11	-42/-44	-45/-49	-42/-44	-45/-49	-27/-17
Total Acid Number (TAN)*	1.34	0.32	1.02	1.83	1.93	1.97	0.58
Base Number	6.6	2.9	4.7	4.8	3.9	4.2	8.1

The values quoted above are typical of normal production.
They do not constitute a specification.

*Minor variations in typical test data are normal and should be expected under ASTM D664. To ensure maximum repeatability, used oil should be tested in the same lab under the same conditions that the fresh oil was tested.



STATIONARY GAS ENGINE OIL
RECOMMENDED APPLICATIONS



Scan this QR code to view
our table of OEM approvals
and credentials for SENTRON

FUEL APPLICATION GUIDE

FUEL GAS	RECOMMENDED PRODUCT
Natural/Pipeline Gas*, "Light" Biogas/ Digester/Sewage Gas - Treated	SENTRON™ LD 8000, SENTRON LD 5000, SENTRON LD Synthetic Blend, SENTRON SP 40, SENTRON SP 30
Natural/Pipeline Gas*	SENTRON LD 3000, SENTRON LD 8000, SENTRON LD Synthetic Blend, SENTRON Ashless 40, SENTRON LD 5000, SENTRON VLA 40, SENTRON SP 40, SENTRON SP 30
Landfill Gas – Some treated, lower chlorine	Preferred: SENTRON LD 8000, SENTRON CG 40 PLUS, SENTRON LD 5000 Secondary: SENTRON CG 40
Landfill Gas – Severe, untreated, high chlorine	Preferred: Pre-treat gas to reduce contaminants / align with OEM Fuel quality minimums. Secondary: SENTRON CG 40 PLUS, SENTRON CG 40
"Heavy" Biogas/Digester Gas/ Sewage Gas – Untreated	SENTRON CG 40 PLUS SENTRON CG 40 with more frequent combustion zone cleaning

*Please consult a Technical Services Advisor to discuss your application before choosing a gas engine oil so that you ensure correct product is being used.

TURBINE FLUIDS

TURBOFLO™ LOW VARNISH

TURBOFLO Low Varnish (LV) is a premium turbine fluid designed to lubricate and cool gas, steam and combined-cycle turbines and deliver excellent lubrication to bearings operating in severe conditions. TURBOFLO LV demonstrates an industry leading resistance to varnish and sludge buildup, which will contribute to optimum turbine performance and reliability. The product's outstanding resistance to oxidation and thermal stability minimizes fluid breakdown caused by air and high temperatures.

TURBOFLO LV fluids are suitable for use in gas, steam and combined-cycle turbines requiring the following major manufacturer and industry specifications:

ASTM	D-4304 TYPE I, III
DIN	DIN 51515 PART 1, 2
DIN	DIN 51524 PART 1
ISO	11158 HH, HL
ISO	808 TSA, TGA, TGB and TGSB
British Standard	BS 489
General Electric	GEK 32568J (ISO 32 only)
Siemens	TLV 9013 04 STANDARD THERMAL STABILITY
Siemens	TLV 9013 05 HIGH THERMAL STABILITY
GE (formerly Alstom)	HTGD 90 117
Solar	ES 9-224Y

TURBOFLO LV is also suitable for use in turbines requiring Chinese National Turbine Specifications GB 11120-2011 L-TSA Class A and L-TSE Class B, in addition to the technical requirements of L-TGA and L-TGSB.

TURBOFLO LV		
	32	46
Viscosity cSt @ 40°C	33.6	45.2
cSt @ 100°C	5.68	6.79
Viscosity Index	108	104
Flash Point, COC, °C/°F	220/428	230/446
Pour Point, °C/°F	-39/-38	-33/-27
Oxidation Stability (D943), hours to 2.0 AN	10,000+	10,000+



TURBOFLO™ XL

TURBOFLO XL is a premium turbine fluid designed to lubricate and cool steam, hydraulic and gas turbines and deliver excellent lubrication to bearings operating in severe conditions. TURBOFLO XL demonstrates exceptional oxidative and thermal stability, which surpasses that of many competitive turbine lubricants on the market. TURBOFLO XL's superior performance is especially important in severe service situations common to gas turbines. Its outstanding oxidation and thermal stability minimizes fluid breakdown caused by air and high temperatures. It is suitable for turbine applications with bearings operating in ambient temperatures above 260°C/500°F.

TURBOFLO XL is designed to significantly exceed the demanding requirements of many steam and gas turbine lubricant specifications.

TURBOFLO XL can also be used, with careful system analysis, as a top-up product to enhance operating characteristics of used oil.

TURBOFLO XL fluids are suitable for use in steam and gas turbines requiring the following major manufacturer and industry specifications:

General Electric	GEK 32568J, GEK 46506E (ISO 32 only)
Siemens	TLV 9013 04, TLV 9013 05 (ISO 32 and 46 only)
Siemens / Westinghouse	1500 0020, 5512 5Z3
Solar	ES 9-224Y (ISO 32 and 46 only)
GE (formerly Alstom)	HTGD 90 117
DIN	DIN 51515, Part 1, 2
ASTM	D4304 Type I
JIS	K 2213 Type 2
Ansaldo Energia	Ansaldo AD00020487 (ISO 46 only)

Typical characteristics are shown below:

TURBOFLO XL			
	32	46	68
Viscosity cSt @ 40°C	33.9	46.4	68.2
cSt @ 100°C	5.6	6.8	8.8
Viscosity Index	101	100	102
Flash Point, COC, °C/°F	220/428	235/455	247/477
Pour Point, °C/°F	-30/-22	-30/-22	-24/-11
Oxidation Stability (D943), hours to 2.0 AN	10,000+	10,000+	10,000+

TURBOFLO™ EP

TURBOFLO EP is a premium turbine fluid designed for the lubrication of geared heavy-duty gas turbines with common gear and bearing lubrication systems. Its outstanding thermal and oxidative stability also makes it an excellent choice for severe service gas and steam turbine applications.

TURBOFLO EP with its zinc free, ashless anti-wear additive system delivers excellent wear and scuffing protection for heavily loaded geared turbines.

TURBOFLO EP fluids are suitable for use in steam and gas turbines requiring the following major manufacturer and industry specifications:

General Electric	GEK 101941A, GEK 32568J, GEK 28143A, GEK 46506E (ISO 32 only)
Siemens	TLV 9013 04, TLV 9013 05
Siemens / Westinghouse	1500 00 20, 5512 5Z3
Solar	ES 9-224Y
GE (formerly Alstom)	HTGD 90 117
DIN	DIN 51515
ASTM	D4304 Type II (EP)
JIS	K 2213 Type 2
Voith	Variable Speed Drives
Ansaldo Energia	TG02-0171-E00000/B

Typical characteristics are shown below:

TURBOFLO EP		
	32	46
Viscosity	cSt @ 40°C	34.2
		46.4
	cSt @ 100°C	5.6
		6.8
Viscosity Index	100	101
Flash Point, COC, °C/°F	220/428	237/459
Pour Point, °C/°F	-33/-27	-30/-22
Oxidation Stability (D943), hours to 2.0 AN	10,000+	10,000+
FZG Failure Load Stage	12	12



TURBOFLO™ R&O/PREMIUM R&O 77 – TURBINE/ CIRCULATING OILS

TURBOFLO R&O/Premium R&O 77 oils are high quality lubricants designed for use in steam and gas turbines, as well as the circulating oil systems of a wide range of industrial machinery. TURBOFLO R&O 10 and 22 grades are also suitable for use as spindle oils. These oils are designed to minimize rust and oxidation with blends of ultra-pure, high quality base oils and specially selected additives. In addition, they offer excellent water separability.

Premium R&O 77 meets National Defence Standard C-82-001-000/SF-001, Naval Steam Turbine and Main Gearing Lubrication.

TURBOFLO R&O 32, 46, 68 and Premium R&O 77 are suitable for use in steam and gas turbines requiring the following major manufacturer and industry specifications:

General Electric	GEK 46506E (ISO 32)
Siemens	TLV 9013 04 (ISO 32)
Siemens / Westinghouse	1500-00-20 (ISO 32, 46)
GE (formerly Alstom)	HTGD 90 117
Solar	ES 9-224Y (ISO 32, 46)
ASTM	D 4304 Type I (ISO 32, 46, 68, 100)
JIS	K 2213 Type 2 (ISO 32, 46, 68)

Typical characteristics are shown below:

TURBOFLO R&O						
	10	22	32	46	68	Premium R&O 77
Viscosity cSt @ 40°C	9.8	22.1	32.0	44.4	65.0	79.3
cSt @ 100°C	2.7	4.3	5.4	6.7	8.6	9.9
Viscosity Index	105	95	103	104	104	104
Flash Point, COC, °C/°F	182/360	204/399	220/428	224/435	234/453	270/518
Pour Point, °C/°F	-54/-65	-39/-38	-39/-38	-36/-33	-30/-22	-36/-33
Oxidation Stability (D943) hours to 2.0 AN	5,900+	5,900+	5,000+	5,000+	5,300+	5,500+

TURBOFLO R&O					
	100	150	220	320	460
Viscosity cSt @ 40°C	94.3	137.1	205.5	303.2	439.5
cSt @ 100°C	11.1	14.2	18.3	23.5	29.68
Viscosity Index	103	101	98	97	96
Flash Point, COC, °C/°F	262/504	269/516	275/527	297/566	317/602
Pour Point, °C/°F	-24/-11	-30/-22	-21/-6	-18/0	-15/5
Oxidation Stability (D943) hours to 2.0 AN	6,300+	3,500+	3,500+	2,700+	1000+



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INTRODUCTION

Greases are designed to lubricate bearings and gears where a continuous oil supply cannot be maintained. Grease is a solid to semi-solid material produced by the dispersion of a thickening agent in a liquid lubricant. In many cases, specialty additives are also used to enhance the performance of the product. When selecting grease for an application, capabilities such as operating temperatures, water resistance, oxidation stability, etc. are important considerations. The grease's characteristics, including viscosity and consistency, are also key factors to consider.

The most important factors affecting the properties and characteristics of a grease are:

- Amount and type of thickener
- Oil viscosity and physical characteristics

A grease is expected to:

- Reduce friction and wear
- Provide corrosion protection
- Seal bearings from water and contaminants
- Resist leakage, dripping and throw-off
- Resist change in structure or consistency during service
- Maintain mobility under conditions of application
- Be compatible with seals
- Tolerate or repel moisture

REGULAR GREASE

Regular (or simple) greases are primarily made through the reaction of a metal hydroxide with a fatty acid. The metal hydroxide is typically lithium or calcium.

Simple lithium greases provide wide temperature capabilities with good water resistance. Simple calcium greases provide good water resistance, but do not perform as well at high temperatures.

COMPLEX GREASE

Complex greases are also made with fatty acids similar to regular greases except that they use an additional carboxylic acid, which is the complexing agent. This imparts good high temperature characteristics to the final product along with the characteristics of the base metal hydroxide. Common complex greases include lithium complex, aluminum complex, and calcium complex.

Calcium sulphonate complex grease is based on a unique micellar soap structure. It provides both thickening and performance properties for the grease, including excellent wear and corrosion protection.



LUBRICATING OIL

Greases typically contain 75-95% oil, which must be of high quality and proper viscosity for the intended application. Low viscosity or synthetic oils are normally used for low temperature service. Low viscosity oils are also used for low load and/or high speed applications. Conversely, high viscosity or synthetic oils are generally used for high temperature service. High viscosity oils are also used for high load and/or slow speed applications.

ADDITIVES

The most common additives found in grease are as follows:

- Tackifiers – helps hold grease in place
- Oxidation Inhibitors – prolong the life of a grease
- Extreme Pressure (EP) Agents – prevent welding and seizing at high loads
- Anti-Corrosion Agents – protect metal against attack from water
- Anti-Wear Agents – prevent abrasion and metal-to-metal contact

GREASE DEFINITIONS

- **Consistency** – is the degree of hardness of a grease and may vary considerably with temperature. This has been classified by the National Lubricating Grease Institute (NLGI) into the following categories:

NLGI GRADE	PENETRATION @ 25°C (1/10th mm)
000	445 - 475
00	400 - 430
0	355 - 385
1	310 - 340
2	265 - 295
3	220 - 250
4	175 - 205
5	130 - 160
6	85 - 115

- **Shear Stability** – is the ability of a grease to resist a change in consistency during mechanical working. Under high rates of shear, grease structures tend to change in consistency (usually becoming softer).
- **Oil Separation** – is the percentage of oil which separates from the grease under static (e.g. storage) conditions. It cannot predict separation tendencies in use under dynamic conditions.
- **High Temperature Stability** – is the ability of a grease to retain its consistency, structure, and performance at temperatures above 125°C/260°F.

GREASE SERVICE CLASSIFICATION

The following five (5) categories for Automotive Service Greases have been developed by the NLGI. The scope of this classification (ASTM D 4950) covers greases designed for the lubrication of chassis components and wheel bearings of passenger cars, trucks and other vehicles. The NLGI classifies automotive service greases into two (2) main groups: Chassis greases designated by the prefix L, and Wheel Bearing greases designated by the prefix G.

The following table outlines the five (5) categories:

NLGI AUTOMOTIVE SERVICE GREASE CATEGORIES		
Category	Service	Performance
LA chassis	Frequent relubrication intervals (<3200 km). Mild duty (non-critical applications).	Oxidation resistant, shear stable, and corrosion and wear protective.
LB chassis	Prolonged relubrication intervals (>3200 km). Mild to severe duty (high loads, vibration, exposure to water).	Oxidation resistant, shear stable, and corrosion and wear protective even under heavy loads and in presence of aqueous contamination. Temperature range -40°C to 120°C.
GA wheel bearings	Frequent relubrication intervals. Mild duty (non-critical applications).	Temperature range -20°C to 70°C.
GB wheel bearings	Mild to moderate duty (cars, trucks in urban and highway service.)	Oxidation and evaporation resistant, shear stable, and corrosion and wear protective. Temperature range -40°C to 120°C with occasional excursions to 160°C.
GC wheel bearings	Mild to severe duty (vehicles in frequent stop-and-go service, trailer hauling, mountain driving, etc.)	Oxidation and evaporation resistant, shear stable, and corrosion and wear protective. Temperature range -40°C to 120°C with frequent excursions to 160°C and occasional excursions to 200°C.

The majority of greases certified under this classification meet the requirements of both LB and GC, and are thus certified as NLGI GC-LB.

