PETRO-CANADA LUBRICANTS

Lubricants Handbook

Beyond today's standards.

PETRO-CANADA

PREFACE

Petro-Canada Lubricants: Going Beyond Today's Standards™

For more than 30 years, Petro-Canada has researched, developed and produced more than 350 world-class, advanced lubricants, specialty fluids and greases. Our products serve a diverse range of industries around the globe including transportation, mining, the food industry, general manufacturing, industrial, power generation, plastics processing, forestry, and agriculture.

Petro-Canada's lubricants are manufactured using a patented HT Purity Process resulting in crystal-clear base oils that are 99.9% pure – one of the purest in the world. We're focused on producing products that last longer, are more environmentally friendly, are recyclable, non toxic and biodegradable. We have an enviable reputation for high quality and long lasting products. This translates into a performance edge for our customers when it comes to increasing productivity and cutting operating costs. Our products deliver Tangible Savings Solutions for outstanding performance and savings.

This Handbook is current as of the time of publication. However, specification writers and Petro-Canada are constantly upgrading and improving products to meet the ever-changing demands of the marketplace so the information contained herein is subject to change. This Handbook is also available electronically on www.lubricants.petro-canada.ca. The products throughout are available in a wide range of package sizes and are stocked at many strategic locations around the world either by Petro-Canada or one of our many global distributors.

To help our customers select the right lubricant for the job, request a copy of our LubeSource Product Catalogue, LUB 2097. It's an informative guide that systematically narrows your lubricant choices to a primary recommendation.

-Petro-Canada Lubricants Inc.
Mississauga, Ontario, Canada

MAXIMUM PERFORMANCE
HT
PATENTED PURITY PROCESS™

PETRO-CANADA QUALITY AND ENVIRONMENT STATEMENT

At Petro-Canada, we take quality very seriously. We are in constant, relentless pursuit of quality excellence in our products, our processes and our people.

Petro-Canada was the first lubricants manufacturer in North America to be ISO 9001 registered. We were the first lubricants manufacturer in Canada to become QS 9000 certified. In keeping with our committment to meet the latest quality standards and practice, we are also ISO 14001 registered. We also meet some of the world's most demanding specifications including Ford Q-1 and DAB X. We produce food grade lubricants that are NSF H-1 approved and also have Kosher and Halal approvals.

In 2009, we upgraded to the revised version of ISO 9001:2008, which emphasizes our focus on customer satisfaction and a process approach to quality. In October of 2002, Petro-Canada Lubricants opened the door to the global market by being the first Lubricant's manufacturer in the world to be registered to ISO/TS 16949. This new global standard is designed for third party suppliers to the automotive industry. It replaces QS 9000 registration and confirms our ability to continually improve our quality system

We are guided in our day-to-day business activities by the following Management System Vision:

To achieve recognition as a first quartile supplier of choice for quality lubricants, specialty fluids, greases and related services.

Petro-Canada Lubricants will:

- Demonstrate our commitment by maintaining our ISO 9001, ISO 14001 and ISO/TS 16949 registrations.
- Ensure our operations comply with customer requirements, specific performance standards, government legislation, corporate policy and applicable industry standards.
- Work towards the reduction of pollution by determining, evaluating and mitigating the environmental impacts of our business during the start-up, normal operation and shutdown of our facilities, as well as during project planning and implementation through to decommissioning.
- Ensure all employees and others working on our behalf are informed, trained and authorized to meet our quality and environmental performance requirements.
- Continually improve our products through design, manufacturing, delivery and service processes. This will be achieved through ongoing improvement of the effectiveness of our Quality and Environmental Management Systems utilizing Total Loss Management philosophies.
- Establish quality and environmental objectives and targets and periodically review performance through the Management Review Process.

Our No-nonsense Lubricants Warranty.

"We will repair damaged equipment, or replace damaged equipment parts resulting from a failure due to defects of the Petro-Canada lubricant, 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.

DIRECTORY

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INTRODUCTION

This Lubricants Handbook has been produced as a concise, comprehensive reference guide to provide users with a broad knowledge of Petro-Canada's many lubricant products. We have indexed the contents by product brand name, by product application and by subject. We have included a reference guide with current and former names where products have undergone recent name changes. We have also included many pages of general lubricant and industry information to help simplify the complexities of understanding the vast world of lubricants.

This Handbook is divided into nine (9) sections:

- The Indexes – Product Application Index, Product Name Index and the Subject Index, Lubricants Handling & Storage, Product Shelf Life - Lubricating Oils
- The Patented HT Purity Process (Base Oils)
- Automotive Lubricants
- Industrial Lubricants
- Greases
- Food Grade Lubricants
- Process Oils
- Fuels and Refinery Products
- Glossary of Terms, Conversion Charts and Tables

Each Product Group is comprised of subsections that begin with a general description of the product and its applications. This includes the certifications and approvals granted by various specification writing bodies and technical organizations. This is followed by the typical characteristics for each of the various grades of the product.

More comprehensive data for each product can be sourced from our extensive TechData series that are available from your Petro-Canada Representative or one of our many global distributors. TechDatas are also available on our website, lubricants.petro-canada.ca

- Most areas (English) – www.lubricants.petro-canada.ca
- United Kingdom – www.petro-canada.co.uk
- Germany – www.petro-canada.de
- China – www.petro-canada.cn

You can also get in touch with one of the Petro-Canada contact points listed on the outside back cover of this Handbook.

LUBRICANTS HANDLING & STORAGE

Petro-Canada's lubricating oils and greases are the result of considerable research work and are carefully manufactured and delivered, and are as good for their intended use as we can make them. However, during storage it is important to guard against contamination, which can drastically reduce the performance and life of a lubricant. Numerous studies have shown that both water and dirt can lessen the life of bearings and other components. Preventing contamination during storage has a direct pay-back in terms of optimum lubricant performance, longer lubricant life and reduced maintenance costs.

INSIDE STORAGE

Preferably lubricants should 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.

OUTSIDE STORAGE

If outside storage is unavoidable, then the following 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 tending to leak.
- 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 preferably should be covered with a tarpaulin 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. IBC's) should be properly stored, covered, examined regularly and kept to a minimum to provide a quick turnover.

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. Petro-Canada provides Material Safety Data Sheets (MSDS) on all of its products and these are available from your Sales Representative or Customer Service Representative (CSR).

Some general guidelines for handling lubricating oils and greases follow:

- Use 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 using clean hand towels.
- Wash hands and arms at the end of the working day and before eating.
- 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 oil injection into the skin (hydraulics, pneumatics, etc.)

*Always refer to product MSDS for specific safety and handling requirements.

PRODUCT SHELF LIFE – LUBRICATING OILS

The performance properties of liquid lubricants (oils) will remain intact for many years provided they have been in protected storage and not exposed to severe high/low temperature cycles. Generally, the simpler the oil formulation, the longer the oil will remain satisfactory.

Almost all lubricating oils may be stored for three (3) years under protected conditions*. These include:

- Hydraulic, Air & Gas Compressor, Turbine and most other industrial oils
- Heat Transfer Fluids
- Natural Gas Engine Oils, Locomotive Diesel Engine Oils
- Industrial and Automotive Gear Oils and Automatic Transmission Fluids
- Food Grade Lubricants (with a few exceptions)
- USP / NF White Mineral Oils (must be protected from exposure to light).

Exceptions include:

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 / colour may occur. If they are used as part of a special manufacturing process or application, the product properties should be reconfirmed if over 3 years old.

5 Year Shelf Life

• Passenger Car and Heavy Duty Truck Diesel Engine Oils

Industry performance standards for these oils are changing rapidly. An oil which is 4 or 5 years old will still meet its original design, but may not meet the latest industry requirements

2 Year Shelf Life

- PURITY™ Food Grade Oils with MICROL
- EP / DAB X White Mineral Oils (must be protected from exposure to light).
- Neat (Non-Emulsifiable) Metalworking Fluids

1 Year Shelf Life

- PURITY™ FG Trolley Fluid
- Soluble (Emulsifiable) Metalworking Fluids – CUTSOL™ and CUTSOL™ HD

Storage under unprotected conditions can result in water ingress which causes the oil to become 'milky' or form an emulsion and can also cause rust formation/corrosion in metal containers.

If you locate a significant volume of a 'date expired' product, please consult your Petro-Canada Sales Representative who will arrange to have it tested to see if it is still satisfactory for use.

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

GREASE SHELF LIFE

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 Straight Lithium, Lithium Complex and Calcium Complex greases remain stable for a long time. Aluminum Complex greases tend to set and harden, but remain stable. Barium grease tends to soften on aging.

The shelf life of all PetroCanada greases, EXCEPT those of NLGI grade #0 or softer (i.e. #00 & #000), is five (5) years.

The shelf life of NLGI Grade 0 and softer greases is two (2) years. These products include:

- PEERLESS™ OG 0
- PRECISION™ XL EP00, PRECISION™ XL EP000, PRECISION™ XL 5 Moly EP0
- PRECISION™ Synthetic EP 00
- PURITY™ FG 00
- VULTREX™ Gearshield NC, VULTREX™ Gearshield P
- VULTREX™ Rock Drill EP 000
- VULTREX™ Rolling Cam Light, VULTREX™ Slide Cam, VULTREX™ Slide Cam Light
- VULTREX™ MPG Synthetic Arctic
- VULTREX™ OGL Synthetic All Season 680, OGL Synthetic Arctic, OGL Heavy 3600 and OGL Synthetic 2200.
- VULTREX™ EGF 1000

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, 36, 60	HYDREX™ MV 22, 36, 60	2001
Harmony/Premium Plus	HYDREX™ XV All Season	2001
Hydraflo EAW 32, 46, 68	ENVIRON™ AW 32, 46, 68	2001
Hydraflo ECO 32/Premium ECO 46	ENVIRON™ MV 32, 46	2001
Hydraflo AW 46 “D”	HYDREX™ DT 46	2001
Hydraulic Oil AW 220	HYDREX™ AW 220	2001
WAY LUBRICANTS		
ACCUFLO™ DM 68, 220	ACCUFLO™ TK 68, 220	2001
GM Waylube 68	PC Waylube 68	2001
AUTOMOTIVE GEAR OILS		
Syngear E 75W-90, 80W-140, CD-50	TRAXON™ E Synthetic 75W-90, 80W-140, CD-50	2003
Syngear with TOS 75W-90	TRAXON™ Synthetic 75W-90	2003
Gearlube with TOS 75W-90, 80W-140	TRAXON™ XL Synthetic Blend 75W-90, 80W-140	2003
Gearlube with TOS 80W-90, 85W-140	TRAXON™ 80W-90, 85W-140	2003
PAPER MACHINE OILS		
Ashless Paper Machine Oil 150, 220	SEPRO™ XL 150, 220	2002

FORMER	REPLACEMENTS	YEAR OF CHANGE
COMPRESSOR FLUIDS		
Compressor Oil 32, 68, 100, 150	COMPRO™ 32, 68, 100, 150	2004
RCF-1000	COMPRO™ XL-R	2004
Super Compressor Fluid 32, 46, 68, 100, 150	COMPRO™ XL-S 32, 46, 68, 100, 150	2004
HEAT TRANSFER FLUIDS		
CALFLO™ FG	PURITY™ FG Heat Transfer Fluid	2004
NATURAL GAS ENGINE OILS		
Sentinel 541C, 445, MG-40, 470, 840, CG-40	SENTRON™ 541C, 445, MG-40, 470, 840	2003
TRANSMISSION/DRIVE TRAIN OIL		
Supertest TO-4 Synthetic AS	PRODURO™ TO-4+ Synthetic All Season	2003
Supertest TO-4 MG Lo Temp	PRODURO™ TO-4+ XL Synthetic Blend Lo Temp	2003
Supertest TO-4 10W, 30, 50, 60	PRODURO™ TO-4+ 10W, 30, 50, 60	2003
COMMERCIAL (HEAVY DUTY DIESEL ENGINE) OILS		
Super Plus 10W, 20W-20, 30, 40, 50	DURON™ 10W, 20, 30, 40, 50	2000
Super Plus, 10W-30, 15W-40	DURON-E	2000
Super Plus Arctic 0W-30	DURON™ XL Synthetic Blend 0W-30	2000
Super Plus 10W-40	DURON™ XL Synthetic Blend 10W-40	2000
PASSENGER CAR MOTOR OILS		
Arctic 0W-30	PETRO-CANADA SUPREME™ Synthetic 0W-30	2008
Synthetic	PETRO-CANADA SUPREME™ Synthetic	2008
Petro-Canada Turbo Synthetic 5W-30	PETRO-CANADA Supreme Synthetic 5W-30	2010
TRANSMISSION/HYDRAULIC FLUID		
DURATRAN™ All Season	DURATRAN™ XL Synthetic Blend	2002