NLGI HPM

In January 2021, the NLGI introduced a new standard for industrial greases called HPM standing for High Performance Multiuse grease. The requirements of HPM are somewhat different from GC-LB, as the GC-LB standard is intended for automotive rather than industrial applications. The HPM grease specification defines a new level of performance for industrial greases. In addition to the core HPM specification, there are additional sub-categories of improved performance in specific areas that can be added to the basic HPM certification. These sub-categories are:

- +WR (Water resistance)
- +HL (High load-carrying capacity)
- +CR (Salt water corrosion resistance)
- +LT (Low temperature performance)



One or more of these subcategories may be combined with the core HPM certification to define a grease's performance in multiple areas. The necessary tests and required performance for the HPM standard and subcategories can be found on the NLGI website.

GREASE COMPATIBILITY

Not all grease thickeners, base oils, and additives are compatible and care must be taken when switching to a new grease. If any of the grease components are incompatible, the mixture will fall short of the properties of the individual greases.

It is strongly advised that, in all cases, the old grease be purged or cleaned out from the system, including all supply lines, valves and housings before a new grease is introduced. Compatibility between greases is temperature dependent. As the temperature rises, the problems associated with incompatibility also increase. The following chart indicates the compatibilities of major Petro-Canada Lubricants greases. Competitors' products should be treated as incompatible with Petro-Canada Lubricants greases unless compatibility has been tested.

		Aluminum Complex	Lithium	Polyurea	Lithium Complex	Barium Complex	Silica	Clay
		VULTREX™ MPG	PRECISION™ General Purpose EP2	Chevron SRI 2	PRECISION XL EP2			
Lithium	PRECISION General Purpose EP2	Yes 140						
Polyurea	CHEVRON SRI 2	Yes 130	Yes 145					
Lithium Complex	PRECISION XL EP2	Yes 150	Yes 170	Yes 158				
Barium Complex		Yes 168	Yes 153	Yes 173	Yes 160			
Silica		Yes 115	No (*)	No 80	No (*)	Yes 173		
Clay		No 58	No 95	No (*)	Yes 183	Yes 173		
Calcium Sulphonate Complex	PEERLESS™ OG 2	No 98	Yes 125	No 95	Yes 125	Yes 140	No (*)	No 95

Notes:

1. The number quoted indicates the temperature, in degrees Celsius, at which incompatibility sets in.
2. (*) Indicates the mixture is incompatible at all temperatures.

GREASE PROPERTIES

The following chart provides key properties of all the common grease thickener types.

	REGULAR GREASES		COMPLEX					ORGANIC	INORGANIC
Properties	Calcium	Lithium	Aluminum	Calcium	Barium	Lithium	Calcium Sulphonate	Polyurea	Clay
Dropping Point °C	80-100	175-205	260+	260+	200+	260+	260+	250+	260+
*Max Temp °C	65	125	150	150	150	160	160	150	150
High Temp Use	V. Poor	Good	Excellent	Excellent	Good	Excellent	Excellent	Excellent	Excellent
Low Temp Mobility	Fair	Good	Good	Fair	Poor	Good	Fair	Good	Good
Mech. Stability	Fair	Good	Excellent	Good	Fair	Excellent	Excellent	Good	Fair
Water Resist.	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Fair
Oxidation Stability	Poor	Good	Excellent	Excellent	Poor	Good	Good	Excellent	Good
Texture	Smooth	Smooth	Smooth	Smooth	Fibrous	Smooth	Smooth	Smooth	Smooth

* These temperatures refer to continuous operation. They may be exceeded temporarily in the case of complex greases, and where rigorous lubrication practice is followed.

APPLYING GREASE

The over-packing and over-greasing of bearings accounts for more failures than any other factor. Excess grease in a bearing cavity increases internal friction, which in turn raises the bearing temperature above the dropping point of the grease. This causes oil separation and eventually lack of lubrication.

REGREASING INTERVALS FOR BEARINGS

Re-greasing intervals are determined from:

- Severity of service
- Environment
- Condition of seals
- Shock loading
- Mounting configuration

REGREASING AMOUNTS FOR BEARINGS

When packing a split housing pillow block bearing, ensure that the grease cavity is only 1/3 full. Rolling element bearings should be filled 1/4 to 1/2 the total capacity of the bearing housing. However, the following formulas can be used to determine the correct amount of grease for a greasing interval:

Regreasing amount in ounces: $G(oz) = 0.114 \times W$ (bearing width in inches)*
OD (bearing outer diameter in inches).

Metric Equivalent: $G(gm) = 0.005 \times \text{width in cm} \times \text{OD width in cm}.$



The proper technique for greasing a rolling element bearing is to wipe the grease fitting with a clean, lint free cloth and then add the correct amount of grease to the housing. If a purge plug is present it should be removed and the bearing operated for 10-15 minutes to allow the level of grease to equalize and then replace the purge plug. If no purge plug is present the grease fitting should be removed (or replaced with a self-purging fitting) and operated for 10-15 minutes and then replaced. Always check the temperature before and after this procedure.

The following chart provides a guide to re-greasing intervals and the amount of grease to be applied. Please further confirm re-greasing amounts and intervals with your manufacturer.

GREASE LUBRICATION SCHEDULE: SPHERICAL ROLLER BEARINGS													
Shaft Size		Amount of grease		Operating speed (rpm)									
				500	1000	1500	2000	2200	2700	3000	3500	4000	4500
Inches	mm	in ³	cm ³	Lubrication cycle (months)									
¾-1	25	0.39	6.4	6	6	6	4	4	4	2	2	1	1
1¼-1¼	30	0.47	7.7	6	6	4	4	2	2	1	1	1	1
1⅝-1½	35	0.56	9.2	6	4	4	2	2	1	1	1	1	½
1⅞-1¾	40	0.80	13.1	6	4	2	2	1	1	1	1	½	
1⅞-2	45 - 50	0.89	14.6	6	4	2	1	1	1	1	½		
2⅞-2¼	55	1.09	17.9	6	4	2	1	1	1	½			
2⅞-2½	60	1.30	21.3	4	2	1	1	1	½				
2⅞-3	65 - 75	2.42	39.7	4	2	1	1	½					
3⅞-3½	80 - 85	3.92	64.2	4	2	1	½						
3⅞-4	90 - 100	5.71	93.6	4	1	½							
4⅞-4½	110 - 115	6.50	106.5	4	1	½							
4⅞-5	125	10.00	163.9	2	1	½							
TEMPERATURE 90°C (200°F) HORIZONTAL SHAFT EQUIPMENT													

GREASES

Petro-Canada Lubricants greases are listed according to their performance or application as follows:

- Regular Performance Greases
- Premium Performance Greases
- Synthetic Greases
- Specialty Greases for High Temperatures
- Specialty Greases for Water Resistance
- Specialty Greases
- Incidental Food Contact (H1) Greases
- Mining Greases and Drilling Compounds

REGULAR PERFORMANCE GREASES
MULTI-APPLICATION LITHIUM GREASES

PRECISION™ GENERAL PURPOSE GREASES

PRECISION general purpose greases are a series of high quality, lithium based extreme pressure greases for wide operating temperature ranges and water resistance.

PRECISION GENERAL PURPOSE EP2 Grease is used in bearings operating at low to moderate speeds and at medium temperatures. PRECISION General Purpose EP2 meets NLGI Service Classification LB for automotive chassis lubrication.

PRECISION GENERAL PURPOSE EP1 Grease is recommended for centralized grease systems to lubricate conveyor bearings, mobile mining and forestry equipment, and high speed industrial bearings.

Typical characteristics for PRECISION GENERAL PURPOSE Greases are shown below:

PRECISION GENERAL PURPOSE		
	EP2	EP1
Soap Type	Lithium	Lithium
Color	Brown	Brown
Worked Penetration @ 25°C	271	323
Dropping Point, °C/°F	198/388	194/381
Base Oil Viscosity cSt @ 40°C	162	162
cSt @ 100°C	15.3	15.3
Weld Point, kg	250	250
Operating Range, °C	-25 to 135	-30 to 135
Operating Range, °F	-13 to 275	-22 to 275
Minimum Dispensing Temperature, °C/°F	-25/-13	-30/-22

PREMIUM PERFORMANCE LITHIUM / LITHIUM
COMPLEX GREASES

PRECISION XL GREASES

PRECISION XL greases are versatile premium performance, long-life, lithium/lithium-complex greases designed to lubricate and protect automotive and industrial equipment over a wide range of operating conditions. PRECISION XL greases are recommended for passenger cars, vans, highway truck fleets, and all off-highway vehicles. They are also the prime recommendation for all industrial machinery, as well as pulp and paper and steel mills and mineral extraction equipment.



PRECISION™ XL EP00 Grease is a semi-fluid NLGI #00 EP lithium grease developed for centralized on-board truck chassis lubrication systems. Despite its soft nature, PRECISION XL EP00 retains a good dropping point, high base oil viscosity, and the EP characteristics necessary to handle shock loads and reduce wear. PRECISION XL EP00 has been developed for centralized grease lubrication systems such as Groeneveld, Robertshaw, Lincoln, Grease Jockey, Interlube, and Vogel. This grease handles all autogreasing points on a truck. PRECISION XL EP00 may also be used as a gear drive lubricant, where a medium viscosity gear oil with good low temperature mobility is required, or in leaking gear-boxes.

PRECISION XL EP000 Grease is an extreme pressure, semi-fluid lithium grease inhibited against wear, rust and oxidation. This grease is specifically designed for use in leaky or poorly sealed gear boxes. Applications in general industry include leaky speed reducers*, chain cases, bearings, and in centralized grease systems. It is also well suited to the gear boxes of continuous miners operating in the coal and potash industries.

**Grease level must cover one-half the gear shaft bearings.*

PRECISION XL EP1 Grease is an NLGI #1 EP lithium complex grease designed for use in heavy-duty and general purpose bearing applications supplied by centralized lubrication systems. PRECISION XL EP1 may be used as a winter alternative to PRECISION XL EP2, where greater mobility at low temperatures is desired. PRECISION XL EP1 meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PRECISION XL EP2 Grease is an NLGI #2 EP lithium complex grease designed for use in all types of heavy-duty and general purpose bearings operating at both low and high speeds. PRECISION XL EP2 can be used for grease-gun application for a wide range of equipment and conditions. Applications include automotive wheel bearings (especially wheels fitted with disc brakes), chassis points (on-highway, off-highway and farm vehicles), and industrial machinery such as paper machines, presses, mills and crushers. PRECISION XL EP2 meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PRECISION XL 3 MOLY EP1 and EP2 Greases are lithium greases compounded with 3% molybdenum disulfide. They are best suited for tough, heavy-duty shock loaded equipment in industrial and off-highway applications. They are also suitable for truck fifth wheels. PRECISION XL Moly 3 EP1 is formulated for better pumpability at lower temperatures than PRECISION XL Moly 3 EP2 and may be used in centralized greasing systems. Both grades are on the Certified Lubricants Listing for the Caterpillar Global Mining (formerly Bucyrus International) MPG - Multi Purpose Grease (SD 4711) specification.

PRECISION™ XL 3 MOLY ARCTIC Grease is an NLGI #1 lithium grease formulated with a low viscosity base oil for excellent low temperature mobility. It is compounded with 3% molybdenum disulfide for heavy-duty shock loaded industrial and off-highway applications. It is also recommended for use in centralized lubrication systems especially at low temperatures for mining/forestry applications.

PRECISION XL 5 MOLY EP0, EP1 and EP2 lithium greases contain medium viscosity oil and are compounded with 5% molybdenum disulfide. They are designed to meet Caterpillar lubricant specifications for their 5130 (7TJ & 5ZL), 5230 (7LL) model Mining Excavators and 994 (9YF) model Wheel Loaders. The EP0 grade is on the Certified Lubricants Listing for the Caterpillar Global Mining (formerly Bucyrus International) grease specification SD 4711 (Multi-Purpose Grease). Not recommended for applications requiring a tackified grease.

PRECISION XL RAIL CURVE Grease is a water-resistant NLGI #1 lithium rail curve grease compounded with graphite. It offers enhanced wear protection, excellent adhesion and has a wide application temperature range. It is recommended for the following applications: track-side mechanical lubrication systems (Portec and Lincoln), on-board lubrication systems (Clicomatic), switches, switch plates (hand applied/brushed), fish plates, joint bars, and other railway applications where graphite greases are recommended.

Typical characteristics of PRECISION XL line are shown below:

PRECISION XL				
	EP2	EP1	EP00	EP000
Soap Type	Lithium Complex	Lithium Complex	Lithium	Lithium
Color	Green	Green	Green	Dark Amber
Worked Penetration @ 25°C	274	325	445	445
Dropping Point, °C/°F	302/576	291/556	191/376	189/372
Base Oil Viscosity cSt @ 40°C	220	220	117	325
cSt @ 100°C	17.9	17.9	13.6	23.8
Weld Point, kg	315	315	250	250
Operating Range, °C	-20 to 160	-25 to 160	-35 to 100	-25 to 100
Operating Range, °F	-4 to 320	-13 to 320	-31 to 212	-13 to 212
Minimum Dispensing Temperature, °C/°F	-20/-4	-25/-13	-35/-31	-25/-13

**PRECISION™ XL**

	RAIL CURVE	3 MOLY EP2	3 MOLY EP1	3 MOLY ARCTIC
Soap Type	Lithium	Lithium	Lithium	Lithium
Color	Black-Grey	Green-Grey	Green-Grey	Grey
Worked Penetration @ 25°C	327	285	320	328
Dropping Point, °C/°F	186/367	224/435	225/437	191/376
Base Oil Viscosity cSt @ 40°C	28	444	226	37.7
cSt @ 100°C	5.3	27.9	18.8	6.5
Weld Point, kg	400	500	620	315
Operating Range, °C	-50 to 120	-15 to 135	-25 to 135	-45 to 135
Operating Range, °F	-58 to 248	5 to 275	-13 to 275	-49 to 275
Minimum Dispensing Temperature, °C/°F	-45/-49	-15/5	-25/-13	-45/-49

PRECISION XL

	5 MOLY EP0	5 MOLY EP1	5 MOLY EP2
Soap Type	Lithium	Lithium	Lithium
Color	Grey	Grey	Grey
Worked Penetration @ 25°C	371	320	273
Dropping Point, °C/°F	219/426	212/414	187/369
Base Oil Viscosity cSt @ 40°C	133	162	204
cSt @ 100°C	13.7	15.3	19.4
Weld Point, kg	500	620	620
Operating Range, °C	-50 to 120	-30 to 135	-25 to 135
Operating Range, °F	-58 to 248	-22 to 275	-13 to 275
Minimum Dispensing Temperature, °C/°F	-45/-49	-25/-13	-25/-13

SYNTHETIC GREASES

PRECISION SYNTHETIC GREASE

PRECISION Synthetic is a long-life, premium performance, all-season, extreme pressure lithium complex (NLGI #1) grease containing a synthetic base oil. Originally developed to lubricate heavy mining equipment under arctic conditions, this grease delivers outstanding cold weather performance without compromising high temperature lubrication. PRECISION Synthetic meets NLGI Automotive Service Classification GC-LB for wheel bearing and chassis lubrication.

PRECISION™ Synthetic 220 is a long life, premium performance all-season, extreme pressure lithium complex NLGI #2 grease with a higher viscosity base fluid than PRECISION Synthetic. PRECISION Synthetic 220 meets NLGI Automotive Service Classification GC-LB for wheel bearing and chassis lubrication.

PRECISION Synthetic Moly is a variation of PRECISION Synthetic containing 3% molybdenum disulfide for added protection against vibration and shock loading. This grease is particularly suitable for on and off highway equipment subjected to heavy vibration and operating under extreme hot and cold temperature conditions.

PRECISION Synthetic Heavy is an NLGI #1.5 grease. It is designed for heavy-duty, slow moving, and/or high temperature applications including steel mills and paper machines.

PRECISION Synthetic EP00 is a synthetic semi-fluid lithium complex grease designed primarily for lubricating truck/trailer wheel-end bearings. This softer grade of PRECISION Synthetic Heavy is also recommended for use in leaky gearcases.

PRECISION Synthetic EMB is a non-EP, NLGI #2 synthetic electric motor bearing grease formulated for long service life and excellent high and low temperature performance. It meets CGE specification 6298 for Class B or F insulation.

Typical characteristics are shown below:

PRECISION Synthetic						
	Synthetic	220	Moly	Heavy 460	EP00	EMB
Soap Type	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex
Color	Gold	Gold	Grey	Gold	Gold	Tan
Worked Penetration @ 25°C	314	288	320	304	407	293
Dropping Point, °C/°F	292/558	>304/ >579	289/552	>304/ >579	282/540	309/588
Base Oil Viscosity cSt @ 40°C	130	220	130	456	456	114
cSt @ 100°C	15.6	23.5	15.6	42.9	42.9	15.6
Weld Point, kg	315	315	400	315	315	N/A
Operating Range, °C	-40 to 170	-35 to 170	-40 to 170	-30 to 170	-40 to 170	-40 to 170
Operating Range, °F	-40 to 338	-31 to 338	-40 to 338	-22 to 338	-40 to 338	-40 to 338
Min. Dispensing Temperature, °C/°F	-35/-31	-30/-22	-35/-31	-25/-13	-35/-31	-35/-31



SPECIALTY GREASES FOR HIGH TEMPERATURES

PEERLESS™ GREASES

PEERLESS LLG is an NLGI # 2 calcium sulphonate complex grease, specifically formulated for high temperature and very long life applications. It has excellent water washout resistance and corrosion protection, and meets NLGI Automotive Service Classification GC-LB. PEERLESS LLG is recommended for all sealed-for-life bearings found on automotive and industrial equipment, as well as other "life-pack" applications, such as constant-velocity joints. It is also recommended for equipment with bearings and slide-ways operating continuously at temperatures up to 200°C/392°F or intermittently as high as 300°C/572°F. It can also be used to grease electric-motor bearings.

PEERLESS LLG	
Thickener Type	Calcium Sulphonate Complex
Color	Burgundy
Worked Penetration @ 25°C	284
Dropping Point, °C/°F	314/597
Base Oil Viscosity cSt @ 40°C	100
cSt @ 100°C	10.8
Weld Point, kg	500
Operating Range, °C	-20 to 200
Operating Range, °F	-4 to 392
Minimum Dispensing Temperature, °C/°F	-20/-4

SPECIALTY GREASES FOR WATER RESISTANCE

PEERLESS™ OG GREASES

PEERLESS OG products are based on a special type of calcium sulphonate complex thickener, which retains its effectiveness in the presence of water. They are capable of absorbing moderate levels of water without softening or changing consistency, while still providing outstanding rust protection. PEERLESS OG greases are EP multipurpose, high temperature greases.

PEERLESS OG2 is an NLGI #2 with excellent adhesiveness and is ideally suited for all types of industrial and automotive bearings, for fifth wheels, forklift mast slides, boat trailer wheel bearings, king pins, and for open gears. PEERLESS OG2 meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PEERLESS OG2 RED is similar to PEERLESS OG2, but contains a red dye and an additional tackifier for enhanced adhesion. It also meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PEERLESS OG1 is an NLGI #1 with lower oil viscosity and thickener content for ease of pumpability under cooler ambient conditions. It meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PEERLESS OG0 is an NLGI #0 designed for use in low ambient temperature conditions.

PEERLESS OG Plus is an NLGI #2.5 tenacious grease with exceptional sealing properties and extremely low water washout. It contains a polymer-enhanced base oil which is suitable for heavily loaded bearings. It is recommended for the wet end bearings of paper mills and other applications requiring longer re-lubrication intervals.

PEERLESS 3 MOLY 322

Petro-Canada Lubricants PEERLESS 3 MOLY 322 is a premium performance grease containing 3% of molybdenum disulphide. The outstanding performance of PEERLESS 3 MOLY 322 results in lower operating costs by reducing the re-greasing frequency, even during warm weather. The exceptional mechanical stability of PEERLESS 3 MOLY 322, coupled with its high dropping point, and high load carrying performance help to ensure long component life and excellent wear protection in low speed, high load and high temperature environments subjected to shock loading and vibration.

Typical characteristics are shown on the next page:



PEERLESS™						
	OG0	OG1	OG2	OG2 Red	OG PLUS	3 MOLY 322
Soap Type	Calcium Sulphonate/Carbonate Complex	Calcium Sulphonate/Carbonate Complex	Calcium Sulphonate/Carbonate Complex	Calcium Sulphonate/Carbonate Complex	Calcium Sulphonate/Carbonate Complex	Calcium Sulphonate/Carbonate Complex
Color	Tan	Tan	Tan	Red	Tan	Grey
Worked Penetration @ 25°C	366	329	276	270	249	279
Dropping Point, °C/°F	284/ 543	310/ 590	304/ 579	300/ 572	309 /588	>304/ >579
Base Oil Viscosity cSt @ 40°C	38	53	73	73	78	302
cSt @ 100°C	7.3	8.9	9.4	9.4	9.4	20.9
Weld Point, kg	315	400	400	500	500	620
Operating Range, °C	-35 to 163	-30 to 163	-25 to 163	-25 to 163	-20 to 163	-15 to 170
Operating Range, °F	-31 to 325	-22 to 325	-13 to 325	-13 to 325	-4 to 325	-5 to 338
Minimum Dispensing Temp °C/°F	-30/-22	-25/-13	-18/0	-18/0	-15/5	-15 °C/5 °F

SPECIALTY GREASES

PEERLESS™ POLY EMB is a premium performance polyurea thickened grease specifically intended for high-speed ball and roller bearing lubrication in alternators, generators, starters, electric motors, and other long life applications. PEERLESS POLY EMB is intended for applications where shock loading is absent and an extreme pressure (EP) grease is not required. In particular, PEERLESS POLY EMB is suitable for electric motor lubrication where EP additives are not recommended because of detrimental effects on motor windings.

Typical characteristics are shown below:

PEERLESS POLY EMB	
Thickener type:	Polyurea
Color:	Blue
Worked Penetration @ 25 °C:	291
Dropping Point, °C/ °F	290/594
Base Oil Viscosity cSt @ 40 °C:	110
cSt @ 100 °C:	12
4 Ball Wear scar, mm:	0.43
Oil Separation, %:	1.1
High temperature grease life test @ 10,000 RPM, 350 °F (177 °C):	>750 hours
Operating Range, °C:	-30 to 163
Operating Range, °F	-22 to 325
Minimum Dispensing Temperature: °C/°F	-30/-22



PEERLESS™ SVG 102 VALVE GREASE is an NLGI #1 calcium sulphonate complex grease formulated primarily for the lubrication of the internal parts of valves employed in the production and distribution of sour gas in natural gas plants. It protects the valves against corrosion and the deleterious effects of hydrogen sulfide present in these gas streams. PEERLESS SVG 102 has also been successfully applied to valves used in LPG and water injection systems in the oil and gas industry.

PEERLESS XCG-Flex is an NLGI #1 calcium sulphonate complex grease with outstanding mechanical stability and resistance to oil separation. In addition, it has a high-load carrying ability, a high dropping point, and excellent resistance to corrosion and water wash-out.

PEERLESS XCG-Flex is an ideal choice for use in high-speed flexible couplings where severe centrifugal forces are generated. It prevents oxidative fretting corrosion and protects against wear under high gear tooth loadings and vibration. PEERLESS XCG-Flex meets AGMA coupling grease specifications CG-1 and CG-2.

Typical characteristics are shown below:

PEERLESS		
	SVG 102 Valve Grease	XCG-Flex
Thickener Type	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex
Color	Green Grey	Brown
Worked Penetration @ 25°C	324	335
Dropping Point, °C/°F	262/504	290/554
Base Oil Viscosity cSt @ 40°C	80	329

INCIDENTAL FOOD CONTACT (H1) GREASES

PURITY™ FG GREASE - ALUMINUM COMPLEX

PURITY FG greases exhibit good low temperature pumpability and excellent resistance to water wash-out and spray loss. In addition, they have exceptional anti-wear and extreme pressure properties, protect against rust and corrosion and are white in color.

PURITY FG2, PURITY FG1, and PURITY FG00 greases are NSF H1 registered for incidental food contact. These advanced food grade lubricants are specially formulated to deliver exceptional performance under the highly demanding conditions of food processing operations. They can be used in a wide range of food processing applications including sleeve and anti-friction bearings, slides, and guides found on food processing machinery.

PURITY FG2 with MICROL™ MAX[†] grease is specially formulated to inhibit the growth of microbes that can cause product degradation in lubricants. PURITY FG2 with MICROL™ MAX is an NSF H1 registered lubricant formulated with a U.S. EPA registered antimicrobial product preservative.

PURITY FG2 Extreme grease is a high viscosity, semi synthetic, heavy-duty, NSF H1 registered grease specifically formulated for low to medium speed, heavily loaded industrial bearings operating under severe conditions. PURITY FG2 Extreme exhibits excellent protection in applications subjected to high temperature, high pressure, and heavy loads. PURITY FG2 Extreme is best suited for applications under 1000 rpm.

PURITY FG2 Clear grease is an advanced colorless lubricant specially formulated to deliver superior performance under the highly demanding conditions of food processing operations when compared to other clear food grade greases. PURITY FG2 Clear grease is NSF H1 registered and designed for use in anti-friction bearings, slides, and guides throughout food processing plants. It is specifically formulated for beverage production machinery such as canning and bottling equipment.

Typical characteristics are shown below:

PURITY GREASES						
	FG2	FG1	FG00	FG2 with MICROL™ MAX [†]	FG2 Extreme	FG2 Clear
Thickener Type	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex
Color	White	White	White	Cream	White	Clear
Worked Penetration @ 25°C	283	328	420	292	276	293
Dropping Point, °C/°F	277/531	266/511	211/412	287/549	264/507	277/531
Base Oil Viscosity cSt @ 40°C	182	172	182	182	469	185
cSt @ 100°C	17	16	17	17	33	18
Weld Point, kg	500	400	620	315	400	200
Operating Range, °C	-20 to 160	-25 to 160	-35 to 120	-20 to 160	-20 to 160	-20 to 160
Operating Range, °F	-4 to 320	-13 to 320	-31 to 248	-4 to 320	-4 to 320	-4 to 320
Minimum Dispensing Temperature, °C/°F	-20/-4	-25/-13	-30/-22	-20/-4	-20/-4	-20/-4

[†]MICROL™ MAX is an antimicrobial product preservative.



PURITY™ FG GREASE - CALCIUM SULPHONATE COMPLEX

PURITY FG2 Synthetic and PURITY FG2 Synthetic Heavy 220 greases are NSF H1 registered products specially formulated to provide outstanding lubrication in food processing applications running under heavier loads or subject to high and low temperature extremes. They are recommended as multiservice or multi-application lubricants across all food processing applications such as cold temperature applications including freezers, high temperature applications including ovens, multi service bearings, canning, bottling equipment, animal feed pellet mills and mixers. PURITY FG2 Synthetic Heavy 220 has enhanced tackiness to stay in place.

PURITY FG2 MULTI PURPOSE is a H1 food grade lubricant specially formulated for tough food processing applications where high loads can be challenging. This advanced formula contains a patented thickener complex to provide outstanding wear and extreme pressure protection, with excellent mechanical stability in the presence of heat and water to keep surfaces well lubricated.

Ideal for wide operating temperatures, rust prevention and enhanced resistance to water washout, PURITY FG2 MULTI PURPOSE is a solution for all types of food processing and general industrial applications.

PURITY FG2 Synthetic, PURITY FG2 Synthetic Heavy 220 and PURITY FG2 Multipurpose have been designed to meet the highest food industry safety standards and can be easily integrated into Hazard Analysis and Critical Control Point (HACCP) plans and Good Manufacturing Practice (GMP) programs.

Typical characteristics are shown below:

PURITY GREASES			
	FG2 Synthetic	FG2 Synthetic Heavy 220	FG2 Multi Purpose
Thickener Type	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex
Color	Tan	Tan	Tan
Worked Penetration @ 25°C	294	268	280 mm/10
Dropping Point, °C/°F	304/579	>304/579	>309/>588
Base Oil Viscosity cSt @ 40°C	50	220	105
cSt @ 100°C	7.8	24.0	11.3
Weld Point, kg	500	400	620
Operating Range, °C	-40 to 200	-25 to 200	-25 to 160
Operating Range, °F	-40 to 392	-13 to 392	-13 to 320
Minimum Dispensing Temperature, °C/°F	-35/-31	-20/-4	-20 °C/-4 °F

Please refer to the Food Industry Registrations/Credentials chart on 360 Marketing Support (LUB3152) or contact your local representative.