FORMER	REPLACEMENTS	YEAR OF CHANGE
INDUSTRIAL GEAR OILS		
Ultima Synthetic	ENDURATEX™ Synthetic	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™ WG	2006
TURBINE FLUIDS		
AJT 6000	TURBONYCOIL 600	2007
Super TURBOFLO™ 32, 46, 68	TURBOFLO™ 32, 46, 68	2005
Super TURBOFLO™ EP 32, EP46	TURBOFLO™ EP 32, EP 46	2005
Premium R&O 10, 22, 32, 46, 68, 100, 150, 220, 320	TURBOFLO™ R&O 10, 22, 32, 46, 68 100, 150, 220, 320	2005
GREASES		
PRECISION™ Gold Heavy EP00	PRECISION™ Synthetic EP00	2005
PRECISION™ Gold	PRECISION™ Synthetic	2005
PRECISION™ Gold Heavy	PRECISION™ Synthetic Heavy	2005
PRECISION™ Gold Moly	PRECISION™ Synthetic Moly	2005
PRECISION™ EP1, EP2	PRECISION™ XL EP1, EP2	2005
Steel Mill LC EP2	PRECISION™ XL Heavy Duty	2005
PRECISION™ EMB	PRECISION™ XL EMB	2005
Semi-Fluid Grease EP	PRECISION™ XL EP000	2005
PRECISION™ EP00	PRECISION™ XL EP00	2005
Rail Curve Grease	PRECISION™ XL Rail Curve Grease	2005
PURITY™ FG Food Machinery Grease	PURITY™ FG2	2007
PRECISION™ Moly EP1, EP2	PRECISION™ XL 3 Moly EP1, EP2	2005
Supreme Moly EP0, EP1, EP2	PRECISION™ XL 5 Moly EP0, EP1, EP2	2005
Multipurpose EP1, EP2	PRECISION™ General Purpose EP1, EP2	2005
Multiflex Moly EP2	PRECISION™ General Purpose Moly EP2	2005
Multiflex Moly Special	PRECISION™ XL 3 Moly Arctic	2005

FORMER	REPLACEMENTS	YEAR OF CHANGE
Grease OG-0, OG-1, OG-2 OG (Red), OG-PLUS	PEERLESS™ OG-0, OG-1, OG-2 PEERLESS™ OG2 Red, PEERLESS™ OG PLUS	2005
PEERLESS™ LLG Grease	PEERLESS™ LLG	2005
SVG102	PEERLESS™ SVG 102	2005
XCG-Flex	PEERLESS™ XCG-Flex	2005
Vulcan Synthetic All Season	VULTREX™ OGL Synthetic All Season 680	2005
Vulcan Synthetic Arctic	VULTREX™ OGL Synthetic Arctic	2005
Vulcan EGF 1000	VULTREX™ EGF 1000	2005
Vulcan Heavy	VULTREX™ OGL Heavy	2005
Supreme Arctic	VULTREX™ MPG Synthetic Arctic	2005
Supreme EP1, EP2	VULTREX™ MPG EP1, EP2	2005
Supreme G-123, G-124	VULTREX™ G-123, G-124	2005
API Modified Thread Compound	VULTREX™ API Modified Thread Compound	2005
ARDEE™ EP000	VULTREX™ Rock Drill EP000	2005
Cam Compound	VULTREX™ Rolling Cam	2005
Cam Compound Light	VULTREX™ Rolling Cam Light	2005
Drill Rod Heavy	VULTREX™ Drill Rod Heavy	2005
Gear Dressing EP	VULTREX™ Gear Dressing EP	2005
Petro-Canada Gear Shield NC, P	VULTREX™ Gear Shield NC, P	2005
Slide Compound	VULTREX™ Slide Compound	2005
Slide Compound Light	VULTREX™ Slide Compound, Light	2005
Tool Joint Compound	VULTREX™ Tool Joint Compound	2005
CHAIN OIL		
Winter Chain Oil	DURATAC™ Chain Oil 32 (Red)	2005
Summer Chain Oil	DURATAC™ Chain Oil 150 (Red)	2005
DURATAC™ 68, 100, 150	DURATAC™ Chain Oil 68, 100, 150 (Red)	2005
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MAXIMUM PERFORMANCE
PATENTED PURITY PROCESS
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PETRO-CANADA AND THE PATENTED HT PURITY PROCESS

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 lubricant base oil is as follows:

- Separation of lighter boiling materials, such as gasoline, diesel, etc.
- Distillation to give 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

Generally both Solvent Refined and Hydrocracked base oils are manufactured this way, but differ in the processes used.

BASE OIL CLASSIFICATION

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

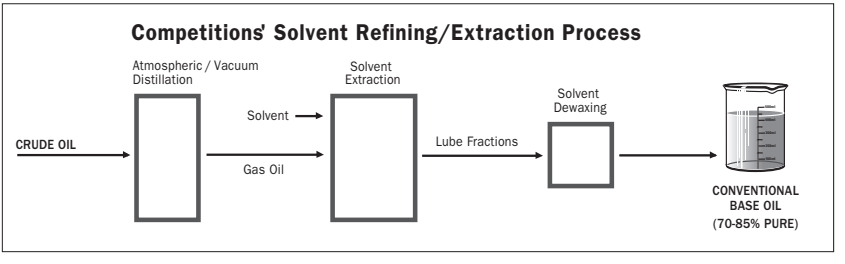
API	Base Oil Characteristics			Manufacturing
Group	Sulphur	Saturates	Viscosity Index	Method
	Wt, %	Wt, %	VI	
I	> 0.03	< 90	80-119	Solvent Refined
II	< 0.03	> 90	80-119	Hydroprocessed
III	< 0.03	> 90	120 +	Severely Hydroprocessed
IV	Polyalpha Olefins (PAOs)			Oligomerization
V	Other Base Oils			Various

Group I, or conventional base oils manufactured by Solvent Refining, make up most of the base oil produced in the world today. Containing more than 0.03 wt % Sulphur and less than 90 wt % Saturates, they are less pure than Hydroprocessed or Synthetic base oils.

Group II and III base oils are manufactured by what the API calls Hydro - processing or Severe Hydroprocessing. These are just other names for Petro-Canada's Patented HT Purity Process. With Sulphur content of less than 0.03 wt % and Saturates content of more than 90 wt %, they are more pure than Group I base oils.

SOLVENT REFINING PROCESS

Initially, light oils such as gasoline, diesel, etc., are separated from crude petroleum by atmospheric distillation. The resulting material is 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 them 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 are sometimes finished to improve their colour and stability, depending on the application requirements. One common method of finishing is mild hydrofinishing. This step should not be confused with Petro-Canada's Patented HT Purity Process, as conditions of temperature and pressure in hydrofinishing are mild and less effective. The API classifies the products of Solvent Refining as Group I base oils.



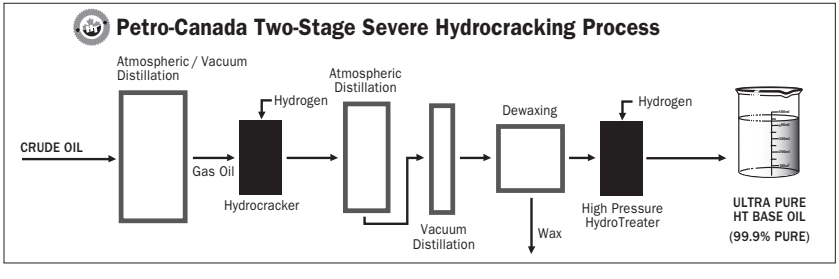
PETRO-CANADA'S HT SEVERE HYDROCRACKING PROCESS

In Petro-Canada's HT Severe Hydrocracking process, the elimination of aromatics and polar compounds is achieved 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 polar compounds, containing sulphur, nitrogen and oxygen
- Conversion of aromatic hydrocarbons to saturated cyclic hydrocarbons
- Breaking up of heavy polycyclo-paraffins to lighter saturated hydrocarbons

These reactions take place at temperatures as high as 400°C , 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 use as lubricant base oils. They are classified by the API as Group II base oils.

There are two stages in the Petro-Canada Severe Hydrocracking process. The first one 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 high pressure hydro-treater for additional saturation. This final step maximizes base oil stability, by removing the last traces of aromatic and polar molecules.



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HT SEVERE HYDROCRACKING/ HYDROISOMERIZATION

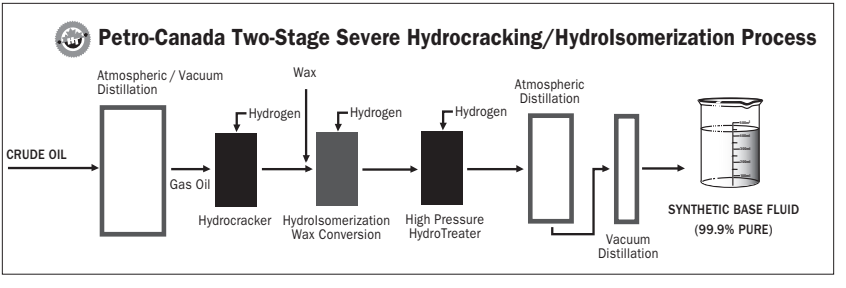
In 1996, Petro-Canada completed a new base oil manufacturing unit to run in parallel with its existing base oil plant. This new unit utilizes the HT Severe Hydrocracking process, but replaces the conventional dewaxing step .... *HydroIsomerization.*

The HydroIsomerization process employs a special catalyst to selectively isomerize wax (n-paraffin mixture) to high VI, low pour point, iso-paraffinic lube oil. The process yields base oils with higher VIs and improved yields, compared to previous conventional dewaxing techniques. The process is capable of giving 130 VI base fluids, in a single pass. More usually, it is set up to produce high viscosity index (Group II) base oils with VIs ranging from 95 to 105 or unconventional (Group II+ and III) base fluids with VIs ranging from 115 to 130. A further process feature is the flexibility it offers to produce base oils with ultra low pour points .... lower than - 25°C.

Petro-Canada employs HydroIsomerization Catalytic Dewaxing in conjunction with HT Severe Hydrocracking and as a result its base oils have the following attractive features:

- Very High Viscosity Index (100 to 130)
- Low Volatility
- Excellent Oxidation Resistance
- High Thermal Stability
- Excellent Low Temperature Fluidity
- Low Toxicity

These features give performance characteristics very similar to lubricants based on poly-alpha-olefin (PAO), a type of synthetic.



COMPARISON OF THE PRODUCTS OF PATENTED HT PURITY PROCESS AND SOLVENT REFINING

- **BASE OILS**

There are significant differences in certain characteristics between HT Severely Hydrocracked and Solvent Refined base oils. The main reason for the difference lies in the virtual elimination of aromatic molecules (less than 0.5%) in our HT Purity Process. HT Severely Hydrocracked base oils are termed “99.5+% Pure”. In comparison, the aromatics content of Solvent Refined oils is somewhere between 10-30% so Solvent Refined base oils are considerably less pure.

Characteristic	***Significant Difference***
COLOUR	HT Severely Hydrocracked base oils are clear and colourless
VISCOSITY INDEX	HT Severely Hydrocracked base oils have high VIs so they ‘thin-out’ less at high temperatures.
OXIDATION RESISTANCE	HT Severely Hydrocracked base oils respond very well to anti-oxidants and so have excellent resistance to oxidation and long lubricant life in finished products.
THERMAL STABILITY	HT Severely Hydrocracked base oils have very good resistance to heat.
CARBON RESIDUE	HT Severely Hydrocracked base oils produce low residues.
DEMULSIBILITY	HT Severely Hydrocracked oils separate readily from water.
LOW TOXICITY	HT Severely Hydrocracked base oils have low toxicity, due to a virtual absence of impurities. Petro-Canada White Oils are pure enough to be used in cosmetics and pharmaceuticals.
BIODEGRADABILITY	HT Severely Hydrocracked base oils have biodegradability characteristics.