MINING GREASES

VULTREX™ OGL

The VULTREX OGL family of grease-based gear lubricants are sophisticated, next-generation lubricants designed for use on large, heavy-duty, open and enclosed gear drives as well as bearings and exposed sliding surfaces. This machinery is most commonly found in open-pit mining operations using large mining shovels, drills, excavators, and draglines. The VULTREX OGL line of greases is designed with a darkening agent that allows mining operators to more easily identify gears that have adequate grease applied.

VULTREX OGL SYNTHETIC 2200 is a high viscosity aluminum complex-based, solvent-free open gear lubricant specifically designed to provide “ONE LUBRICANT” for mining shovels, draglines, excavators, drills and haul trucks. It is intended for summer use or for year-round use in warmer climates, with a lower temperature limit of -15°C/5°F. It meets the P&H 464 Open Gear Lubricant specification. It also meets the Caterpillar Global Mining (formerly Bucyrus International) SD 4713 specification. VULTREX OGL SYNTHETIC 2200 is also approved by Komatsu for lubrication of slew ring gear on Komatsu hydraulic shovels.

VULTREX OGL SYNTHETIC ALL SEASON 680 is an aluminum complex based, solvent-free open gear lubricant. Its wide operating temperature range allows it to be used from fall through spring seasons at most mines. VULTREX OGL Synthetic All Season 680 resists water wash-off from the shovel stick or rack and pinion systems under all weather conditions, and has a low temperature limit of -40°C/-40°F. It meets the P&H 464 Open Gear Lubricant specification and the Caterpillar Global Mining (formerly Bucyrus International) SD 4713 specification. VULTREX OGL SYNTHETIC ALL SEASON 680 is approved by Komatsu for lubrication of slew ring gear on Komatsu hydraulic shovels.

VULTREX OGL HEAVY 6200 is an aluminum complex based, solvent-free open gear lubricant with higher viscosity and thicker consistency than the other VULTREX OGL lubricants. It is intended for the most demanding open gear lubrication requirements, including heavily loaded hoist gears and high temperature applications. It meets the P&H 464 Open Gear Lubricant specification and the Caterpillar Global Mining (formerly Bucyrus International) SD 4713 specification, including the special requirements for electric mining shovel hoist gear lubrication.



Typical characteristics are shown below:

VULTREX™			
	OGL Synthetic 2200	OGL Synthetic All Season 680	OGL Heavy 6200
Soap Type	Aluminum Complex	Aluminum Complex	Aluminum Complex
Color	Black	Black	Black
Worked Penetration @ 25°C	390	374	361
Dropping Point °C/°F	214/417	208/406	248/478
Weld Point, kg	800	800***	800
Operating Range, °C	-15 to 40	-40 to 25	-5 to 60
Operating Range °F	5 to 104	-40 to 77	23 to 140
Minimum Dispensing,** Centralized System °C/°F	-15/5	-40/-40	-5/23

* Plastic cone used

** Based on pumpability test, but is dependent on the design and type of the dispensing systems, length and diameter of the lines, the mode of application and rate of pressurization.

*** Measured before the addition of diluent, as per the Caterpillar Global Mining (formerly Bucyrus International) SD 4713 specification.

VULTREX™ MPG GREASES

VULTREX MPG greases are high dropping point, heavy-duty greases containing an aluminum complex thickener and a high viscosity base oil. They are designed to deliver outstanding service life and equipment protection over specific ranges of temperatures and environmental conditions. Unlike many other greases, they possess the unique property of reverting to their original consistency after overheating and recooling. The adhesiveness of these greases assures that they will stay in place.

VULTREX MPG greases excel when used in bearings subjected to high pressures or heavy shock loading, where application is frequent and regular, such as in steel mills.

VULTREX MPG SYNTHETIC ARCTIC is an NLGI #0 grease recommended for centralized greasing systems on heavy-duty off-highway, and mining equipment operating in extreme low temperature conditions. It has excellent Extreme Pressure, antiwear and water resistance properties.

VULTREX MPG EP1 is recommended for heavy-duty gear and bearing applications served by centralized greasing systems, and for heavy-duty off highway and mining equipment not requiring the low temperature performance of VULTREX MPG Synthetic Arctic.

VULTREX G-124 is a red tacky grease designed for visibility and stay-in-place properties, and to lubricate heavy-duty truck components such as wheel bearings, bushings, kingpins and chassis points found on vehicles operated by the mining, forestry, and transportation industries.

Typical characteristics are shown below:

VULTREX			
	MPG SYNTHETIC ARCTIC	MPG EP1	G-124
Soap Type	Aluminum Complex	Aluminum Complex	Aluminum Complex
Color	Brown	Green-Brown	Red
Worked Penetration @ 25°C	366	333	279
Dropping Point, °C/°F	244/471	247/477	277/531
Base Oil Viscosity			
cSt @ 40°C	151	473	220
cSt @ 100°C	21.6	28.7	17.9
Weld Point, kg	400	400	315
Operating Range, °C	-40 to 120	-25 to 160	-20 to 160
Operating Range, °F	-40 to 248	-13 to 320	-4 to 320
Minimum Dispensing Temperature, °C/°F	-40	-20/-4	-15/5



VULTREX™ SPECIALTY GREASES

VULTREX GEAR SHIELD® NC is a semi-fluid high-viscosity base fluid combined with EP and oxidation-resistant additives designed for the open gear systems found in many types of ore-crushing mills, including ball, rod and SAG (Semi Autogenous Grinding) mills, as well as kilns and dryers. It meets the requirements of most major mill and gear manufacturers, including UBE, Koppers, Falk, Dominion, Boliden-Allis, Metso (Svedala) and Fuller.

VULTREX ROCK DRILL EP000 is a lithium semi-fluid grease specially formulated to reduce airborne oil concentration in air-operated rock drills and similar mining equipment versus typical rock drill oils. It meets the requirements of rock drill manufacturers, such as Ingersoll-Rand, Joy and Parts Headquarters. VULTREX ROCK DRILL EP000 can be applied easily at low temperatures in the 0°C to 5°C (32°F to 41°F) range and field testing has confirmed it still flows down to -20°C/-4°F.

VULTREX DRILL ROD HEAVY is a barium complex grease recommended for use on diamond drill rods where it reduces friction between the rod and rock strata. This tenacious, long fibre barium grease has lubricated successfully to more than 2000 foot drill depths without wash off or wipe off.

Typical characteristics are shown below:

VULTREX GEAR SHIELD® NC	
Color	Black
Viscosity @40°C, cSt	4765
Flash point, COC, °C	>121
Mobility, 0°C, g/s	0.03
Lincoln Ventmeter, 0°C, psig	600
4-ball wear, scar diameter, mm	0.49
4-ball weld point, kg	400
Load wear index	77
FZG Passing Load Stage, A/8.3/90	>12

VULTREX™ ROCK DRILL EP000	
Soap Type	Lithium
Color	Dark Amber
Worked Penetration @ 25°C	458
Dropping point, °C / °F	158/316
Base oil viscosity	
cSt @ 40°C	129
cSt @ 100°C	13.1
Weld point, kg	200
Operating Range, °C	-20 to 100
Operating Range, °F	-4 to 212
Minimum Dispensing Temperature, °C/°F	-20/-4

VULTREX DRILL ROD HEAVY	
Soap Type	Barium Complex
Color	Green/Brown
Worked Penetration @ 25°C	234
Dropping point, °C / °F	201/394
Base oil viscosity	
cSt @ 40°C	163
cSt @ 100°C	14.8
Four Ball EP Weld, kg	315
Four ball EP weld Load Wear Index, kg	44
Water washout, % loss	8
Water spray-off, % loss	6
Operating Range, °C	-12 to 135
Operating Range, °F	10 to 275



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ACID NUMBER – (see NEUT NUMBER)

AGMA – American Gear Manufacturers Association, one of whose activities is the establishment and promotion of standards for gear lubricants.

ANTI-FOAM AGENT – (see FOAM INHIBITOR)

ANTI-WEAR AGENT – An additive that minimizes wear caused by metal-to-metal contact during conditions of mild boundary lubrication (e.g. stops and starts, oscillating motion). The additive reacts chemically with, and forms a film on, metal surfaces under normal operating conditions.

ANTI-OXIDANT – (see OXIDATION INHIBITOR)

API – (American Petroleum Institute) – society organized to further the interests of the petroleum industry. In this capacity, it serves to clear information, conduct research, improve marketing conditions, etc. One of the Institute's activities has been the development of the API SERVICE CLASSIFICATIONS for crankcase oils, and rules for Base Oil Interchange, which gave rise to Base Oil Groups I-V.

ASH CONTENT – non-combustible residue of a lubricating oil (also fuels) determined in accordance with ASTM D582 – also D874 (sulphated ash). Since some detergents are metallic salts or compounds, the percentage of ash has been considered to have a relationship to detergency. Interpretations can be grossly distorted, however, for the following reasons: 1. Detergency depends on the properties of the base oil as well as on the additive. Some combinations of base oil and additive are much more effective than others. 2. Detergents vary considerably in their potency, and some leave more ash than others. Organic detergents have been developed, in fact, that leave no ash at all. 3. Some of the ash may be contributed by additives other than detergents. 4. There appears to be a limit to the effective concentration of detergent. Nothing is gained by exceeding this limit, and a superabundance of detergent may actually reduce cleanliness.

ASLE – (American Society of Lubrication Engineers) – the former name of an organization involved with friction, wear, and lubrication, which is now known as the Society of Tribologists and Lubrication Engineers (STLE).

ASTM International – (formerly known as American Society for Testing and Materials) – organization devoted to "the promotion of knowledge of the materials of engineering, and the standardization of specifications and methods of testing." In North America, a preponderance of the data used to describe, identify, or specify petroleum products is determined in accordance with ASTM Test Methods.

AUTO IGNITION TEMPERATURE – See description under Flash Point.

BASE NUMBER – (see NEUT NUMBER)

BLOCK GREASE – A very firm grease manufactured in block form to be applied to certain large open plain bearings and rotary cement-kiln rings operating at high temperatures and slow speeds.

BOUNDARY LUBRICATION – a state of lubrication characterized by partial contact between two metal surfaces, and partial separation of the surfaces by a fluid film of lubricant. Due to metal-metal contact, severe wear can take place during boundary lubrication. Specific additives in certain lubricants will minimize wear under boundary lubrication conditions. These additives prevent excessive

friction and scoring by providing a film on the metal surface. There are varying degrees of boundary lubrication, and they are met with various additive types. For the milder conditions, OILINESS ADDITIVES may be used. These are polar materials that are oil soluble and have an exceptionally high affinity for metal surfaces. Plating out on these surfaces in a thin but durable film, oiliness additives give protection under some conditions that are too severe for a straight mineral oil. In addition, COMPOUNDED OILS which are formulated with polar fatty oils, are sometimes used for this purpose. Another class of boundary lubricants is that which contains ANTI-WEAR ADDITIVES. These additives, typically zinc-phosphorus compounds, reduce the wear of metal surfaces, as distinct from reducing the possibility of scoring. High quality engine oils contain anti-wear additives to protect the heavily loaded parts of modern engines, particularly valve trains. The more severe cases of boundary lubrication are defined as EXTREME PRESSURE (EP) conditions. These conditions are met with lubricants which contain EP additives. Under the less severe EP conditions, as in certain worm gear or shock loaded applications, a mild EP additive such as sulfurized fatty oil may be used. For somewhat more severe EP conditions, as occurs in many industrial gear sets, a moderate EP additive package is used. Under the most severe extreme pressure conditions, as occurs in automotive hypoid gears and in many rolling mill applications, for example, more active EP compounds containing sulfur, chlorine and/or phosphorus may be used. At the very high local temperatures associated with metal contact, these additives combine chemically with the metal to form a surface film. Not only is this film effective in reducing friction, but it prevents the welding of opposing asperities (high points) and the consequent scoring that is destructive to sliding surfaces.

BROOKFIELD VISCOSITY – viscosity, in centipoise, as determined on the Brookfield viscometer (ASTM D2983). The operating principle for the Brookfield viscometer is the torque resistance on a spindle rotating in the fluid being tested. Although Brookfield viscosities are most frequently associated with low temperature properties of gear oils and transmission fluids, they are in fact determined for many other types of lubricant, e.g. white oils.

CARBON RESIDUE – percent of coked material remaining after a sample of lubricating oil has been exposed to high temperatures under ASTM D189 (Conradson) or D524 (Ramsbottom). While carbon residue may have significance in the evaluation of roll oils and pneumatic-tool lubricants, it should be interpreted with caution. There may be little similarity between conditions of test and conditions of service. As far as the effects of residue on performance go, moreover, many consider that the type of carbon is of greater significance than the quantity.

CENTISTOKE (cSt) – (see VISCOSITY)

CENTIPOISE (cP) – (see VISCOSITY)

CGSB – (Canadian General Standards Board) – a consensus organization composed of people representing producers, users, and general interest groups, which develops standards for products and test methods specifically required in Canada.

CHANNELLING – formation of a “groove” in grease (or in oil too viscous to flow readily under existing conditions). Channels are cut by the motion of a lubricated element, such as a gear or the rolling member of an anti-friction bearing. The amount of channelling can be controlled to a large extent by the consistency or viscosity of the lubricant. While some degree of channelling is desirable to prevent excessive churning of the lubricant, particularly in high-speed rolling element bearings, a channel so permanent as to preclude further movement of lubricant to the contacting surfaces might cause equipment failure due to lack of lubricant.

CLOUD POINT – (see POUR POINT)

COMPOUNDED OIL – a blending of petroleum oil with small amounts of fatty or synthetic fatty oils is referred to as COMPOUNDING. Compounded oils are used for certain wet applications to prevent washing-off of the lubricant from the metal surfaces. The fatty materials enable the oil to combine physically with the water instead of being displaced by it. Cylinder oils for wet steam applications and for some air compressors are compounded. Because the fatty material imparts a strong affinity for metal surfaces, moreover, compounded oils are frequently used for applications in which lubricity or extra load-carrying ability are needed. They are not generally recommended, however, for service that requires high oxidation stability. (See BOUNDARY LUBRICATION).

COPPER STRIP CORROSION – evaluation of a product's tendency to corrode copper or copper alloys, ASTM D130. Test results are based on the matching of corrosion stains. Non corrosiveness is not to be confused with rust inhibiting, which deals with the protection of a surface from some contaminant, such as water, rather than from the oil itself.