2

• FINISHED LUBRICANTS

Finished lubricants blended from Petro-Canada HT Severely Hydrocracked base oils can be superior to lubricants blended from Solvent Refined base oils in several areas. These include:

- Viscosity Stability
- Oxidation Resistance
- Thermal Stability
- Reduced Environmental Impact

• VISCOSITY STABILITY

In service, Petro-Canada HT Severely Hydrocracked lubricants do not 'thicken-up', i.e. increase in viscosity, or thin-out as much as many Solvent Refined lubricants. This is especially valuable for *automatic transmission fluids,* where consistent shift characteristics depend on viscosity stability. This feature also contributes to greater fuel efficiency in *motor oils* and reduced power consumption from *industrial lubricants.*

• OXIDATION RESISTANCE

Finished lubricants based on Petro-Canada HT Severely Hydrotreated base stocks have shown the ability for superior resistance to oxidation compared to Solvent Refined lubricants. This allows them to be used at higher temperatures or for longer time periods than Solvent Refined lubricants. Petro-Canada's unique line of products, such as *COMPRO™ XL-S Compressor Fluid, TURBOFLO™ Fluid,* etc. are based upon this valuable property.

• THERMAL STABILITY

Petro-Canada HT Severely Hydrocracked lubricants demonstrate excellent thermal stability. This leads to reduced deposits and cleaner equipment internals, compared to many Solvent Refined lubricants. Petro-Canada product lines that exploit this feature include *CALFLO™ Heat Transfer Fluid, COMPRO™ XL-S Compressor Fluid, Automatic Transmission Fluid,* etc.

• REDUCED ENVIRONMENTAL IMPACT

Petro-Canada HT Severely Hydrocracked base oils have very low toxicity and can biodegrade faster than many Solvent Refined lubricants of comparable viscosity, due to a virtual absence of impurities. When carefully formulated with selected additives, these features are preserved in finished lubricants. Applications where these features may be found include:- *Petro-Canada PURITY™ FG Food Grade Lubricants, ENVIRON™ MV Hydraulic Oil, PARAFLEX™ HT Fluids, SEPRO™ XL, etc.*

QUALITY ASSURANCE – SECOND TO NONE IN THE WORLD

ISO 9001 REGISTRATION

ISO 9001 is the global standard for documenting quality control throughout an entire manufacturing and business process. It is administered by the International Organization for Standardization (ISO), a Swiss based organization that sets rigid standards for a very wide range of products and services.

ISO 9001 is an international standard that adopts a process approach to quality management and business. It promotes a focus on customer quality requirements, enhancing customer satisfaction, and achieving continual improvement through the use of setting measurable objectives and targets.

Petro-Canada Lubricants earned the distinction of being the first lubricants manufacturer in North America to be ISO 9001 registered. To be registered, the ISO 9001 process requires a thorough inspection of a company's production and control systems by an independent registrar. Stringent audits are conducted to ensure detailed procedures are rigidly adhered to and all products are manufactured consistently in accordance with established standards. Following registration, twice yearly audits are conducted by the registrar to ensure ongoing compliance and improvement.

ISO/TS 16949 REGISTRATION

In March 1997, Petro-Canada became the first Canadian lubricant manufacturer to receive QS9000 certification. Developed by Chrysler, Ford, General Motors, and the North American truck manufacturers, the goal of QS9000 was the creation of fundamental quality systems to provide continuous improvement with an emphasis on defect prevention and the reduction of variation and waste in the supply chain.

In October 2002, Petro-Canada Lubricants opened the door to the global market by being the first lubricants manufacturer in the world to be registered to ISO/TS 16949. This new global standard, which replaces QS9000, is designed for third party suppliers to the automotive companies. This strongly demonstrates Petro-Canada's ability to continuously improve our quality system. ISO/TS 16949 was jointly developed by ISO and the IATF (International Automobile Task Force) and contains all requirements of ISO 9001 and additional automotive requirements.

ISO 14001

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, and as member of the ISO family of International Standards, provides a consistent set of operating guidelines.

ISO 14001 differs fundamentally from ISO/TS 16949 and ISO 9001. While these programs provide guidelines to address customer needs and expectations in terms of quality of product/service, ISO 14001 focuses on the protection of the natural environment and protecting people from environmental impacts. It is more rigorous than the environmental elements prescribed in Petro-Canada's Total Loss Management (TLM) Standard.

Petro-Canada Lubricants has chosen ISO 14001 as the foundation for its Environmental Management System due to its wide recognition and global acceptance. ISO 14001 principles are in line with Petro-Canada's internal TLM philosophy.


MAXIMUM PERFORMANCE
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AUTOMOTIVE LUBRICANTS

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, such as Petro-Canada. Operators of automotive equipment have come to expect high quality and reliable performance from today's automotive lubricants.

Petro-Canada is committed to maintaining its leadership in automotive lubricant quality, by continued R&D effort to develop new and improved products. Researchers at our Lubricants Centre are continually working on products in the lab and in the field with commercial equipment. Petro-Canada keeps in close contact with all the car, truck, engine and other equipment manufacturers as well as with our customers. Our goal is to meet the ever changing needs of the market.

ENGINE OIL FUNCTIONS

A 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 doing the following:

- Permit easy starting
- Lubricate engine parts and prevent wear
- Reduce friction
- Protect against rust and corrosion
- Keep engine parts clean
- Reduce combustion chamber deposits
- Fight soot
- Cool engine parts
- Seal combustion pressures
- Be non-foaming

• 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 motor 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.

The characteristic of an oil which determines ease of cranking is its viscosity at the cranking temperature. Viscosity is a measure of the oil's resistance to flow. 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 resistance 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 satisfactory 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 standard has been developed for measuring the amount of viscosity change with temperature change. This standard is called the Viscosity Index (V.I.). An oil with a high viscosity index is one that shows less change in viscosity with temperature. Today, through the use of new refining methods and special chemical additives, there are many high viscosity index engine oils that are light enough for easy cranking at low temperatures and still be heavy enough to perform 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.

• 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 engine protection.

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

Full-film or 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 thicker than 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 on sliding surfaces. Lubrication engineers call this boundary 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 always exist during engine starting 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.

• 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.

Car 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 motor oil must be kept low. This can be best accomplished by changing the oil and filter at proper intervals.

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 motor 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 vapor 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 much research, effective oil-soluble chemical compounds have been developed. These are added to motor oil during manufacture to provide vital protection to engine parts.

• Keep Engine Parts Clean

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 vapor 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 motor 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 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 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 short out. Their build-up causes pinging, knock, or other combustion irregularities that reduce the efficiency and economy of the engine. Because these deposits 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 overhaul.

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

- The oil must keep the 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.

• Fight Soot

Soot is a by-product of diesel-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 and go out of grade. In addition, soot can agglomerate to form particles large enough to cause 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, prevents abrasive wear developing and inhibits the formation of sludge.

Effective with the 2007 model year, 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-sulphur diesel (ULSD) fuel and new engine oil technology, these new vehicles cut harmful emissions by 95 percent. In addition, the regulation calls for a 97 percent reduction in the sulphur 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, creating more internal soot.

• 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 definite 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. These parts must get an ample supply of cool oil to pick up the heat and carry it back to the crankcase where it is cooled by heat transfer to the surrounding air.

To keep this cooling process working, large volumes of oil must be constantly circulated to the bearings and other engine parts. 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 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.

• 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, with the consequent reduction in engine power and efficiency. Motor oil fills in these hills and valleys on ring surfaces and cylinder walls and helps to seal in compression and combustion pressures. Because 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.

• Be Non-Foaming

Because of 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 prevent wear 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.

ADDITIVES

In summary, an engine oil has to perform ten basic functions. To carry out these functions, the base oil must be refined to the highest level possible and then compounded with specially selected chemical additives. Skillful selection of additives, blended together with Petro-Canada's HT Severely Hydrocracked base oils results in engine oils of outstanding performance.

• DETERGENTS

These chemicals, usually metallic 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 engine exhaust and oil oxidation.

• 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 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. Petro-Canada's HT Severely Hydrocracked 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 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

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.

• VISCOSITY INDEX (VI) IMPROVERS

VI improvers control the viscosity of multi-grade oils. They are polymers which act like “popcorn”. At low temperatures, they are “tight-balls” which do not significantly increase the oil’s resistance to flow. However, at high temperatures, these “tight-balls” explode into long chain polymers, which interweave and increase the oil’s resistance to flow (viscosity). Thus, the tendency of an oil to “thin” at high temperatures is controlled and reduced. VI improvers must be shear stable, that is be able to perform when the oil film is subject to great stress and also resist high temperatures.

• POUR POINT DEPRESSANTS

Base oils 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.

• 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 moving 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 his 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 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 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 eleven distinct motor oil viscosity classifications or grades. SAE 0W, SAE 5W, SAE 10W, SAE 15W, SAE 20W, SAE 25W, SAE 20, SAE 30, SAE 40, SAE 50 and SAE 60.

SAE VISCOSITY GRADES FOR ENGINE OILS (SAE J300 JAN. 09)

SAE Viscosity Grade	Viscosity (cP) at Temperature (°C), Max		Viscosity (cSt) at 100°C		High Shear Viscosity (cP) at 150°C and 10^6 S^{-1} Min
	Cranking	Pumpability	Min	Max	
0W	6200 at –35	60 000 at –40	3.8	—	—
5W	6600 at –30	60 000 at –35	3.8	—	—
10W	7000 at –25	60 000 at –30	4.1	—	—
15W	7000 at –20	60 000 at –25	5.6	—	—
20W	9500 at –15	60 000 at –20	5.6	—	—
25W	13000 at –10	60 000 at –15	9.3	—	—
20	—	—	5.6	Less than 9.3	2.6
30	—	—	9.3	Less than 12.5	2.9
40	—	—	12.5	Less than 16.3	3.5†
40	—	—	12.5	Less than 16.3	3.7††
50	—	—	16.3	Less than 21.9	3.7
60	—	—	21.9	Less than 26.1	3.7

† with 0W-40, 5W-40 and 10W-40 grades
†† with 15W-40, 20W-40, 25W-40 & 40 grades

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 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 0W20, 0W30, 0W40, 5W-20, 5W-30, 5W-40, 10W-30, 10W-40, 15W-40 and 20W-50 - have been marketed for decades in North America.

Multi-grade 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 car manufacturers' recommendations for crankcase oil viscosity should be followed at all times. However, a basic guide prepared from car 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-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 for your vehicle, consult your 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, the American Society for Testing and Materials, and the Society of Automotive Engineers 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 classes of service 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-scuff 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 onwards requirements of automotive manufacturers
SN	2011 gasoline engine warranty requirements	Meets 2011 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 sulphur 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 E0-K/2 and Cummins NTC-400 approvals.

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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 sulphur (>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 sulphur-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 sulphur 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 sulphur 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 sulphur 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 and may also be used where API, CH-4 and CI-4 / CI-4 Plus oils are required.

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.

"S" – SPARK IGNITION (Gasoline, Propane, CNG)

Standards SA to SF have been removed as they are considered obsolete. The current standard is backservicable to these standards.

SG FOR 1989 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

Service typical of gasoline engines in passenger cars, vans, and light trucks beginning with the 1989 model year operating under manufacturers' recommended maintenance procedures. (Obsolete)

SH FOR 1994 GASOLINE ENGINE WARRANTY MAINTENANCE SERVICE

Service typical of gasoline engines in passenger cars, vans and light trucks beginning with the 1994 model year, operating under manufacturers' recommended maintenance procedures. Oils developed for this service provide improved control of engine deposits, oxidation and engine wear relative to oils developed for previous categories. Oils meeting API Service Classification SH may be used where API Service Categories SG, SG/CC, SF, SF/CC and SE are recommended. (Obsolete)

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 Dec. 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 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. When combined with Resource Conserving (see below), SN oils help improve fuel economy, protect emissions systems, protect turbochargers and protect engines when ethano-containing fuels up to E85 are used. 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.

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 systems components, protect turbo chargers 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, Technical Bulletin 1, June 17, 2010.

Resource Conserving in Conjunction with API Service Category SN

API Service SN 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 VID test at the percentages listed in the following table when compared with a baseline oil (BL) used in the Sequence

VID 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 SN 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 SN 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 SN

PERFOMANCE TEST	PERFOMANCE CRITERIA	
SEQUENCE VID(ASTM D7589)[a]		
Viscosity Grade	FEI SUM	FEI2 minimum after 100 hours aging
XW-20	2.6%	1.2%
XW-30	1.9%	0.9%
10W-30 and all other viscosity grades not listed above	1.5%	0.6%
Sequence IIIGB (ASTM D7320)	79% phosphorus retention min	
Emulsion Retention (ASTM D7563)	No water separation	
High Temperature Deposits TEOST 33C (ASTM D6335), Total Deposit Weight, mg		
SAE 0W-20	Not Required	
All other viscosity grades	30 Max	

[a]Viscosity grades are limited to 0W, 5W and 10W multi-grade oils.