CORROSION INHIBITOR – a lubricant additive for protecting surfaces against chemical attack from contaminants in the lubricant. The most common types of corrosion inhibitors generally react chemically with the metal surfaces to be protected, forming a protective film on the metal surfaces.

DEMULSIBILITY – test time required for a specified oil-water emulsion to break, using ASTM D1401 or D2711 test methods. Highly refined, unadditized mineral oils have inherently good demulsibility. Even after violently agitating an oil/water mixture, the oil separates and rises rapidly to the top of the water. This is true also of other oils formulated for good demulsibility. It is a desirable characteristic, for example, of circulating oils that must separate from water readily. Demulsibility is thus a measure of a lubricating oil's ability to separate from water, an important consideration in the maintenance of many circulating oil systems.

DETERGENTS – help maintain cleanliness, prevent deposits and neutralize acids. These additives can be found in crankcase oils and are generally combined with dispersant additives. A detergent chemically neutralizes acidic contaminants in the oil before they become insoluble and fall out of the oil, forming sludge. Neutral or basic compounds are created which can remain in suspension in the oil.

DISPERSANT – operates to break up insoluble contaminant particles already formed. Particles are kept finely divided so that they can remain “dispersed” or colloiddally suspended in the oil.

DROPPING POINT – the temperature at which a grease changes from semi-solid to a liquid state under test conditions. It indicates the upper temperature limit at which a grease retains its structure and is not the maximum operating temperature of the grease.

EMULSION – a mechanical mixture of two mutually insoluble liquids (such as oil and water). Emulsification may or may not be desirable, depending on circumstances. Soluble cutting oils are designed with an emulsifier to maintain a stable emulsion of oil and water for lubricating and cooling machining operations.

EP AGENT – an additive to improve the extreme pressure properties of a lubricant. (see BOUNDARY LUBRICATION)

FIRE POINT – (see FLASH POINT)

FLASH POINT – minimum temperature of a petroleum product or other combustible fluid at which vapour is produced at a rate sufficient to yield a combustible mixture. Specifically, it is the lowest sample temperature at which the air vapour mixture will “flash” in the presence of a small flame. Flash point may be determined by the following ASTM Methods: CLOSED CUP (covered sample container): D93 “Flash Point by Pensky-Martens Closed Test” for fuel oils – also for cutback asphalts and other viscous materials and suspensions of solids: OPEN CUP (uncovered sample container): D92 “Flash and Fire Points by Cleveland Open Cup”: for lubricating oils. As indicated, this last method provides also for the determination of a FIRE POINT. Fire point is the minimum sample temperature at which vapour is produced at a sufficient rate to sustain combustion. Specifically, it is the lowest sample temperature at which the ignited vapour persists in burning for at least 5 seconds. Since the fire points of commercial petroleum oils ordinarily run about 30°C above the corresponding flash point, they are often omitted from petroleum product data. Flash and fire points have obvious safety connotations – the higher the test temperature the less the hazard of fire or explosion.

Of comparable significance, however, is their value in providing a simple indication of volatility, where a lower flash point denotes a more volatile material. The dilution of a crankcase oil with fuel, for example, lowers the flash point. Flash and fire points should not be confused with AUTO-IGNITION TEMPERATURE, the temperature at which combustion occurs spontaneously (without an external source of ignition).

FOAM INHIBITOR – an additive which causes foam to dissipate more rapidly. It promotes the combination of small bubbles into large bubbles which burst more easily.

FOUR BALL TESTS – two test procedures based on the same principle – the Four-Ball EP Test (ASTM D2596) and Four-Ball Wear Test (ASTM D2266). The three lower balls are clamped together to form a cradle upon which the fourth ball rotates in a vertical axis. The balls are immersed in the lubricant under investigation. The FOUR BALL WEAR TEST is used to determine the relative wear-preventing properties of lubricants operating under boundary lubrication conditions. The test is carried out at a specified speed, temperature, and load. At the end of a specified period, the average diameter of the wear scar on the three lower balls is reported. The FOUR-BALL EP TEST is designed to evaluate performance under

much higher unit loads. In this test the top ball is rotated at a specified speed (1700 ± 60 rpm), but temperature is not controlled. The loading is increased at specified intervals until the rotating ball seizes and welds to the other balls. At the end of each interval the average scar diameter is recorded and reported as 4 ball wear scar diam in mm. Two values are generally reported – LOAD WEAR INDEX (formerly mean Hertz load) and WELD POINT.

HYDROFINISHING – a term sometimes used to describe a catalytic, hydrogen process that is used as a finishing step to remove any residual deleterious compounds, which improves the color and/or stability odour of fuels or basestocks.

HYDROISOMERIZATION – the hydroisomerization process employs a special catalyst which selectively isomerize wax molecules to isoparaffinic lube oils. The process produces base stocks with higher VIs (Viscosity Index) and improved low temperature fluidity, compared to stocks produced with conventional dewaxing. This process can also be utilized to produce selected base oils with VIs approaching 130 and performance characteristics very similar to synthetic lubricants such as polyalphaolefins (PAO).

HYDROTREATING – a generic name for a refinery process for treating fuels and lubricant feedstocks, at elevated temperatures, in the presence of a pressurized hydrogen and a catalyst.

The elimination of aromatics and polar compounds is achieved by reacting select feedstocks with hydrogen, in the presence of a specialized catalyst at temperatures as high as 400°C / 752°F and pressures as high as 3000 psi.

HYDRODYNAMIC LUBRICATION – a lubrication regime characterized by a full fluid film between two moving surfaces. The most common example is the type of lubrication which occurs in oil lubricated journal bearings. The movement of one surface (the shaft or journal) “pulls” lubricating oil into the space between the journal and the bearing. This action develops a high pressure in the fluid which completely separates the two surfaces. By contrast, in boundary lubrication there is only a partial fluid film separating the two surfaces and some surface-to-surface contact occurs.

INHIBITOR – additive for the control of an undesirable phenomenon in grease, oils, or fuels, etc., for example: oxidation inhibitors, rust inhibitors, foam inhibitors, etc.

ISO – (International Organization for Standardization) – an organization which establishes internationally recognized standards for products and test methods. One example is the ISO Viscosity Grade system for industrial oils.

KINEMATIC VISCOSITY – absolute viscosity of a fluid divided by its density at the same temperature of measurement. It is the measure of a fluid's resistance to flow under gravity, as determined by test method ASTM D445. To determine kinematic viscosity, a fixed volume of the test fluid is allowed to flow through a calibrated capillary tube (viscometer) that is held at a closely controlled temperature. The kinematic viscosity, in centistokes (cSt), is the product of the measured flow time in seconds and the calibration constant of the viscometer. See VISCOSITY.

NEUT NUMBER – or NEUTRALIZATION NUMBER: the specific quantity of reagent required to “neutralize” the acidity or alkalinity of a lube oil sample. Either of these characteristics – acidity or alkalinity – may be exhibited by an unused oil, depending on its composition. In addition, certain additives impart acidity, while alkalinity may be derived from the presence of detergents or of basic material added to control oxidation. In service, the oil will, in time, show increasing acidity as the result of oxidation and, in some cases, additive depletion. Though acidity is not, of itself, necessarily harmful, an increase in acidity may be indicative of oil deterioration, and neut number is widely used to evaluate the condition of an oil in service. The most common measurement is ACID NUMBER, the specific quantity of KOH (potassium hydroxide) required to counterbalance the acid characteristics. How high an acid number can be tolerated depends on the oil and the service conditions; and only broad experience with the individual situation can determine such a value. Neut number is determined in accordance with ASTM D664 or D974. The former is a potentiometric method, the latter, colorimetric. Values for TOTAL ACID, STRONG ACID, TOTAL BASE, and STRONG BASE can, where they exist, be obtained. Strong acid numbers are considered to be related to inorganic acids, such as those derived from sulfur, while the difference between the total and strong acid numbers is attributed to weak acids – possibly the products of oxidation. A total acid number (TAN) and a total base number (TBN) can exist simultaneously, both components too weak to completely neutralize the other. When results are reported simply as “neut number” or “acid number”, a TOTAL ACID NUMBER (TAN) is implied.

OXIDATION – A form of chemical deterioration to which petroleum products – like most other organic materials – are subject. The resistance of many petroleum products to oxidation, however, is very high. Oxidation usually involves the addition of oxygen atoms, and the result is nearly always one of degradation. It is accelerated by higher temperatures, the reaction becoming significant at temperatures above 70°C. For every 10°C rise, the rate of oxidation essentially doubles. Oxidation is also promoted by the presence of catalytic metals, copper being particularly active in this latter respect. What is more, the peroxides that are the initial products of oxidation are themselves oxidizing agents. So the oxidation of petroleum products is a chain reaction; the farther it progresses, the more rapid it becomes. With fuels and lube oils, oxidation produces sludges, varnishes, gums, and acids, all of which are undesirable. Nevertheless, many oils, such as turbine oils, give years of service without need for replacement. Petroleum products that require a long service or storage life can be formulated to meet requirements by: 1. proper selection of crude type. Paraffinic oils are noted for natural resistance to oxidation; 2. thorough refining, which removes oxidation-susceptible materials and allows greater response to inhibitor; 3. addition of oxidation inhibitors. Long service is also promoted by good maintenance practices – filtration, centrifuging, or other means of controlling contamination; limiting duration or intensity of high temperatures; eliminating the presence of air and of catalytic metals. For information on determining the degree of deterioration sustained by a used oil and hence, its suitability for further service, see NEUT NUMBER.

OXIDATION INHIBITOR – chemical added in small quantities to a petroleum product to increase its oxidation resistance and hence to lengthen its service or storage life. An oxidation inhibitor may combine with the peroxides formed initially by oxidation, thereby modifying them in such a way as to arrest their oxidizing influence. Or the inhibitor (a passivator) may react with a catalyst either to “poison” it or to coat it with an inert film.

POISE – CGS unit of absolute viscosity: shear stress (in dynes per square centimeter) required to move one layer of fluid along another over a total layer thickness of one centimeter at a shear rate of one centimeter per second. Dimensions are dyne-sec/cm². The CENTIPOISE (cP) is 1/100 of a poise and is the unit of absolute viscosity most commonly used. Whereas ordinary viscosity measurements depend on the force of gravity on the fluid to supply the shear stress and are thus subject to distortion by differences in fluid density, ABSOLUTE VISCOSITY measurements are independent of density and are directly related to resistance to flow. (See also VISCOSITY.)

POUR POINT – is a widely used low-temperature flow indicator and is 3°C above the temperature at which a normally liquid petroleum product maintains fluidity. It is a significant factor in cold-weather start-up, but must be considered along with pumpability, the ease with which an oil pumps at low temperatures. Paraffinic oils contain wax which forms a honeycomb of crystals at low temperatures near the pour point. However, agitation by a pump breaks down this wax structure and allows paraffinic oil to be pumped at temperatures well below their pour point. Naphthenic oils, on the other hand, contain little or no wax and reach their pour point through increase in viscosity: they cannot be pumped readily near the pour point. ASTM D5950 is used to determine pour point. Another low temperature property that is characteristic only of paraffinic oils is CLOUD POINT, which is the temperature at which wax crystals first appear in the sample as its temperature is reduced. It is determined by ASTM D2500 and is a consideration in the evaluation of fuels whose filtration might be impaired by the plugging effect of wax crystals.

RUST INHIBITOR – a lubricant additive for protecting ferrous (iron and steel) components from rusting caused by water contamination or other harmful materials from oil degradation. Some rust inhibitors operate similarly to corrosion inhibitors by reacting chemically to form an inert film on metal surfaces. Other rust inhibitors absorb water by incorporating it into water-in-oil emulsion so that only the oil touches the metal surfaces.

SAYBOLT VISCOSITY – the efflux time in Saybolt Universal Seconds (SUS) required for 60 milliliters of a petroleum product to flow through the calibrated orifice of a Saybolt Universal viscometer, under a carefully controlled temperature, as prescribed by test method ASTM D88. This test method has largely been replaced by the kinematic viscosity method (ASTM D445). As a rule of thumb, the comparable KINEMATIC VISCOSITY of a given product whose viscosity in SUS at 100°F is known can be determined by using the following conversion formula: SUS @ 100°F / 5 ~ cSt @ 40°C. See VISCOSITY.

SCUFFING – engine wear resulting from the localized welding and fracture of rubbing surfaces.

SOLVENT EXTRACTION – a traditional refinery process that is used to upgrade chemical and physical properties in the manufacture of lube oil basestocks. The process relies on the solubility of impurities (especially aromatic components that may also contain sulfur and nitrogen) in an extractive solvent, usually furfural or phenol. The by-product of this process is highly aromatic EXTRACT, used to make EXTENDER oils, and as feed for other refinery processes.

STLE – (Society of Tribologists and Lubrication Engineers) – formerly known as ASLE.

SULPHATED ASH – (see ASH CONTENT)

SYNTHETIC LUBRICANTS - lubricants manufactured by a process, where a chemical conversion or transformation of one complex mixture of molecules into another complex mixture takes place. A simple purification or physical separation process, such as distillation or freezing, does not constitute a synthesis.

Common types of synthetic base oil include:

- Polyalphaolefins (PAO)
- Hydrotreated/Hydroisomerized Unconventional Base Oils (UCBOs)
- Organic esters
- Polyglycols (PAG)

Synthetic lubricants can exhibit one or more of the following advantages over conventional mineral oils:

- Excellent low temperature fluidity
- Low pour point
- High natural viscosity index
- Outstanding oxidation stability
- High flash and auto-ignition points
- Low volatility
- Non-toxic

Synthetic lubricants have been used for some time in applications such as jet engine lubricants, arctic lubricants and fire resistant hydraulic fluids. They are now replacing conventional mineral oils in a number of applications, where one or more of the above properties are required. Despite their higher price, synthetics offer operating advantages that can make them more economical in the long run. For example - reduced oil consumption, longer oil life, improved fuel economy and easier starting at low temperatures.

TIMKEN OK LOAD – measure of the extreme pressure properties of a lubricant. Lubricated by the product under investigation, a standard steel roller rotates against a block. Timken OK load is the heaviest load that can be carried without scoring.

TOTAL ACID/BASE NUMBER – (see NEUT NUMBER)

VISCOSITY – measure of a fluid's resistance to flow. It is ordinarily expressed in terms of the time required for a standard quantity of the fluid at a certain temperature to flow through a standard orifice. The higher the value, the more viscous the fluid. Since viscosity varies inversely with temperature, its value is meaningless unless accompanied by the temperature at which it is determined. With petroleum oils, viscosity is commonly reported in CENTISTOKES (cSt), measured at either 40°C or 100°C (ASTM D445 – KINEMATIC VISCOSITY). An earlier method for reporting viscosity in North America was in Saybolt Seconds Universal – SSU or SUS – or, for very viscous oils, in Saybolt Seconds Furol – SSF (ASTM D88). Other less common viscosity units are the ENGLER and REDWOOD scales, principally used in Europe. (See also BROOKFIELD VISCOSITY, KINEMATIC VISCOSITY, POISE, SAYBOLT VISCOSITY.)

VISCOSITY INDEX (VI) – an indicator of the rate of change of viscosity with temperature. This change is common to all non-reactive fluids – some more, some less. Heating tends to make them thinner – cooling, thicker. The higher the VI, the less the tendency for the viscosity to change. VI is determined by formula from the viscosities at 40°C and 100°C in accordance with ASTM D567 or D2270. The latter test is required for VI's above 100. High VI oils are often preferred for service in which a relatively constant viscosity is desired under conditions of varying temperature. Some hydraulic systems require this property. Paraffinic oils are inherently high in VI, and the VI of any petroleum oil can be increased by the addition of a VI improver. Naphthenic oils are inherently low in VI and aromatic oils are still lower – often having negative numbers. Synthetic oils usually have a higher VI than do mineral oils.

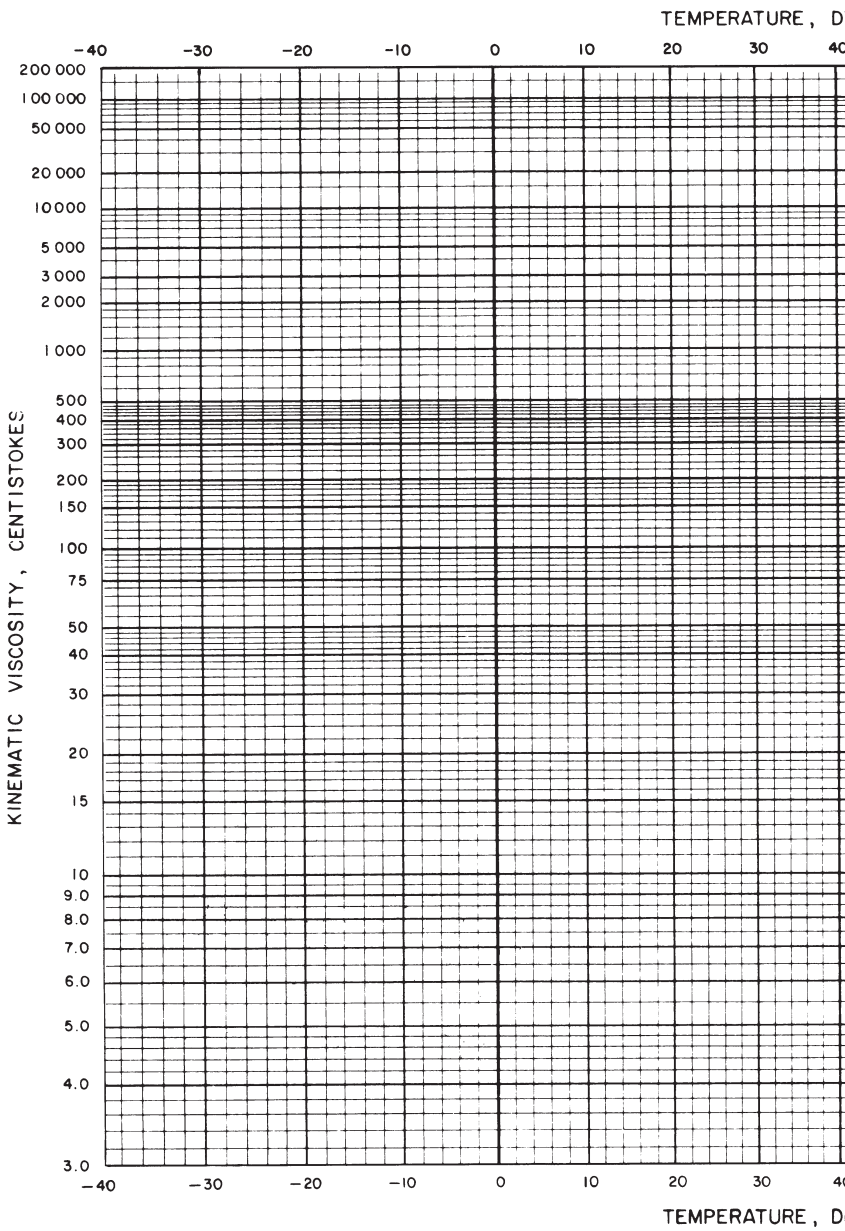
VOLATILITY – that property of a liquid that defines its evaporation characteristics. Of two liquids, the more volatile will boil at a lower temperature, and it will evaporate faster when both liquids are at the same temperature. The volatility of petroleum products can be evaluated by tests for FLASH POINT, VAPOUR PRESSURE, DISTILLATION, and EVAPORATION RATE.

VISCOSITY GUIDE

TABLE OF LIMITS	
Maximum Viscosities Centistokes	(Normally At Start-Up)
22,000	Probably maximum pouring viscosity.
11,000	Probably maximum for splash or bath lubrication.
8,600	Barely pumpable by gear or piston pump – too heavy to be serviceable.
2,200	Upper limit for an automatic oil lubricator.
2,200	Upper limit for circulation system (good practice).
2,200	Upper limit for an oil constituent of a grease for dispensing.
1,000	Ring or rolling element bearings.
860	Hydraulic Vane Pumps @ start-up temperature – to prevent cavitation and wear.
860	Fuel oil for good pumpability and atomizing.
220	Oil mist generators without heat at minimum operating temperature.
220	Hydraulic-piston pump – start-up temperature – to prevent wear.
54	Hydraulic Systems at operating fluid temperature.

Minimum Viscosities Centistokes	(At Operating Temperature)
33	For gear lubrication.
30	For a gear pump.
21	Spherical roller bearings.
13	Other rolling element bearings.
13	Hydraulic systems to prevent excessive pump wear and slippage.
13	Plain bearings.
4	Minimum viscosity to support a dynamic load.

OPTIMUM VISCOSITIES	
The optimum viscosity is the ideal allowable at the operating temperature.	
Centistokes	
25	Hydraulic systems.
30	Plain Bearings.
40	Spur & Helical Gears (e.g. ISO-VG 150 @ 60°C).
75	Worm Gears (e.g. TSO-VG 460 @ 75°C).

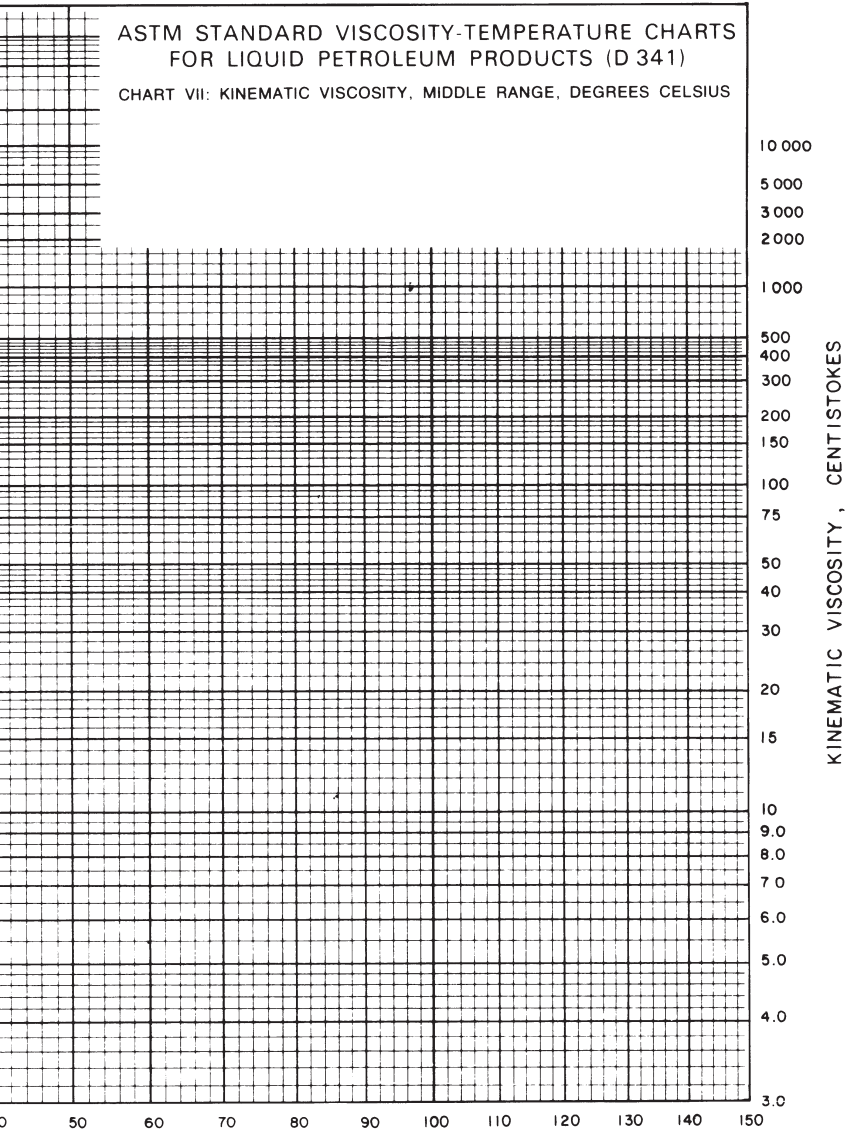


DEGREES, CELSIUS

0 50 60 70 80 90 100 110 120 130 140 150

ASTM STANDARD VISCOSITY-TEMPERATURE CHARTS
FOR LIQUID PETROLEUM PRODUCTS (D 341)

CHART VII: KINEMATIC VISCOSITY, MIDDLE RANGE, DEGREES CELSIUS

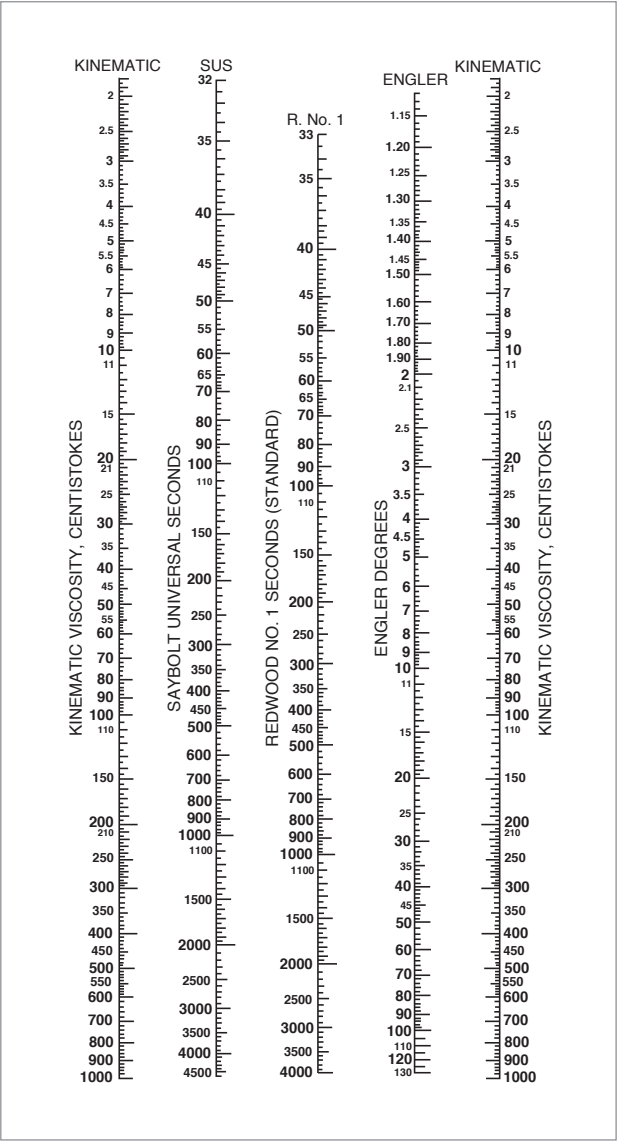


DEGREES, CELSIUS



AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 RACE ST., PHILADELPHIA, PA. 19103
PCN 12-403417-12

VISCOSITY CONVERSION CHART



How to use: Place straight edge at equal centistoke values on both Kinematic scales. All viscosities on each scale will be equivalent for the same temperatures. To extend scale ranges to higher viscosities utilize powers of 10 in these scales between the 100 and 1000 divisions on the Kinematic scale.
Example: 3000 centistokes = 300 cSt x 10 and is approximately equivalent to 1400 x 10 = 14000 SUS.

TO USE:

Place straight edge at equal centistoke values on both Kinematic scales.

All viscosities on each scale will be equivalent for the same temperature.