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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, turbo-charged 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 sulphur 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 sulphur 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 sulphur 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 and may also be used where API CD, CE, CF-4, CG-4 and CH-4 oils are required.

CJ-4 FOR 2007 SEVERE DUTY DIESEL ENGINE SERVICE

For use in high-speed four-stroke cycle diesel engines designed to meet 2007 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 sulphur content up to 500 ppm (0.05% by weight). However, the use of these oils with greater than 15 ppm (0.0015% by weight) sulphur fuel may impact exhaust aftertreatment system durability and/or oil drain interval.

OTHER DIESEL ENGINE OIL SPECIFICATIONS

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

DETROIT DIESEL

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 manufacturers 2-cycle engines for the commercial market.

MACK EO-M

Over the years, Mack Trucks have been very active in developing heavy duty diesel engine oil standards for the lubrication of their engines.

The MACK EO-M engine oil specification was introduced in 1998. Use of EO-M oils is mandatory in all MACK 1998 year engines, running in severe service or operating with extended oil drain intervals.

MACK EO-M oils must be multigraded, meet the requirements of API CH-4 and pass the following engine tests: Mack T-8E (300 hours), Mack T-9 (500 hours) and Cummins M-11 (200 hours).

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

This specification defines the requirements for Mack engines designed to meet the EPA 2007 and 2010 on-road emission requirements. The new engines are equipped with diesel particulate filters (DPFs). As a premium specification, it exceeds 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. It is equivalent to Volvo VDS-4 in Europe. 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 sulphur.

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 sulphur.

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 and1.3-1.5% 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 ⩽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 sulphur.

API SERVICE CLASSIFICATION SYMBOL

API's Lubricants Subcommittee established the symbol illustrated below 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 features of an oil (bottom part of the symbol). Resource Conserving is not applicable for heavy-duty diesel engines. The symbol clearly provides all the pertinent information a customer needs in one convenient location.

ILSAC CERTIFICATION SYMBOL

The ILSAC (International Lubricants Standardization and Approval Committee) certification mark, commonly referred to as "the Starburst", is shown below.

This symbol enables the general public to identify oils which meet the warranty requirements of Chrysler, Ford and General Motors, as well as the Japanese automakers.

The latest ILSAC specification (October 2010) is identified as ILSAC GF-5. The API "Starburst" symbol only applies to 0W-XX, 5W-XX and 10W-XX viscosity oils that not only meet the GF-5 specification, but also meet API SN and the Resource Conserving classification.

The "Starburst" symbol must be displayed on the front of a motor oil container.

USED OIL ANALYSIS

Used Oil Analysis programs for engine oils, such as Petro-Canada's "LUBRI-TEST" provide several customer benefits:

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

Used engine oil analyses are carried out principally to determine the overall condition of an oil. 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
  - 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 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.
- **Insolubles** - suspended material present in the oil, due to presence of soot from diesel fuel combustion and contamination from airborne dust, dirt or sand.
- **Total 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.
- **Total Base Number** - measures the reserve alkalinity of an oil, which is the ability of an alkali to neutralize the effect of acid formation.
- **Wear or Additive Metals** - The presence of the following elements is

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%
Dilution	Greater than 5%
Insolubles	0.5% or more
Total Acid Number	More than 5 units (motor oil) or 1 unit (industrial oil)
Total Base Number	No lower than 3 to 4 units

AUTOMOTIVE WEAR METALS WARNING LEVELS

ELEMENT	WARNING LIMITS	COMMENTS
Iron (Fe)	Greater than 100 ppm	High levels indicate worn crankshafts, valves, cylinder--liners, bearings
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 and bushings
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 anti-freeze 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
Magnesium (Mg), Calcium (Ca) Barium (Ba), Sodium (Na) Phosphorus (P), Zinc (Zn)		These elements may be part of the additive package. They remain in the oil and do not deplete

PETRO-CANADA GASOLINE MOTOR OILS

SERVICE STATION MOTOR OILS

Passenger cars are delivering more power and performance than ever before. Engine power outputs, in horse-power 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 service station oils. Petro-Canada's complete 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 car makers' service requirements for gasoline powered engines, found in passenger cars and light trucks.

PETRO-CANADA SUPREME™ 5W-20, 5W-30 and 10W-30 give excellent year-round performance in today's passenger car engines, equipped with the latest emission controls and turbochargers. Classified by the API as exceeding API SN, 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 reduced to save fuel. PETRO-CANADA SUPREME™ Motor Oils meet the latest API Resource Conserving standard as well as the ILSAC GF-5 specification for motor oil.

PETRO-CANADA SUPREME™ 5W-20 is designed for use in new model Ford, Honda and Mazda automobiles. 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	47.3	62.3	67.7	105.4	159.1
cSt @ 100°C	8.4	10.7	10.4	15.4	17.9
SUV @ 100°F	238	314	336	500	855
SUV @ 210°F	53.8	61.5	60.4	75.7	91.7
Viscosity Index	153	163	141	154	124
Flash Point, °C / °F	219/426	231/448	237/459	247/477	267/513
Cold Crank Viscosity, cP @ °C	4,600@-30	4,760@-30	5,190@-25	5,510@-25	7,590@-15
Borderline Pumping Viscosity, cP @ °C	13,210@-35	16,780@-35	16,140@-30	24,360@-30	22,500@-20
Sulphated Ash, % Wt	0.90	0.90	0.90	0.93	0.91

Meet: API SN, Resource Conserving (only 5W-20, 5W-30, 10W-30), ILSAC GF-5 (only 5W-20, 5W-30,10W-30), GM 6094M (5W-20, 5W-30 and 10W-30), Ford WSS-M2C945-A (5W-20 only), Ford WSS-M2C946-A (5W-30 only), Chrysler MS-6395, Honda, Hyundai, Kia, and Mazda Service Fill (5W-20, 5W-30, and 10W-30 only).

PETRO-CANADA SUPREME™ SYNTHETIC MOTOR OILS

PETRO-CANADA SUPREME™ Synthetic 0W-20, 0W-30, 5W-20, 5W-30, and 10W-30 are our top-of-the-line passenger car motor oils. Specially formulated with 100% Petro-Canada's own Very High Viscosity Index (VHVI) Synthetic Base Fluids and a unique additive chemistry, they help deliver consistent, superior performance under the toughest driving conditions.

PETRO-CANADA SUPREME™ Synthetic have outstanding resistance to thermal breakdown and provide exceptional wear protection under both low and high temperature situations. PETRO-CANADA SUPREME™ Synthetic 0W-30 and 0W-20 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 passenger car and light truck manufacturers' warranty requirements, as well as API Service Categories SN, Resource Conserving and ILSAC GF-5 standards.

Petro-Canada SUPREME™ Synthetic 5W-30 is also fully approved against the GM dexos1™ specification (GM dexos1™ Global license number GB1A1201024), and is suitable for use where Honda HTO-06 is recommended.

Typical characteristics are shown below:

	PETRO-CANADA SUPREME™ Synthetic				
SAE Grade	0W-20	0W-30	5W-20	5W-30	10W-30
Viscosity cSt @ 40°C	45.2	61.9	45.1	63.9	64.3
cSt @ 100°C	8.5	11.2	8.3	11.0	10.5
SUV @ 100°F	229	314	229	323	328
SUV @ 210°F	54.4	64.1	63.2	63.2	61.5
Viscosity Index	168	177	162	165	153
Flash Point, °C / °F	229/444	223/433	233/451	230/446	237/459
Cold Crank Viscosity, cP @ °C	5250@-35	5920@-35	4700@-30	4850@-30	3730@-25
Borderline Pumping Viscosity, cP @ °C	15,100@-40	24,800@-40	9,000@-35	15,700@-35	10,300@-30
Sulphated Ash, % Wt	0.95	0.92	0.92	0.92	0.92
Total Base No. (TBN), mgKOH/g	7.9	7.9	7.9	7.9	7.9

Meet: API SN, Resource Conserving, ILSAC GF-5, GM 6094M (0W-30, 5W-30, 10W-30 and 5W-20), GM dexos1™ (5W-30), Ford WSS-M2C946A (5W-30) & Ford WSS-M2C945A (5W-20), Chrysler MS-6395.

"dexos1™ is a trademark of General Motors LLC."

HEAVY DUTY ENGINE OILS

Commercial and Industrial requirements for heavy duty engine oils continue to stress higher levels of turbo-charging and power outputs, and demand the use of ultra low sulphur 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 designs. This 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 Exhaust Gas Recirculation (EGR). In addition to these technologies, the 2010 EPA compliant low emissions engines now include emissions systems using Selective Catalytic Reduction (SCR). Petro-Canada has responded to these developments by again improving the quality and performance of its commercial engine oils, using its HT Severely Hydrotreated/Hydrocracked base oils and high performance additives.

These oils are non-friction modified and have high friction coefficients making them suitable for many wet-clutch applications.

DURON™ ENGINE OILS

The DURON™ line of premium quality, heavy duty engine oils is designed to improve engine reliability and reduce operating costs through its exceptional soot dispersancy and extended drain capabilities. The DURON-E product line is formulated to meet the challenges of current low emission engines (API CJ-4/SM) includng the 2010 EPA standards. DURON-E products are suitable for use in pre-2007 engines as well. DURON™ multi-grades generally exceed API CI-4 Plus standards required in pre-2007 on-road and off-road engines, while the single grades are suitable where former API categories CF or CF-2 are recommended.

DURON-E and DURON™ Heavy Duty Multigrade 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-E ENGINE OILS (API CJ-4)

Petro-Canada DURON-E multigrade engine oils are premium heavy duty engine oils that typically exceed the requirements of API CJ-4/SM and 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-E heavy duty engine oils are suitable for use in engines powered by both ultra low and low sulphur diesel.

DURON-E is available in six performance offerings – DURON-E 15W-40, DURON-E 10W-30, DURON-E XL Synthetic Blend 15W-40, DURON-E Synthetic 0W-40*, DURON-E Synthetic 5W-40 and DURON-E Synthetic 10W-40. 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-E is formulated to meet the latest OEM specifications for current low emission engines equipped with advanced exhaust aftertreatment devices. DURON-E is back-serviceable and carries the API CI-4 Plus, CI-4, CH-4, licenses required by pre-2007 diesel engines.*

* DURON E Synthetic 0W-40 is built on the same platform as our other DURON-E API CJ-4/SM products. It is suitable for use but not CJ-4 licensed.

			Synthetic	Synthetic	Synthetic	XL Synthetic Blend
SAE Grade	15W-40	10W-30	0W-40	5W-40	10W-40	15W-40
Viscosity cSt @ 40°C	117	78	89	94	99	115
cSt @ 100°C	15.4	11.6	15.1	15.4	15.1	15.5
SUS @ 100°F	600	400	450	479	506	591
SUS @ 210°F	81	66	79	81	79	81
Viscosity Index	139	142	179	173	160	142
Flash Point, °C/°F	230/446	233/451	221/430	229/444	235/455	231/448
Pour Point, °C/°F	-42/-44	-45/-49	-66/-87	-51/-60	-48/-54	-45/-49
High-Shear-Rate Viscosity cP @ 150°C	4.3	3.5	4.0	4.2	4.3	4.4
Cold Crank Viscosity, cP @°C/°F	5,843@-20/-4	6,159@-25/-13	5,548@ -35/-31	5,161@ -30/-22	5,957@-25/-13	5,686@ -20/-4
Borderline Pumping Viscosity, cP @°C/°F	19,960@-25/-13	18,690@-30/-22	26,940@-40/-40	20,250@-35/-31	24,610@-30/-22	17,460@-25/-13
Sulphated Ash, % Wt	<1.0%	<1.0%	<1.0%	<1.0%	<1.0%	<1.0%
Total Base No. (TBN), mg KOH/g	8.3	8.6	8.1	8.8	10.3	10.3

For DURON-E Performance Specifications, Refer to Table (see Page 64)

DURON™ SYNTHETIC ENGINE OIL

DURON™ SYNTHETIC is a full synthetic, super premium, all season heavy duty engine oil, designed for 4-stroke diesel engines that require wide temperature range performance. Under extreme cold temperature environments, DURON™ SYNTHETIC will help provide excellent reliability and wear protection, and may be used in extended drain service under good operating practices and maintenance programs.

DURON™ Synthetic 5W-40 exceeds the requirements of API CI-4 Plus required in off-road engines and pre-2007 EPA compliant low emission on-road diesel engines. DURON™ Synthetic 0W-30 is licensed as API CH-4.

Typical Characteristics are shown below:

		DURON™ SYNTHETIC	
SAE Grade		0W-30	5W-40
Viscosity cSt @ 40°C		64.0	95.4
cSt @ 100°C		11.5	15.5
SUS @ 100°F		324	485
SUS @ 210°F		65.1	80.9
Viscosity Index		175	173
Flash Point, °C / °F		231/448	223/433
Pour Point, °C / °F		-50/-60	-48/-54
Cold Crank Viscosity	**cP @ -30°C / -22°F**	5,651	6,070
Borderline Pumping Viscosity	**cP @ -35°C / -31°F**	11,289	23,120
	cP @ -40°C / -40°F	22,784	48,010
Sulphated Ash, % Wt		1.3	1.4
Total Base No. (TBN), mg KOH/g		9.2	10.8

For DURON™ SYNTHETIC Performance Specifications, Refer to Table (see Page 64)

DURON™ XL SYNTHETIC BLEND ENGINE OILS

DURON™ XL Synthetic Blend Engine Oils are premium, heavy duty engine oils specially formulated to meet the rigors of cold, harsh winters and are recommended for year-round use in vehicles operating in both highway and off-highway applications.

DURON™ XL Synthetic Blend 15W-40 possesses the superior soot dispersing properties required by modern off-road and pre-2007 low emission on-road engine designs – beyond that of API CI-4 Plus, Detroit Diesel Power Guard 93K214 & 93K215, Mack EO-N Premium Plus '03, Caterpillar ECF-2, ECF-1-a and Cummins 20078. It is especially recommended for use in severe operating conditions, in both on- and off-highway applications.

DURON™ XL Synthetic Blend 10W-40 delivers the same high temperature performance as SAE 15W-40 grade diesel engine oil, but with exceptional low-temperature fluidity for easier winter operation and can help with fuel savings through reduced idling time and viscous drag.

DURON™ XL Synthetic Blend 0W-30 is API CH-4 licensed and meets the requirements of the following applications: Caterpillar ECF-1-a, Mack EO-M Plus and Cummins 20076. It aids in permitting unassisted start-ups down to -45°C. It also serves as an excellent hydraulic fluid for mobile equipment, where a motor oil is specified.

Typical Characteristics are shown below:

	DURON™ XL Synthetic Blend		
SAE Grade	15W-40	10W-40	0W-30
Viscosity cSt @ 40°C	114	108	68.7
cSt @ 100°C	15.4	15.6	12.1
SUS @ 100°F	584	555	348
SUS @ 210°F	80.6	81.4	67.4
Viscosity Index	146	153	176
Flash Point, °C / °F	233/451	235/455	231/448
High-Shear-Rate Viscosity cP@150°C / 302°F	4.4	4.4	3.5
Cold Crank Viscosity,			
cP @ -20°C / -4°F	5,106	–	
cP @ -25°C / -13°F	–	6,441	
cP @ -35°C / -31°F	–	–	5,249
Pour Point, °C / °F	-45/-49	-48/-54	<-51/<-60
Borderline Pumping Viscosity, cP @ °C	15,610@-25	25,340@ -30	18,113@-40
Sulphated Ash, % Wt	1.37	1.37	1.18
Sulphur, % Wt	0.46	0.47	0.43
Phosphorus, % Wt	0.13	0.13	0.11
Total Base No.	9.6	9.7	9.1

For DURON™ XL Synthetic Blend Performance Specifications, Refer to Table (see Page 64)

DURON™ SINGLE GRADE ENGINE OILS

Petro-Canada DURON™ Single Grade Engine Oils are universal oils, designed to lubricate engines in heavy-duty service fueled by diesel, gasoline, propane or compressed natural gas (CNG). They are recommended for vehicles operating over the road, as well as many off-highway applications, such as forestry, mining, farming, construction and marine. They are also used in many stationary and marine applications.

DURON™ Single Grade Engine Oils are available in five SAE grades: 10W, 20, 30, 40 and 50.

3

Typical Characteristics are shown below:

	DURON™ Single Grade				
SAE Grade	10W	20	30	40	50
Viscosity cSt @ 40°C	41.5	65	83	134	209
cSt @ 100°C	6.8	9.1	11.2	14.6	19.3
SUS @ 100°F	213	334	429	696	1100
SUS @ 210°F	49	57	64	77	97
Viscosity Index	119	118	123	109	105
Flash Point, °C / °F	194/381	231/448	249/480	265/509	249/480
Pour Point, °C / °F	-42/-44	-39/-38	-36/-33	-30/-22	-21/-6
Cold Crank Viscosity, cP @ °C	4,606@-25	4,932@-20	–	–	–
Borderline Pumping Viscosity, cP@ °C	9,670@-30	–	–	–	–
Phosphorus, % Wt.	0.10	0.10	0.10	0.10	0.10
Sulfur, % Wt.	0.38	0.38	0.38	0.38	0.42
Sulphated Ash, % Wt	1.0	1.0	1.0	1.0	1.0
Total Base No.	8.0	7.9	7.9	7.9	7.9

For DURON™ Single Grade Performance Specifications, Refer to Table (see Page 64)

- DURON™ Single Grades can be used in transmissions, where a motor oil is specified.
- DURON™ Single Grades are excellent hydraulic fluids for mobile equipment, where a motor 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 (SAE 30 & 40 grades are suitable where Caterpillar 3600 is specified), Chrysler, Cummins, Daihatsu, John Deere, Detroit Diesel, 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, Yanmar. DURON™ 30 is also approved for use with Simplex seals from ThyssenKrupp.

PETRO-CANADA HDEO RECOMMENDED APPLICATIONS

	DURON-E Synthetic 10W-40	DURON-E XL 15W-40	DURON-E 15W-40	DURON-E 10W-30	DURON-E Synthetic 5W-400	DURON Synthetic 5W-40	DURON XL 10W-40	DURON XL 0W-30	DURON XL 15W-40	DURON 50	DURON 40	DURON 30	DURON 20	DURON 10W
API CJ-4	●	●	●	●	●				●					
API CI-4 PLUS	●	●	●	●	●	●	●		●					
API CI-4	●	●	●	●	●	●	●		●					
API CH-4	●	●	●	●	●	●	●	●	●					
API CF				●	●	●	●	●	●	●	●	●	●	●
API CF-2					●					●	●	●		
API SM	●	●	●	●	●									
API SL	●	●	●	●		●	●	●	●					
API SJ	●	●	●	●		●	●	●	●		●	●	●	
API SH	●	●	●	●		●	●	●	●		●	●	●	
Caterpillar TO-2	●	●	●	●		●	●	●	●			●		●
Caterpillar TO-2 / Allison C4														
Caterpillar 3600									●		●	●		
Caterpillar ECF-1-a	●	●	●	●		●	●	●	●					
Caterpillar ECF-2	●	●	●	●		●	●		●					
Caterpillar ECF-3	●	●	●	●	●									
Caterpillar SEBU 6385	●	●	●	●					●					
Cummins CES 20071	●	●	●	●		●	●	●	●					
Cummins CES 20072	●	●	●	●		●	●	●	●					
Cummins CES 20076	●	●	●	●		●	●	●	●					
Cummins CES 20077	●	●	●	●		●	●		●					
Cummins CES 20078	●	●	●	●		●	●		●					
Cummins CES 20081	●	●	●	●	●									
Detroit Diesel Power Guard 93K214	●	●	●						●					
Detroit Diesel Power Guard 93K215									●					
Detroit Diesel Power Guard 93K218	●	●	●		●									
Detroit Diesel, 7SE270 2-Stroke Cycle*										●	●	●		
Detroit Diesel, 7SE273 (Series 2000/4000)			●						●					
Ford M2C171-C	●	●	●			●	●	●	●	●	●	●		
Ford M2C171-D	●	●	●			●	●		●					
Ford WSS-M2C171-E	●	●	●											
General Motors 9985930		●	●											
GLOBAL DHD-1									●					
JASO DH-1									●					
JASO MA, MA2	●	●	●	●										
Mack EO-M / EO-M Plus	●	●	●		●		●	●	●					
Mack EO-N Premium Plus	●	●	●		●		●		●					
Mack EO-N Premium Plus '03	●	●	●		●		●		●					
Mack EO-O Premium Plus '07	●	●	●		●									
Volvo VDS-2	●	●	●	●			●		●					
Volvo VDS-3	●	●	●	●					●					
Volvo VDS-4	●	●	●	●	●									
ACEA E9 - 2008			●											
ACEA E7 - 2008	●	●	●						●					
MAN 271, MAN 3275			●						●					
MB 228.1 / MB 228.3									●					
MB 228.31			●											
MTL 5044 (MTU Type 1 & 2)			●						●					
Renault VI RLD-3	●	●	●	●	●				●					
Scania LDF, LDF-2									●					
DEUTZ DQC III - 05	●													

*Detroit Diesel recommends an SAE 40 grade only for 2-stroke cycle engines, except where starting aids are not available or at very cold temperatures, when the use of an SAE 15W-40 or SAE 30 will facilitate starting.

RALUBE™ – LOCOMOTIVE DIESEL ENGINE OIL

RALUBE™ oils are designed to lubricate large medium-speed diesel engines driving railroad locomotives, marine vessels and electric-power generators.

RALUBE™ oils incorporate chlorine-free additive chemistry. RALUBE™ oils help provide strong oxidation resistance, wear protection and deposit control.

RALUBE™ oils are designed to provide exceptional deposit control necessary for severe railroad service. In addition, by minimizing engine deposits, they allow maximum oil drain intervals to be achieved without compromising engine durability.

RALUBE™ oils are zinc-free for compatibility with silver plated or silver alloy engine components. RALUBE™ oils have been tested and approved in railroad service, in close co-operation with the major locomotive engine builders such as Electro-Motive Diesel and General Electric. Electro-Motive Diesel and General Electric list these oils as approved for use in their equipment.

RALUBE™ 940 CF is a SAE 40 grade, 9 TBN railway diesel engine oil designed to address the emerging EPA fuel and emission standards for 2011 and is suitable for use with current and late model EMD and GE units operating on Ultra Low Sulphur Diesel.

RALUBE™ 40 CFS is a SAE 40 grade, 13 TBN premium quality crankcase oil, formulated for severe service in diesel locomotive engines, driving railroad locomotives, marine vessels and electric power generators.

Typical characteristics are shown below:

	RALUBE™	
	940 CF	**40 CFS**
SAE Grade	40	40
Viscosity cSt @ 40°C	141	133
cSt @ 100°C	14.7	15.0
SUS @ 100°F	735	691
SUS @ 210°F	78.4	79.6
Viscosity Index	104	115
Flash Point, °C / °F	283/541	272/522
Pour Point, °C / °F	-27/-17	-27/-17
Sulphated Ash, % Wt	1.0	1.5
Total Base No.	9.2	13

DIESELTONIC™ MOTOR OIL

Petro-Canada DIESELTONIC™ Motor Oil is a special, single grade, low ash engine oil intended for use in all models of 2-stroke cycle Detroit Diesel engines, including the Series 149, operated in fleet, construction and stationary applications.

Typical Characteristics are shown below:

	DIESELTONIC™
SAE Grade	40
Viscosity cSt @ 40°C	131
cSt @ 100°C	14.2
SUS @ 100°F	684
SUS @ 210°F	76
Viscosity Index	108
Flash Point, °C / °F	251/484
Pour Point, °C / °F	-24/-11
Sulphated Ash, % Wt	0.7
Total Base No.	8.0

Meets: Former API category CF-2, CF, Detroit Diesel 7SE270 (2-Stroke), Detroit Diesel 6V92TA.

AUTOMATIC TRANSMISSION FLUIDS

Automatic Transmission Fluids (ATFs) are among the most complex lubricants on the market today. Containing as many as 15 components, ATFs represent a careful balance of properties needed to meet the unique requirements of automatic transmissions. They may be described as viscometrically similar to SAE 0W-20 grade oils, but with exceptionally good low temperature properties. ATFs contain some of the same additives as engine oils, but have additional components to give special frictional properties and exceptional oxidation resistance. Their excellent low temperature fluidity and antiwear properties, enable automatic transmission fluids to perform well as hydraulic fluids in industrial equipment and air compressors, provided that water separation is not required.