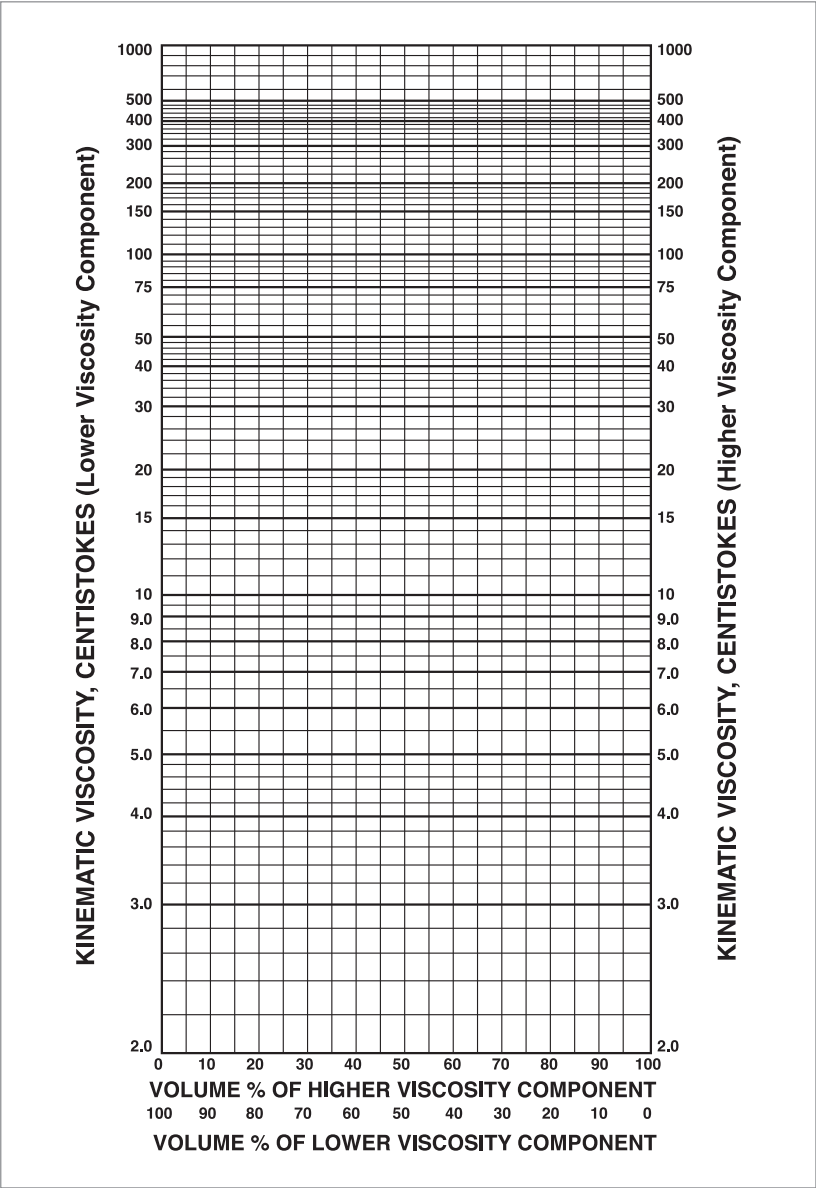
To extend scale ranges to higher viscosities, utilize powers of 10 in these scales between the 100 and 1000 divisions on the Kinematic scale,

**i.e. 3000 centistokes = 300 cSt x 10
 and is approximately equivalent to
 1400 x 10 = 14000 SUS.**

To convert from dynamic or absolute viscosity in centiPoise (cP) to kinematic viscosity in centiStokes (cSt), at a given temperature, use the following equation:

$$\text{cSt} = \text{cP} / \text{density (Kg/L)}$$

ASTM TWO BASE OIL BLENDING CHART – CENTISTOKES



EXAMPLE: TWO BASE OIL BLENDING

Determine the relative viscosities, at a common temperature, of the two base oils to be blended.

i.e. 80 Neutral 15 cSt @ 40°C
160 Neutral 35 cSt @ 40°C

Locate these viscosities on the appropriate sides of the chart and join them with a straight line. From this chart and the line, you can:

1. Determine blend percentages to give a desired viscosity by reading down from intersection point of line and desired viscosity. In this example, if plotted, 20 cSt @ 40°C oil with a 60/40 blend of the two base oils could be obtained.
2. Determine the viscosity of a blended base oil if the volume percentages of the two base oils are known. Simply read up from the volume percentages point to the line and read across to the viscosity.

CLEANLINESS CODE OF A LUBRICATING OIL

ISO 4406:1999 Scale Number Table		
Number of particles per milliliter		Scale number
More than	Up to and including	
2 500 000		> 28
1 300 000	2 500 000	28
640 000	1 300 000	27
320 000	640 000	26
160 000	320 000	25
80 000	160 000	24
40 000	80 000	23
20 000	40 000	22
10 000	20 000	21
5 000	10 000	20
2 500	5 000	19
1 300	2 500	18
640	1 300	17
320	640	16
160	320	15
80	160	14
40	80	13
20	40	12
10	20	11
5	10	10
2.5	5	9
1.3	2.5	8
0.64	1.3	7
0.32	0.64	6
0.16	0.32	5
0.08	0.16	4
0.04	0.08	3
0.02	0.04	2
0.01	0.02	1
0	0.01	0

NOTES: For automatic particle counter analysis, the contaminant code is determined by allocating a first scale number to the total number of particles equal to or larger than 4 µm, allocating a second scale number to the total number of particles equal to or larger than 6 µm and allocating a third scale number to the total number of particles equal to or larger than 14 µm, and then writing these three numbers one after another separated by oblique strokes (slashes). For an example, see 22/18/13 in the table above. For analysis by microscope, use a “—” in place of the first scale number and allocate the second and third numbers based on the counts at 5 µm and 15 µm, respectively.

Reproducibility below scale number 8 is affected by the actual number of particles counted in the fluid sample. Raw counts should be more than 20 particles. If this is not possible, then the scale number for that size range shall be labelled with the symbol \geq .

EXAMPLE: A code of 14/12/ \geq 7 signifies that there are more than 80 and up to and including 160 particles equal to or larger than 4 µm per millilitre and more than 20 and up to and including 40 particles equal to or larger than 6 µm per millilitre. The third part of the code, \geq 7, indicates that there are more than 0.64 and up to and including 1.3 particles equal to or larger than 14 µm per millilitre, but less than 20 particles were counted, which lowers statistical confidence. Because of this lower confidence, the 14 µm part of the code could actually be higher than 7, indicating a particle count more than 1.3 particles per millilitre.

API GRAVITIES AND DENSITIES

Note: All conversions are at 15.6°C (60°F)

API Gravity	Density (kg/L)	API Gravity	Density (kg/L)
0	1.074	21	0.926
1	1.066	22	0.920
2	1.058	23	0.914
3	1.050	24	0.908
4	1.042	25	0.902
5	1.034	26	0.896
6	1.027	27	0.891
7	1.020	28	0.885
8	1.012	29	0.880
9	1.005	30	0.874
10	0.998	31	0.869
11	0.991	32	0.864
12	0.984	33	0.858
13	0.977	34	0.853
14	0.970	35	0.848
15	0.964	36	0.843
16	0.957	37	0.838
17	0.951	38	0.833
18	0.944	39	0.828
19	0.938	40	0.823
20	0.932	41	0.818

APPROXIMATE COLOR SCALE EQUIVALENTS

ASTM Color D 1500	Union (N.P.A.) Colorimeter ASTM D 155	N.P.A. Color Descriptions
0	—	Standard White
0.5	1	Lily White
1.0	1½	Cream White
1.5	1¾	—
2.0	2	Extra Pale
2.5	2½	Extra Pale Lemon
3.0	3	Lemon Pale
3.5	3½	Extra Orange Pale
4.0	4	Orange Pale
4.5	4½	—
5.0	5	Pale
5.5	5½	Light Red
6.0	6	—
6.5	6½	Dark Red
7.0	7	Claret Red
7.5	7½	—
8.0	8	—

VAPOR PRESSURE OF LUBRICATING OIL

The vapor pressure of lubricating oil is very low and except for certain low vacuum or very high temperature applications, is not a limiting factor in typical lubrication practice. The data below were obtained by extrapolating the boiling points, at several reduced pressures, for three common viscosity grades of lube oil.

	30-35 cSt 150 SUS	65-70 cSt 300 SUS	80-85 cSt 400 SUS
	Oil Viscosity @ 40°C		
Oil Temp °C	Vapour Pressure, millimeters of Mercury		
40	0.00004	0.0000005	0.00000025
60	0.0003	0.000007	0.0000027
90	0.002	0.00008	0.000035
120	0.015	0.0009	0.0004
150	0.11	0.011	0.005
180	0.8	0.12	0.055
230	5.8	1.5	0.7
290	35	15	7.4

TEMPERATURE CONVERSION TABLE

°F to °C Example: What is the °C equivalent of 100°F? Look at 100 in the middle column. To the left, in the °C column, is the equivalent 37.8°C.

°C to °F Example: What is the °F equivalent of 50°C? Look at 50 in the middle column. To the right, in the °F column, is the equivalent 122.0°F.

To	From	To
°C	°T	°F
−40.0	−40	−40.0
−38.9	−38	−36.4
−37.8	−36	−32.8
−36.7	−34	−29.2
−35.6	−32	−25.6
−34.4	−30	−22.0
−33.3	−28	−18.4
−32.2	−26	−14.8
−31.1	−24	−11.2
−30.0	−22	−7.6
−28.9	−20	−4.0
−27.8	−18	−0.4
−26.7	−16	3.2
−25.6	−14	6.8
−24.4	−12	10.4
−23.3	−10	14.0
−22.2	−8	17.6
−21.1	−6	21.2
−20.0	−4	24.8
−18.9	−2	28.4
−17.8	0	32.0
−16.7	2	35.6
−15.6	4	39.2
−14.4	6	42.8
−13.3	8	46.4
−12.2	10	50.0
−11.1	12	53.6
−10.0	14	57.2
−8.9	16	60.8
−7.8	18	64.4
−6.7	20	68.0
−5.6	22	71.6
−4.4	24	75.2
−3.3	26	78.8

To	From	To
°C	°T	°F
−2.2	28	82.4
−1.1	30	86.0
0	32	89.6
+1.1	34	93.2
2.2	36	96.8
3.3	38	100.4
4.4	40	104.0
5.6	42	107.6
6.7	44	111.2
7.8	46	114.8
8.9	48	118.4
10.0	50	122.0
11.1	52	125.6
12.2	54	129.2
13.3	56	132.8
14.4	58	136.4
15.6	60	140.0
16.7	62	143.6
17.8	64	147.2
18.9	66	150.8
20.0	68	154.4
21.1	70	158.0
22.2	72	161.6
23.3	74	165.2
24.4	76	168.8
25.6	78	172.4
26.7	80	176.0
27.8	82	179.6
28.9	84	183.2
30.0	86	186.8
31.1	88	190.4
32.2	90	194.0
33.3	92	197.6
34.4	94	201.2

To	From	To
°C	°T	°F
35.6	96	204.8
36.7	98	208.4
37.8	100	212.0
38.9	102	215.6
40.0	104	219.2
41.1	106	222.8
42.2	108	226.4
43.3	110	230.0
44.4	112	233.6
45.6	114	237.2
46.7	116	240.8
47.8	118	244.4
48.9	120	248.0
50.0	122	251.6
51.1	124	255.2
52.2	126	258.8
53.3	128	262.4
54.4	130	266.0
55.6	132	269.6
56.7	134	273.2
57.8	136	276.8
58.9	138	280.4
60.0	140	284.0
61.1	142	287.6
62.2	144	291.2
63.3	146	294.8
64.4	148	298.4
65.6	150	302.0
66.7	152	305.6
67.8	154	309.2
68.9	156	312.8
70.0	158	316.4
71.1	160	320.0
72.2	162	323.6

To	From	To
°C	°T	°F
73.3	164	327.2
74.4	166	330.8
75.6	168	334.4
76.7	170	338.0
77.8	172	341.6
78.9	174	345.2
80.0	176	348.8
81.1	178	352.4
82.2	180	356.0
83.3	182	359.6
84.4	184	363.2
85.6	186	366.8
86.7	188	370.4
87.8	190	374.0
88.9	192	377.6
90.0	194	381.2
91.1	196	384.8
92.2	198	388.4
93.3	200	392.0
94.4	202	395.6
95.6	204	399.2
96.7	206	402.8
97.8	208	406.4
98.9	210	410.0
100.0	212	413.6
101.1	214	417.2
102.2	216	420.8
103.3	218	424.4
104.4	220	428.0
105.6	222	431.6
106.7	224	435.2
107.8	226	438.8
108.9	228	442.4
110.0	230	446.0
111.1	232	449.6
112.2	234	453.2
113.3	236	456.8
114.4	238	460.0
115.6	240	464.0
116.7	242	467.6

To	From	To
°C	°T	°F
117.8	244	471.2
118.9	246	474.8
120.0	248	478.4
121.1	250	482.0
126.7	260	500
132.2	270	518
137.8	280	536
143.3	290	554
148.9	300	572
154.4	310	590
160.0	320	608
165.6	330	626
171.1	340	644
176.7	350	662
182.2	360	680
187.8	370	698
193.3	380	716
198.9	390	734
204.4	400	752
210.0	410	770
215.6	420	788
221.1	430	806
226.7	440	824
232.2	450	842
237.8	460	860
243.3	470	878
248.9	480	896
254.4	490	914
260.0	500	932
265.6	510	950
271.1	520	968
276.7	530	986
282.2	540	1004
287.8	550	1022
293.3	560	1040
298.9	570	1058
304.4	580	1076
310.0	590	1094
315.6	600	1112
321.1	610	1130

To	From	To
°C	°T	°F
326.7	620	1148
332.2	630	1166
337.8	640	1184
343.3	650	1202
348.9	660	1220
354.4	670	1238
360.0	680	1256
365.6	690	1274
371.1	700	1292
376.7	710	1310
382.2	720	1328
387.8	730	1346
393.3	740	1364
398.9	750	1382
404.4	760	1400
410.0	770	1418
415.6	780	1436
421.1	790	1454
426.8	800	1472
432.2	810	1490
437.8	820	1508
443.3	830	1526
448.9	840	1544
454.4	850	1562
460.0	860	1580
465.6	870	1598
471.1	880	1616
476.7	890	1634
482.2	900	1652
487.8	910	1670
493.3	920	1688
498.9	930	1706
504.4	940	1724
510.0	950	1742
515.6	960	1760
521.1	970	1778
526.7	980	1796
532.2	990	1814
537.7	1000	1832

COMMONLY USED CONVERSION FACTORS

To Convert From	To	Multiply by
Atmospheres	cm of mercury (0°C)	76
Atmospheres	feet of water (39.2°F)	33.899
Atmospheres	grams/sq cm	1033.3
Atmospheres	inches of mercury (32°F)	29.921
Atmospheres	kg/sq meter	10333
Atmospheres	mm of mercury	760
Atmospheres	pounds/sq ft	2116.32
Atmospheres	pounds/sq inch	14.696
Barrels, oil	gallon (US)	42
Barrels (API)	meter ³	0.1590
BTU (60°F/15.56°C)	joule	1055
BTU/minute	horsepower	0.0236
BTU/pound	calories/gram	0.5555
Calories (mean)	joule	4.190
Calories/gram	BTU/pound	1.8
Centimeters	feet	0.0328
Centimeters	inches	0.3937
Centimeters	yards	0.0109
Centimeters/second	feet/minute	1.9685
Centimeters/second	meter/minute	0.6
Centimeters/second	miles/hour	0.0223
Centipoises	newton-second/meter ²	1.000 x 10 ⁻³
Centistokes	meter ² /second	1.000 x 10 ⁻⁶
Cheval-vapeurs (C.V.)	horsepower	0.9863
Cubic centimeters	cubic inches	0.0610
Cubic centimeters	gallons (British)	0.00022
Cubic centimeters	gallons (US)	0.00026
Cubic centimeters	ounces (British, fluid)	0.0351
Cubic centimeters	ounces (US, fluid)	0.0338
Cubic centimeters	quarts (British, liquid)	0.00088
Cubic centimeters	quarts (US, liquid)	0.00105
Cubic feet	cubic centimeters	28317
Cubic feet	cubic inches	1728