These fluids perform five basic functions:

- Transmit hydrodynamic energy in the torque converter.
- Transmit hydrostatic energy in hydraulic logic control circuits and servomechanisms.
- Lubricate shaft bearings, thrust bearings, and gears.
- Transmit sliding friction energy in bands and clutches.
- Act as a heat transfer medium controlling automatic transmission operating temperatures.

Automatic transmission fluid specifications are in a state of flux and now there are several types of fluids specified for North American automatic transmissions. The most widely marketed fluid by far, is DEXRON®-III/ MERCON® ATF, a friction modified fluid, recommended for transmission top-up or refill, by many automobile manufacturers for late model vehicles (prior to 2006). For 2006 model year and onward General Motors' transmissions, the required fluid is DEXRON®-VI. Ford Motor Company requires all its automatic transmissions, to be serviced with MERCON® V fluid (except where MERCON® SP or MERCON LV is specified). Ford Type F, a non friction-modified fluid, is still required for 1979 and earlier Ford or other older import cars. Chrysler LLC recommends ATF+4® fluid be used in their transmissions for all model years.

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 and +160°C. It has been tested extensively and meets General Motors specification 6297M and Ford specification M2C185A. ATF D3M is fully qualified for use in transmissions where a fluid meeting the former DEXRON®-III(H), -III(G), -II(E), or MERCON® specification is recommended.

Petro-Canada ATF D3M is designed to meet the severe requirements of the Allison C-4 and V-730D specifications for transmission/torque converter fluids. It is approved against the Allison TES-389 specification. It also meets the Caterpillar TO-2 specification and is approved for use in Clark Powershift Transmissions down to –30°C. It is also approved for use in transmissions manufactured by Renke.

Petro-Canada ATF D3M also acts as an excellent hydraulic fluid and it surpasses the performance of most top quality antiwear hydraulic fluids or motor oils. It is suitable for use with Sundstrand, Bosch-Rexroth, Vickers and Denison (except certain axial piston) hydraulic pumps.

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 DURADRIVE™ MV SYNTHETIC ATF

Petro-Canada DURADRIVE™ MV Synthetic ATF is Petro-Canada's best multi-vehicle ATF. This full synthetic formulation offers true multi-vehicle performance, outstanding wear protection, and exceptional fluid life. DURADRIVE™ MV Synthetic 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'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 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: **GM:** DEXRON® II & III **Ford:** MERCON®, MERCON®-V. **Toyota:** T, T-III, T-IV, WS **Honda:** Z1 **Hyundai/Kia/Mitsubishi:** SP-II, SP-III, SP-IV, J2 **Nissan:** Matic D, J, K, S **Mercedes Benz:** 236.1/.2/.5/.6/.7/.9/.10 **Saturn:** Saturn ATF **Subaru:** Subaru ATF, ATF-HP, **BMW:** 7045E, LA2634, LT71141 **VW/Audi:** G 052 025, G 052 162, G 052 990, G 055 025 **Volvo:** 97340. Not recommended for DCT and CVT transmissions or where a non-friction modified fluid is recommended (e.g. Ford Type F). Always consult your vehicle owner's manual for specific transmission fluid recommendations.

PETRO-CANADA ATF TYPE F

As noted earlier, this fluid differs from ATF D3M in its frictional properties, as they relate to the design of old, pre-1980, Ford automatic transmissions. ATF Type F meets requirements of the obsolete Ford specification ESW-M2C33-F. ATF Type F is sometimes specified by other equipment OEMs who want a non-friction modified fluid.

AUTOMATIC TRANSMISSION FLUID TYPICAL CHARACTERISTICS

Typical Characteristics of Petro-Canada DURADRIVE™ MV Synthetic ATF, ATF D3M and ATF Type F are shown below:

		DURADRIVE™ MV Synthetic ATF	Petro-Canada ATF D3M	Petro-Canada ATF Type F
Viscosity	**cSt @ 40°C**	36.1	34	41
	cSt @ 100°C	7.4	7.7	8.2
	SUS @ 100°F	183	171	207
	SUS @ 210°F	51	52	53
Viscosity Index		178	210	180
Brookfield Viscosity,	**cP @ - 18°C**		–	970
	cP @ - 20°C		1,140	–
	cP @ - 40°C	11,538	12,100	23,260
Pour Point, °C / °F		-54/-65	-51/-60	-48/-54
Flash Point, °C / °F		206/403	185/365	204/399
Colour		Red	Red	Red

VEHICLE APPLICATIONS

DEXRON®-III/MERCON®

Petro-Canada ATF D3M is approved for use 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.

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

*Except Borg-Warner transmissions

Type F Fluid

Petro-Canada ATF D3M Automatic Transmission Fluid is not recommended for the vehicles listed below. They require Petro-Canada ATF Type F Fluid.

Ford (1978 & earlier models where Type F fluid is specified)
Jaguar (Borg-Warner)
Mazda (1981-85)
Saab (3-speed)
Toyota (4-speed 1981-83)
Volvo (1984 BW55 & 1981-83)

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

PETRO-CANADA DEXRON®-VI ATF AUTOMATIC TRANSMISSION FLUID

Petro-Canada DEXRON®-VI is an exceptional automatic transmission fluid approved by General Motors 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 your transmission 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 your car and truck transmission 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. General Motors recommends the use of DEXRON®-VI for all automatic transmissions including those prior to 2006 model year. It is fully back serviceable where the former DEXRON®-III(H), -III(G) and -IIE specifications were recommended. Meets GM's latest service fill specification, GMN10060. Petro-Canada DEXRON®-VI ATF is Voith Transmission approved for normal drain interval (36,000 miles).

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, °C / °F	206/403
Colour	Red

PETRO-CANADA ATF+4® AUTOMATIC TRANSMISSION FLUID

Petro-Canada ATF+4® is an automatic transmission fluid specially formulated to meet the needs of Chrysler 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
SUS @ 100°F	167
SUS @ 210°F	51
Viscosity Index	204
Brookfield Viscosity, cP @ - 29°C	2,050
cP @ - 40°C	8,380
Pour Point, °C / °F	-51/-60
Flash Point, °C / °F	198/388
Colour	Red

PETRO-CANADA HEAVY DUTY SYNTHETIC BLEND AUTOMATIC TRANSMISSION FLUID

Petro-Canada's Heavy Duty 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 (Voith G1363) and ZF (ZF TE-ML.14.B) extended drain applications and Allison C-4. Carries 72,000 mile extended drain approval by Voith Turbo as per Voith Service Bulletins DSB013 and DSB118**. Heavy Duty Synthetic Blend ATF is the only fluid endorsed by Voith Turbo with an extended basic warranty coverage and discounted extended warranty package. Fully qualified for use in transmissions where a fluid meeting the former DEXRON®-III(H), -III(G), -II(E) specification is recommended. Also suitable for use where Allison TES-295, Caterpillar TO-2 or MERCON®-V is recommended.

Typical Characteristics are shown below:

		Petro-Canada Heavy Duty Synthetic Blend ATF
Viscosity	**cSt @ 40°C**	34
	cSt @ 100°C	7.8
	SUS @ 100°F	173
	SUS @ 210°F	51.9
Viscosity Index		208
Brookfield Viscosity, cP @ - 40°C		9,700
Pour Point, °C / °F		-45/-49
Flash Point, °C / °F		189/372
Colour		Red

AUTOMOTIVE GEAR OILS

Automotive gear oils protect gears, bearings and cross-shafts from premature failure, assure 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**
  A fluid film of oil 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 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 bearing and 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 lubricate at normal operating temperatures.

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 (June 2005)

SAE Viscosity Grade	Max. Temperature for Viscosity of 150,000 cP (°C) [1,2]	Kin. Viscosity @ 100°C, cSt [3]	
		Minimum [4]	Maximum
70W	–55	4.1	—
75W	–40	4.1	—
80W	–26	7.0	—
85W	–12	11.0	—
80	—	7.0	<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 D 2983.
2. Additional low-temperature viscosity requirements may be appropriate for fluids intended for use in light duty synchronized manual transmissions. See text.
3. Using ASTM D445.
4. 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-graded (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 thickness 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 to assist manufacturers and end-users select 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. In Europe and other parts of the world, API GL-4 oils are used as frequently as API GL-5.

API SERVICE CLASSIFICATION

Classifications	Type	Typical Application
GL-1	Straight mineral oil (inactive)	Automotive manual transmissions
GL-2	Usually contains fatty materials (inactive)	Worm gear drives, industrial gear oils
GL-3	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	Manual transmissions, spiral bevel and hypoid gears where moderate service prevails
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.
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

Each automobile manufacturer has a set of unique test requirements for rear axle factory-fill. An API GL-5 lubricant generally satisfies the majority of these requirements and is often recommended for service-fill.

NOTE – SAE J2360 is equivalent to 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.

Petro-Canada TRAXON™ E and TRAXON™ may be used for top-up in some limited slip differentials.

MACK GO-J & GO-J PLUS SPECIFICATIONS
(SAE 75W-90, 80W-90, 80W-140 & 85W-140 grades)

Manufacturers of trucks and components play an important role in designing the quality and performance level of the lubricants available to their customers. The truck gear performance requirements that have become quite important in the past few years are the up-graded API GL-5 requirements, **Mack GO-J and Mack GO-J Plus.** Mack GO-J is designed to deliver ***250,000 mile/2 year drain intervals*** and Mack GO-J Plus ***500,000 mile/3 year drain intervals,*** both in over-the-road service. To qualify for a Mack GO-J or Mack GO-J Plus listing, an oil must pass all the tests required for a MIL-PRF-2105E approval, and in addition satisfy three further tests:

- The Mack Power Divider Snap Test (MAT 700 WI), which measures an oil's ability to minimize noise and reduce the wear of cams and wedges in a Mack Power Divider differential.
- The Mack Transmission Cycling Test (ASTM D5579), which measures the ability of an oil to prevent glazing and clogging of gear synchronizer plates, requires a Mack GO-J oil to provide satisfactory shifting after 65,000 cycles and a Mack GO-J Plus, extended drain oil, to provide satisfactory shifting after 97,500 cycles.

Mack Truck requires these additional performance levels above API GL-5, because of the continuing increase in truck engine power. Today's truck drive-lines handle power loads that are nearly three times what they were in the early 1960's, when API GL-5 was first developed.

TRAXON™ GEAR OIL

TRAXON™ is Petro-Canada's premium multi-grade line of automotive gear oils. TRAXON™ gear oils are specially formulated to provide excellent shear stability and long oil life for outstanding long-lasting protection to help you 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, power take-off units and final drives found on passenger cars, trucks, and off-highway vehicles used in construction, farm, forestry and mining operations.

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-, or GL-5 oils.

Due to specific lubrication requirements TRAXON™ gear oils 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

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 in higher temperatures
- Resists degradation and sludging for longer oil life with fewer change-outs and better protection of gears
- Approved against SAE J2360 (formerly MIL-PRF-2105E), Mack GO-J, and ZF TE-ML lubricant class 05A, 12E, 16B, 17B, 19B, and 21A.

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.

- Excellent shear stability which ensures retention of viscosity to protect equipment against metal-to-metal contact and wear, especially in high 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 to 45°C at moderate loads) for reduced friction and lubricant drag and a smoother, more efficient operating performance which may lead to lower fuel consumption
- Approved against SAE J2360, Mack GO-J and ZF TE-ML lubricant class 05A, 12E, 16B, 17B, 19B, and 21A.

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.

- Excellent shear stability which ensures retention of viscosity to protect equipment against metal-to-metal contact and wear, especially at high temperatures
- Protection in extreme cold weather conditions which means easier start-ups and cold weather shifting.
- Better torque efficiency vs. GL-5 80W-90s (from 20°C to 45°C at moderate loads) for reduced friction and lubricant drag and a smoother, more efficient operating performance which may lead to lower fuel consumption
- Suitable for use where Mack GO-J or SAE J2360 (formerly MIL-PRF-2105E) specifications are called for

Typical Characteristics are shown below:

		TRAXON™ 80W-90	TRAXON™ XL Synthetic Blend 75W-90	TRAXON™ Synthetic 75W-90
Viscosity	**cSt @ 40°C**	140	107	99.6
	cSt @ 100°C	15.1	16.5	16.5
	SUS @ 100°F	733	544	462
	SUS @ 210°F	79	85	84
Viscosity Index		109	168	179
Flash Point, °C / °F		215/419	183/361	173/345
Pour Point, °C / °F		-33/-27	-42/-44	-51/-60
Low Temperature Viscosity, cP @ °C/°F		132,000@ -26/-15	138,000@ -40/-40	67,200@ -40/-40
Phosphorus, % Wt		0.10	0.11	0.11
Sulphur, % Wt		1.94	2.12	1.79

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

TRAXON™ 85W-140 – HIGH PERFORMANCE PROTECTION

- Outstanding shear stability and anti-wear EP additives protects 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
- Approved against SAE J2360 (formerly MIL-PRF-2105E), Mack GO-J specifications and ZF TE-ML lubricant class 05A, 12E, 16D, and 21A.

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 increase uptime
- Better torque efficiency vs. mineral based GL-5 85W-140 oils (20°C to 45°C at moderate loads) for reduced friction and lubricant drag and a smoother, more efficient operating performance which may lead to lower fuel consumption
- Recommended where a SAE J2360 (formerly MIL-PRF-2105E), Mack GO-J or ZF TE-ML 05A specification is required

Approved against ZF TE-ML lubricant class 05A, 12E, 16D, and 21A.

Typical characteristics are shown below:

		TRAXON™ 85W-140	TRAXON™ XL Synthetic Blend 80W-140
Viscosity	**cSt @ 40°C**	344	255
	cSt @ 100°C	25.6	25.2
	SUS @ 100°F	1835	1333
	SUS @ 212°F	126	124
Viscosity Index		97	127
Flash Point, °C / °F		214/417	193/379
Pour Point, °C / °F		-15/+5	-36/-33
Low Temperature Viscosity, cP @ °C/°F		62,000@ -12/10	105,200@ -26/-15
Phosphorus, % Wt		0.09	0.09
Sulphur, % Wt		2.00	1.84

TRAXON™ E SYNTHETIC

TRAXON™ E Synthetic is Petro-Canada's line of Eaton (Dana)/Road Ranger/ Arvin-Meritor-Approved synthetic gear and transmission lubricants. They are recommended for those customers who need to maintain an Eaton/Roadranger "extended warranty." The line consists of three 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, good low temperature properties and extremely low channel points provide superior protection over a wide range of temperatures for increased productivity
- Possible improved fuel mileage capability provides reduced costs

TRAXON™ E SYNTHETIC CD-50

- 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
- Less transmission friction and drag helps increase fuel economy
- Long lubricant life provides extended drain capabilities for less change-outs and reduced maintenance

Typical characteristics are shown below:

		TRAXON™ E Synthetic		
		75W-90	**80W-140**	**CD-50**
Viscosity,	**cSt @ 40°C**	121	290	132
	cSt @ 100°C	16.8	31.2	17.5
	SUS @ 100°F	621	1507	679
	SUS @ 212°F	86	151	89
Viscosity Index		150	147	146
Flash Point, °C/°F		201/394	221/430	221/430
Pour Point, °C/°F		-48/-54	-42/-44	<-45/<-49
Brookfield Viscosity,				
	cP @ -18°C/0°F	7,125		–
	cP @ -26°C/-15°F	–	71,200	–
	cP @ -30°C/-22°F	–	–	24,550
	cP @ -40°C/-40°F	143,000	–	104,000

DURATRAN™ - TRACTOR TRANSMISSION-HYDRAULIC FLUID

The DURATRAN™ 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 our HT Severely Hydrocracked and Severely Hydroisomerized 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.

- *Protection against transmission gear wear*

  DURATRAN™ fluids exceed existing John Deere Extreme Pressure (EP) and Final Drive Gear Wear test requirements and perform well in the demanding 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 our HT Severely Hydrocracked and Severely Hydroisomerized 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 -40°C.

- *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.

Typical characteristics are shown below:

		DURATRAN™	DURATRAN™ XL Synthetic Blend	DURATRAN™ Synthetic
Viscosity	**cSt @ 40°C**	60.9	39.2	46.8
	cSt @ 100°C	9.5	8.3	10.0
	SUS@ 100°F	307	198	235
	SUS@ 210°F	57.9	53.6	62.4
Viscosity Index		141	196	207
Brookfield Viscosity, cP @ - 20°C		2,670	1,300	1,260
	cP @ - 35°C	23,700	–	–
	cP @ - 40°C	61,200	13,500	15,740
Pour Point, °C / °F		-45/-49	-50/-58	-47/-51
Flash Point, °C / °F		239/462	219/426	225/437
Total Base No.		10.6	10.4	10.0

DURATRAN™ meets the existing requirements of John Deere specification J20C while DURATRAN™ XL Synthetic Blend meets the existing requirements of John Deere specification J20D. DURATRAN™ Synthetic meets both existing John Deere specifications J20C and J20D. All three DURATRAN™ fluids also meet existing or exceed the field-performance requirements of all North American tractor manufacturers, as well as manufacturers from elsewhere in the world. DURATRAN™ fluids are recommended, where the following specifications are called for:

- **Farm Tractors**

  John Deere ..... J20C (DURATRAN™, DURATRAN™ Synthetic); J20D (DURATRAN™ XL Synthetic Blend, DURATRAN™ Synthetic)

  CNH (Case I.H., J.I. Case New Holland Group) ..... MS 1209, MS 1210/JIC 145, MS 1230, MS 1205, MS 1206, MS 1207, MS 1204/JIC 185, JIC 145, JIC 144, JIC 143, B-5, B6 FNHA-2-C-201.00, FNHA-2-201A (134D), FNHA-2-C-200.00, ESN-M2C134-D, ESN-M2C134-A/B/C, ESN-M2C86-B, ESN-M2C53-A, ESN-M2C48-B

  White Farm (Oliver) Q-1826, Q-1802, Q-1766B, Q-1722, Q-1705

  Massey-Ferguson M-1141, M-1135, M-1129-A, M-1127-A/B, M-1110

  AGCO / Deutz-Allis / Allis ..... Power Fluid 821XL, 257541, 272843, 246634

  Kubota UDT, Steiger, Versatile, Landini, Hesston-Fiat, Volvo, WB101 (DURATRAN™, DURATRAN™ Synthetic)

  ZF Transmissions: DURATRAN™ (TE ML 03E, 05F, 05F, 06K)
  DURATRAN™ XL Synthetic Blend (03F)

- **Transmissions and Differentials**

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

- **Hydraulic Pumps**

  Parker / Abex / Denison
  Eaton / Vickers M-2950-S, 1-286-S
  Plessey-Sundstrand

PRODURO™ TO-4+ – TRANSMISSION/DRIVE TRAIN OIL

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 viscosity grades: SAE 10W, 30, 50, 60, XL Lo Temp and Synthetic All-Season. The last two products are formulated with special base oils which confer multigrade pumpability equivalent to SAE 0W20 and SAE 5W30 respectively. They have been fully tested and comply with the performance requirements of Caterpillar TO-4 and Allison C-4. They are recommended for use in hydraulics, manual transmissions and drive lines, where a TO-4 oil is recommended, or to replace TO-2 oils.

Typical Characteristics are shown below:

	PRODURO™ TO-4+					
SAE Grade	**10W**	**30**	**50**	**60**	**Synthetic Blend LoTemp**	**Synthetic All-Season**
Viscosity						
cSt @ 40°C	35.4	88.5	209	371	35	56
cSt @ 100°C	6.3	11.0	18.4	26.9	7.4	10.7
SUV @ 100°F	181	459	1,104	1,979	177	283
SUV @ 210°F	47.3	63.9	94.2	132	51	62.6
Viscosity Index	128	110	97	97	184	187
HT/HS @ 150C	2.4	3.5	5.0	7.0	2.7	3.7
Flash Point, °C / °F	239/462	259/498	253/487	253/487	209/408	222/432
Pour Point, °C / °F	-33/-27	-27/-17	-27/-17	-21/-6	-51/-60	-48/-54
Cold Crank Viscosity, cP @ °C / °F	5,219@ -25/-13	10,433@ -20/-4	11,167@ -10/14	15,854@ -5/23	4,403@ -35/-31	6,530@ -30/-31
Brookfield Viscosity, cP @ °C / °F	48,100@ -35/-31	80,200@ -26/-15	63,400@ -15/5	106,000@ -10/14	10,140@ -40/-40	14,720@ -35/-31
Performance Level	Caterpillar TO-4 (June 05) Allison C-4 API CD API GL-3 ZF TE-ML 03C	Caterpillar TO-4 (June 05) Allison C-4 API CD API GL-3 ZF TE-ML 03C	– – Allison C-4 API CD API GL-3 –	– – – API CD API GL-3 –	Caterpillar TO-4 (June 05) – – –	Caterpillar TO-4 (June 05) Allison C-4 API CD API GL-3 ZF TE-ML 03C

3

Generic Recommendations Based on Viscometrics (TO-4)

Application	SAE Grade	
Hydrostatic Transmissions	10W	-20 to +40
	Synthetic Blend Lo Temp	-40 to +40
	Synthetic All Season	-34 to +45
Hydraulic	10W	-25 to +50
	30	-15 to +50
	Synthetic Blend Lo Temp	-40 to +40
	Synthetic All Season	-34 to +50
**Powershift Transmissions	10W	-21 to +10
	30	-9 to +35
	50	+5 to +50
	Synthetic Blend Lo Temp	-40 to +10
	Synthetic All Season	-34 to +30
**Final Drives on Highway	10W	-30 to 0
	30	-25 to +25
	50	-17 to +52
	60	-9 to +55
	Synthetic Blend Lo Temp	-45 to 0
	Synthetic All Season	-37 to +25
**Final Drives off Highway	10W	-30 to -10
	30	-25 to +15
	50	-17 to +34
	60	-9 to +52
	Synthetic Blend Lo Temp	-45 to 0
	Synthetic All Season	-37 to +15

*Caterpillar models 768C, 769C, -10˚C to 22˚C (-40˚F to 72˚F)
** Wheeled vehicles e.g. tractors, loaders, skidders, compactors and off-highway trucks
***Tracked vehicles e.g. tractors, pipelayers, skidder and loaders

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

PRODURO™ FD-1 60 is Petro-Canada's 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. **PRODURO™ FD-1 60 should not be used in compartments containing friction material unless a FD-1 type of product is specified. This product is not for use in engines, transmission hydraulic systems, or older Caterpillar (789 series) final drive technology, under extreme loading.**

Typical Characteristics are shown below:

	PRODURO™ FD-1 60
SAE Grade	60
Viscosity cSt @ 40°C	341
cSt @ 100°C	26.7
SUV @ 100°F	1,809
SUV @ 210°F	131
Viscosity Index	104
Flash Point, °C / °F	297/567
Pour Point, °C / °F	-24/-11
Cold Crank Viscosity, cP @ °C / °F	13,194@-5/23
Brookfield Viscosity, cP @ °C / °F	25,400@-10/14
Performance Level	Caterpillar FD-1 (Dec 01)

TWO-CYCLE ENGINE OILS

Petro-Canada's family of small engine oils is designed to give excellent performance in both air-cooled and water-cooled two-stroke cycle engines operating under all conditions. These oils are especially formulated for use in oil injection as well as conventional pre-mixed gasoline/oil lubricated 2-cycle engines.

Petro-Canada small engine oils contain high performance additives, which give excellent anti-scuff and anti-wear performance to ensure reliability, internal cleanliness and long engine life. The additive systems used produce minimal spark plug, ring, piston and valve deposits and so allow good starting and continued efficient engine operation.

Petro-Canada small engine oils also contain 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 2-cycle oils from different manufacturers.

SNOWMOBILE MOTOR OIL

Snowmobile Motor Oil is a premium low ash, two-stroke cycle engine oil for use in all conventional pre-mix fuel/oil, as well as oil injection lubricated snowmobile engines such as Bombardier, Artic Cat, Polaris, Yamaha where an API TC Oil is called for. It is also suitable for chain saws, lawn mowers, motorcycles, mopeds, and generators. Snowmobile Motor Oil has the following features:

– Low ash formula for high performance engines
– Minimizes pre-ignition
– Suitable for oil injection (to - 40°C), as well as pre-mix fuel/oil lubricated engines
– Excellent performance at all fuel/oil ratios specified by Original Equipment Manufacturers (OEMs)
– Good anti-wear protection
– Mixes and pumps readily to - 40°C
– Protects against varnish deposits
– Optimum performance in severe climates
– Resists rust and corrosion

Snowmobile Motor Oil meets: API Classification TC, ISO E-GB, JASO FB and SAE Fluidity/Miscibility (F/M) Grade 4.