To Convert From	To	Multiply by
Cubic feet	cubic yards	0.0370
Cubic feet	gallons (British)	6.2288
Cubic feet	gallons (US)	7.4805
Cubic feet	litres	28.3162
Cu ft of water (60°F)	pounds	62.37
Cubic inches	cubic cm	16.3872
Cubic inches	gallons (British)	0.0036
Cubic inches	gallons (US)	0.0043
Cubic inches	litres	0.0164
Cubic meters	cubic feet	35.314
Cubic meters	cubic yards	1.3079
Cubic meters	gallons (British)	219.969
Cubic meters	gallons (US)	264.173
Degrees (F)	degree Kelvin	$tk = (tf + 459.67)/1.8$
Degrees (C)	degree Kelvin	$tk = (tc + 273.15)$
Dynes	newton	1.000×10^{-5}
Fathoms	feet	6
Feet	meters	0.3048
Feet of water (39.2°F)	atmospheres	0.0295
Feet of water (39.2°F)	inches of mercury (32° F)	0.8826
Feet of water (39.2°F)	kg/sq meter	304.79
Feet of water (39.2°F)	pounds/sq ft	62.427
Feet of water (39.2°F)	pounds/sq inch	0.4335
Feet/minute	kilometers/hour	0.0183
Feet/minute	meters/second	0.0050
Feet/minute	miles/hour	0.0114
Foot pounds/minute	horsepower	0.0000303
Gallons (British)	cubic cm	4546.08
Gallons (British)	cubic ft	0.1605
Gallons (British)	cubic inches	277.418
Gallons (British)	gallons (US)	1.2009
Gallons (British)	litres	4.5459
Gallons (British)	meter ³	4.546×10^{-3}

To Convert From	To	Multiply by
Gallons (British)	pounds of water (62°F)	10
Gallons (Imperial)	see Gallons (British)	
Gallons (US)	cubic cm	3785.434
Gallons (US)	cubic ft	0.1337
Gallons (US)	cubic inches	231
Gallons (US)	gallons (British)	0.8327
Gallons (US)	litres	3.7854
Gallons (US)	meter ³	3.785 x 10 ⁻³
Gallons (US)	pounds of water (60°F)	8.3370
Gallons (US)/minute	cubic feet/hour	8.0208
Grams	ounces (avoirdupois)	0.03527
Grams	pounds (avoirdupois)	0.0022
Grams/litre	parts per million (ppm)	1000
Grams/sq cm	atmospheres	0.000967
Grams/sq cm	feet of water (60°F)	0.0328
Grams/sq cm	inches of mercury (32°F)	0.02896
Grams/sq cm	mm of mercury (0°C)	0.7355
Grams/sq cm	pounds/sq ft	2.0482
Grams/sq cm	pounds/sq inch	0.0142
Horsepower	Cheval-vapeur (C.V.)	1.014
Horsepower	foot-pounds/second	550
Horsepower	Pferdestaerke (P.S.)	1.014
Horsepower	watts	745.7
Hundredweight (cwt)	pounds	100
Inches	centimeters	2.54
Inches of mercury (32°F)	atmospheres	0.0334
Inches of mercury (32°F)	feet of water (39.2°F)	1.133
Inches of mercury (32°F)	kg/sq meter	345.3
Inches of mercury (32°F)	pounds/sq ft	70.727
Inches of mercury (32°F)	pounds/sq inch	0.4911
Inches of water (39.2°F)	atmospheres	0.00245
Inches of water (39.2°F)	gms/sq cm	2.5399
Inches of water (39.2°F)	inches of mercury (32°F)	0.07355
Inches of water (39.2°F)	pounds/sq in	0.0361

To Convert From	To	Multiply by
Kilograms	ounces (avoirdupois)	35.274
Kilograms	pounds (avoirdupois)	2.2046
Kg/liters	pounds/US gallon	8.345406
Kg-meters (torque)	pound-feet	7.2330
Kg/cu meter	pounds/cu ft	0.0624
Kilometers	feet	3280
Kilometers	miles	0.6213
Kilometers	miles (nautical)	0.5396
Kilometers	rods	198.836
Kilometers	yards	1093
Kilowatt-hours	BTU	3413
Kilowatts	BTU/minute	56.884
Litres	cubic feet	0.0353
Litres	cubic inches	61.025
Litres	gallons (British)	0.2199
Litres	gallons (US)	0.2641
Litres	ounces (British, fluid)	35.196
Litres	ounces (US, fluid)	33.814
Litres	quarts (US, fluid)	1.0566
Meters	feet	3.2808
Meters	inches	39.37
Meters	yards	1.0936
Miles	feet	5280
Miles	kilometers	1.6093
Miles	rods	320
Miles	yards	1760
Miles (nautical)	feet	6080
Miles/hour	cm/sec	44.7
Miles/hour	km/min	0.0268
Millilitres	cu inches	0.061
Millilitres	ounces (British, fluid)	0.035
Millilitres	ounces (US, fluid)	0.0338
Millimeters	inches	0.039
Millimeters	mils	39.37

To Convert From	To	Multiply by
Millimeters mercury (0°C)	atmospheres	0.0013
Millimeters mercury (0°C)	feet of water (39.2°F)	0.0446
Millimeters mercury (0°C)	gm/sq cm	1.3595
Millimeters mercury (0°C)	kg/sq meters	13.595
Millimeters mercury (0°C)	pounds/sq ft	2.7845
Millimeters mercury (0°C)	pounds/sq in	0.0193
Ounces (avoirdupois)	grams	28.3495
Ounces (British, fluid)	cu cm	28.4130
Ounces (British, fluid)	gallons (British)	0.0062
Ounces (US, fluid)	cu cm	29.5737
Ounces (US, fluid)	cu inches	1.8047
Parts per million (ppm)	grains/gal (British)	0.0701
Parts per million (ppm)	grains/gal (US)	0.0584
Pferdestaerke (P.S.)	horsepower	0.986
Pounds (avoirdupois)	grams	453.5924
Pounds/foot	grams/cm	14.8816
Pounds/sq ft	atmospheres	0.000472
Pounds/sq ft	kg/sq meter	4.8824
Pounds/sq in	atmospheres	0.0680
Pounds/sq in	cm of mercury (0°C)	5.1715
Pounds/sq in	feet of water (39.2°F)	2.3066
Pounds/sq in	grams/sq cm	70.307
Pounds/sq in	inches of mercury (32°F)	2.0360
Pounds/sq in	newton/meter ²	6895
Pounds/US gallon	kg/litres	0.119826
Quarts (British, liquid)	cu cm	1136.521
Quarts (US, liquid)	cu cm	946.3586
Quarts (US, liquid)	cu inch	57.75
Quarts (US, liquid)	ounces (US, fluid)	32
Stones (British)	pounds (avoirdupois)	14
Tons (long)	kilograms	1016.047
Tons (long)	pounds (avoirdupois)	2240
Tons (long)	tons (metric)	1.0160

To Convert From	To	Multiply by
Tons (long)	tons (short)	1.12
Tons (metric)	kilograms	1000
Tons (metric)	pounds (avoirdupois)	2204.62
Tons (metric)	tons (long)	0.9842
Tons (metric)	tons (short)	1.1023
Tons (short)	kilograms	907.1848
Tons (short)	pounds (avoirdupois)	2000
Tons (short)	tons (long)	0.8928
Tons (short)	tons (metric)	0.907
Yards	centimeters	91.440
Yards	miles	0.00057

QUANTITIES FOR VARIOUS DEPTHS OF
CYLINDRICAL TANKS IN HORIZONTAL POSITION

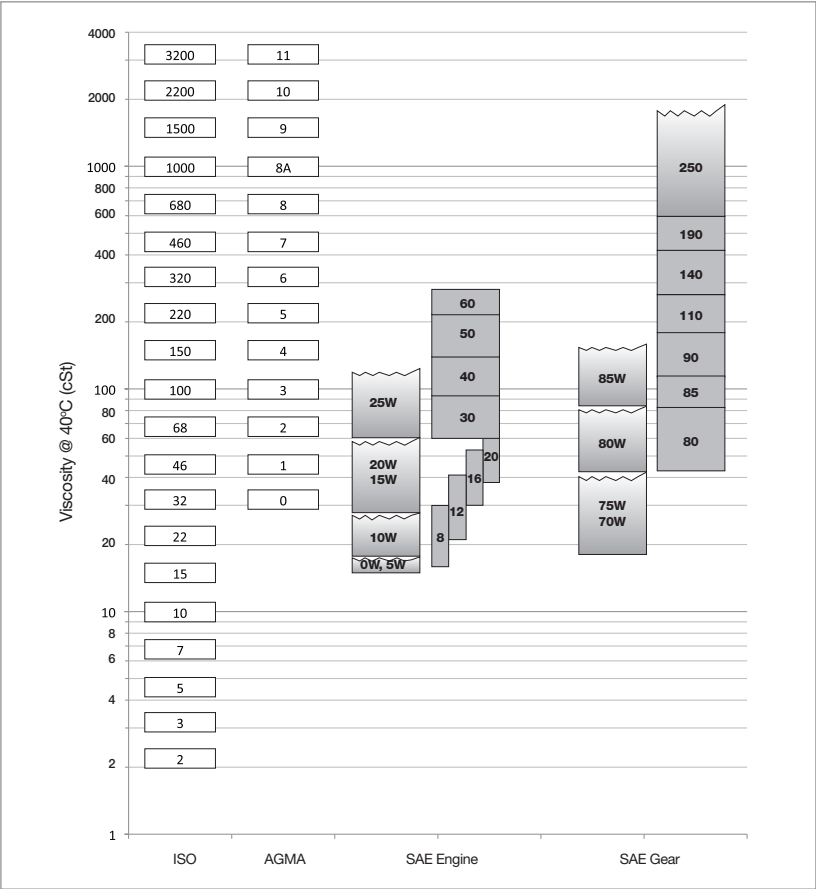
% Depth Filled	% of Capacity	% Depth Filled	% of Capacity
1	0.20	33	28.84
2	0.50	34	30.03
3	0.90	35	31.19
4	1.34	36	32.44
5	1.87	37	33.66
6	2.45	38	34.90
7	3.07	39	36.14
8	3.74	40	37.39
9	4.45	41	38.64
10	5.20	42	39.89
11	5.98	43	41.14
12	6.80	44	42.40
13	7.64	45	43.66
14	8.50	46	44.92
15	9.40	47	46.19
16	10.32	48	47.45
17	11.27	49	48.73
18	12.24	50	50.00
19	13.23	51	51.27
20	14.23	52	52.55
21	15.26	53	53.81
22	16.32	54	55.08
23	17.40	55	56.34
24	18.50	56	57.60
25	19.61	57	58.86
26	20.73	58	60.11
27	21.86	59	61.36
28	23.00	60	62.61
29	24.07	61	63.86
30	25.31	62	65.10
31	26.48	63	66.34
32	27.66	64	67.56

% Depth Filled	% of Capacity
65	68.81
66	69.97
67	71.16
68	72.34
69	73.52
70	74.69
71	75.93
72	77.00
73	78.14
74	79.27
75	80.39
76	82.50
77	82.60
78	83.68
79	84.74
80	85.77
81	86.77
82	87.76
83	88.73
84	89.68
85	90.60
86	91.50
87	92.36
88	93.20
89	94.02
90	94.80
91	96.55
92	96.26
93	96.93
94	97.55
95	98.13
96	98.66

% Depth Filled	% of Capacity
97	99.10
98	99.50
99	99.80
100	100.00

VISCOSITY EQUIVALENTS

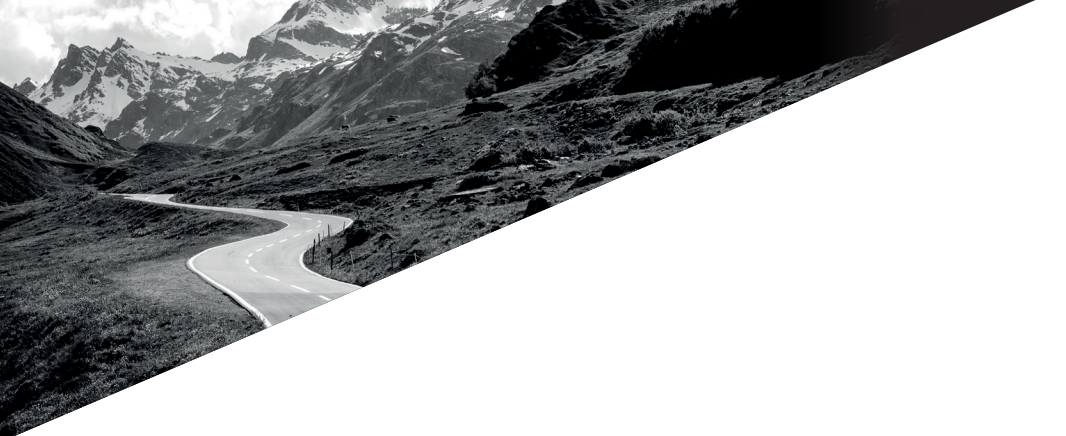
Comparison of ISO/AGMA/SAE Viscosities at 40°C



NOTE:

- Read horizontally.
- Equivalence is in terms of viscosity at 40°C only.
- Viscosities of SAE engine oils based on a VI of 150, an estimated average of current Passenger Car Motor Oil and Heavy-Duty Engine Oil products.
- Viscosities of SAE gear oils based on a VI of 130, an estimated average of current Automotive Gear products.
- Viscosity limits are approximate: for precise data, consult ISO, AGMA and SAE specifications.
- SAE W grades are represented only in terms of approximate 40°C viscosity. For low temperature limits, consult SAE specifications.





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