2-CYCLE MOTOR OIL

2-Cycle Motor Oil is a multipurpose two-stroke cycle engine oil, for use in conventional pre-mix fuel/oil as well as oil injection lubricated engines powering motorcycles, mopeds, chain saws, lawn mowers and generator sets such as Husqvarna, Stihl, Polaris, Weedeater, Lawnboy, Tecumseh, Toro, Briggs & Stratton and Yamaha where API TC oil is called for. 2-Cycle Motor Oil has the following features:

– Suitable for use in oil injection (to –40°C) as well as pre-mix fuel/oil lubricated engines.
– Excellent performance at up to 50:1 fuel/oil ratios in air-cooled engines.
– Anti-scuff and anti-wear properties to minimize wear.
– Excellent rust and corrosion protection.
– Mixes readily at low temperatures.

2-Cycle Motor Oil meets API classification TC, ISO E-GB, JASO FB and SAE Fluidity/Miscibility (F/M) Grade 4.

OUTBOARD MOTOR OIL

Outboard Motor Oil is a premium two-stroke engine oil for use in water-cooled outboard motors (both large and small power outputs), used at all fuel to oil ratios specified by the Original Equipment Manufacturers (OEMs). It is also suitable for motorcycle and snowmobile engines, where the manufacturer calls for a NMMA TC-W3 approved oil. Outboard Motor Oil is especially formulated for oil injected engines. It also meets the SAE Fluidity/Miscibility (F/M) Grade 3.

Outboard Motor Oil has been approved by the National Marine Manufacturers Association (NMMA) against their TC-W3, RL 00440K, API TC specification. Its formulation also meets the warranty requirements of the following engine manufacturers: Mercury Marine, Bombardier (Formerly OMC which makes Johnson & Evinrude engines), Yamaha, Suzuki, Nissan, etc. Outboard Motor Oil has the following features:

– Ashless formula minimizes pre-ignition.
– Resists rust and corrosion.
– Contains a quick-mix additive.
– Reduces engine wear and varnish build-up.
– Suitable for oil injection (to -25°C/-13°F) as well as pre-mixed fuel/oil lubricated engines.
– Reduced smoke emissions.
– Virtually non-toxic to water inhabiting species such as fish.

Typical Characteristics of Petro-Canada Two Cycle Engine Oils are shown below:

	Snowmobile Motor Oil	Outboard Motor Oil	2-Cycle Motor Oil
Viscosity cSt @ 40°C	21	56	21
cSt @ 100°C	4.5	8.8	4.5
SUS @ 100°F	110	285	110
SUS @ 210°F	41	56	41
Viscosity Index	132	136	132
Flash Point, °C / °F	152/306	134/273	152/306
Pour Point, °C / °F	<-54/<-65	-48/-54	<-57/<-71
Brookfield Viscosity, cP @ °C	11,620@ -40	5,910@ -25	8,718@ -40
Sulphated Ash, % Wt	0.1	<0.001	0.1
Colour	Blue/Green	Blue/Green	Blue/Green
Performance Level			
API	TC	–	TC
NMMA	–	TC-W3	–
SAE F/M	Grade 4	Grade 3	Grade 4
JASO	FB	–	FB

QUICK MIX CHART

Ratio	Millilitres (mL) Oil Added to Litres of Gasoline		
Gasoline to Oil	**5 Litres**	**10 Litres**	**25 Litres**
16:1	315	625	1550
24:1	210	420	1050
32:1	165	315	800
50:1	100	200	500
100:1	50	100	250

INDUSTRIAL LUBRICANTS

Business today places heavy demands on industrial plant and machinery. We expect equipment to operate at temperatures between -50°C and 150°C 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 “Four Rs”:

- Right Lubricant
- Right Amount
- Right Place
- Right Time

Your Original Equipment Manufacturer (OEM) together with a Petro-Canada Lubricants Representative or a Technical Services Advisor can assist you in determining the “Four Rights” for your equipment or machinery.

VISCOSITY CLASSIFICATION OF INDUSTRIAL OILS

It used to be the 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 world-wide 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 lubricant grade recommended by the equipment manufacturer is the same as the number in the product name.
- Conversion from one viscosity measurement to another is virtually eliminated.
- The number in the product name for most products represents the viscosity of an industrial oil.

Automotive engine and gear oils are not involved in 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.

ISO-VISCOSITY SYSTEM FOR INDUSTRIAL FLUID LUBRICANTS

ISO Viscosity Grade	Mid Point cSt @ 40°C	Kinematic Viscosity @40C Limits			
		Minimum		Maximum	
		cSt	S.U.S.	cSt	S.U.S.
2	2.2	1.98	32.0	2.42	34.0
3	3.2	2.88	35.5	3.52	37.5
5	4.6	4.14	39.5	5.06	42.5
7	6.8	6.12	46.0	7.48	50.5
10	10	9.00	55.5	11.0	62.5
15	15	13.5	71.5	16.5	83.5
22	22	19.8	97.0	24.2	116
32	32	28.8	136	35.2	165
46	46	41.4	193	50.6	235
68	68	61.2	284	74.8	347
100	100	90.0	417	110	510
150	150	135	625	165	764
220	220	198	917	242	1121
320	320	288	1334	352	1631
460	460	414	1918	506	2344
680	680	612	2835	748	3465
1000	1000	900	4169	1100	5095
1500	1500	1350	6253	1650	7643

AGMA NUMBERS

The American Gear Manufacturers Association (AGMA) has set up a numbering system to define gear oil viscosities required for various gear boxes and applications. These AGMA Lubricant Numbers are normally stamped on the manufacturer's metal name plate. ISO Viscosity Grade numbers and AGMA numbers are compared in the table below.

Viscosity ranges for AGMA Lubricants (ANSI/AGMA 9005-D94)

Rust and oxidation inhibited gear oils AGMA Lubricant No.	Viscosity range (cSt) at 40°C	Equivalent ISO grade	Extreme pressure gear lubricants AGMA Lubricant No.	Synthetic gear oils AGMA Lubricant No.
0	28.8 to 35.2	32		0 S
1	41.4 to 50.6	46		1 S
2	61.2 to 74.8	68	2 EP	2 S
3	90 to 110	100	3 EP	3 S
4	135 to 165	150	4 EP	4 S
5	198 to 242	220	5 EP	5 S
6	288 to 352	320	6 EP	6 S
7, 7 Comp	414 to 506	460	7 EP	7 S
8, 8 Comp	612 to 748	680	8 EP	8 S
8A	900 to 1100	1000	8A EP	–
9	1350 to 1650	1500	9 EP	9 S
10	1920 to 2420	2200	10 EP	10 S
11	2880 to 3520	3200	11 EP	11 S

- TURBOFLO™ R&O can be used where AGMA Rust & Oxidation Inhibited Gear Oils are required.
- ENDURATEX™ EP, ENDURATEX™ XL Synthetic Blend and ENDURATEX™ Synthetic EP oils can be used where AGMA anti-scuff/anti-wear Extreme Pressure (EP) Gear Lubricants are required.
- ENDURATEX™ Mild Worm Gear Oils, which contain special lubricity additives, can be used where AGMA Compounded (CP) 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 oils formulated to meet 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 stage pass rating of 12. For those applications that are subjected to heavy loads or shock loading and require an AGMA EP type of fluid, ENDURATEX™ Synthetic EP is recommended.

VISCOSITY COMPARISONS

Viscosities designated by various organizations may be compared as shown in the table opposite. This is strictly a viscosity comparison and should not be construed as a quality level comparison. To summarize:-

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

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

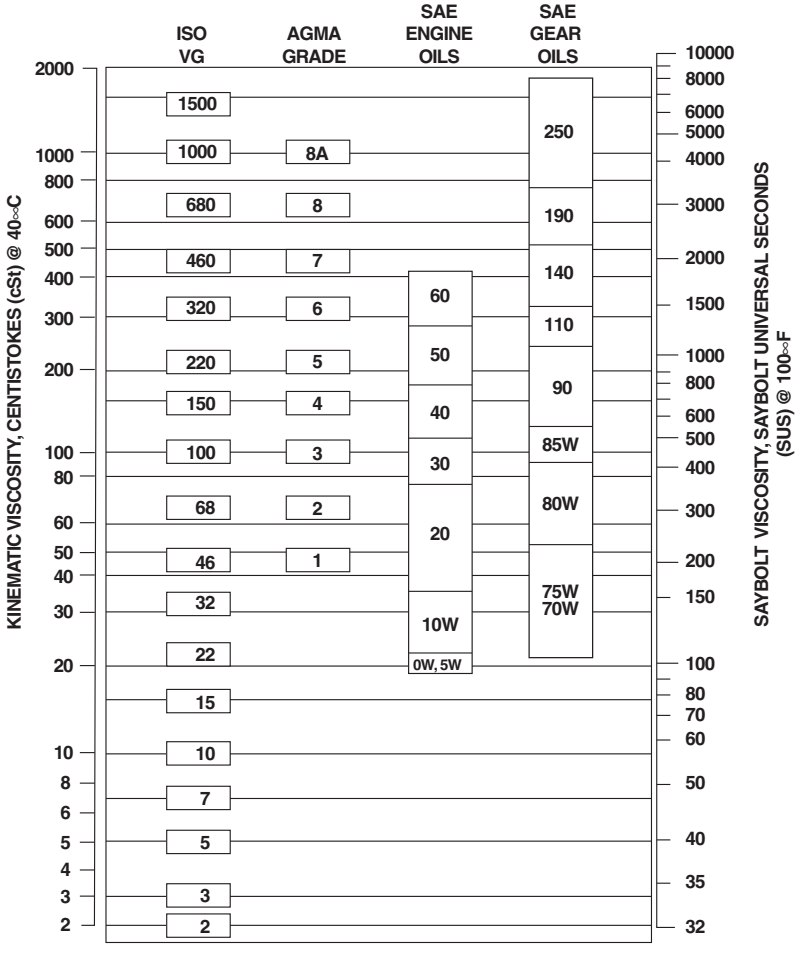
SAE – Society of Automotive Engineers viscosity measurement for automotive engine and gear oils e.g. SAE 30, SAE 90, etc.

Saybolt – These units are in S.U.S. and were used by various refiners/blenders to specify viscosity at 100°F or 210°F.

How to use the chart:

For instance, if a manufacturer requires an SAE 30 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 100.

VISCOSITY EQUIVALENTS



NOTE:

- Read across horizontally.
- Assumes 96 VI single grade oils.
- Equivalence is in terms of viscosity at 40°C only.
- Viscosity limits are approximate: For precise data, consult ISO, AGMA and SAE specifications.
- W grades are represented only in terms of approximate 40°C viscosity. For low temperature limits, consult SAE specifications.

INDUSTRIAL LUBRICANTS

ACCUFLO™ TK - MACHINE TOOL LUBRICANT

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 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 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 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 and 220 are GM LS2 approved, meet ISO-L-G standards, and are approved against Cincinnati Machine standards 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	ACCUFLO™ TK 220
Viscosity cSt @ 40°C	71	217
cSt @ 100°C	9.9	21
SUS @ 100°F	367	1136
SUS @ 210°F	60	107
Viscosity Index	122	118
Flash Point, °C / °F	225/437	255/491
Pour Point, °C / °F	-33/-27	-24/-11
Stick-slip No.	0.76	0.80
Weld Point, kg / lb	200/441	250/551

ACCUFLO™ SS - PRESS OIL AND MACHINE TOOL LUBRICANT

ACCUFLO™ SS is specifically formulated to meet the lubrication requirements of both Goss International and MAN Roland printing presses.

- Meets the requirements of Goss Graphic Systems Service Bulletin "SBM 5078 Lubricating Oil Guidelines" (16/02/00) for Cosmo, Metro, Metroliner, Headliner, Colorliner and Metrocolour models.
- Meets specification standard CLP DIN 51517-3:2004-01 ISO VG 68 (MAN Roland Illustration Machines, Geoman and Colorman models.)

ACCUFLO™ SS 68 is recommended for use in commercial printing machines for the lubrication of units, folders, angle bars and horizontal drive gear boxes.

ACCUFLO™ SS 68 can also be used to lubricate the linear and rotating guideways, and elevating slideways of machine tools. It meets the Cincinnati Machine P-47 specification.

Typical characteristics are shown below:

		ACCUFLO™ SS 68
Viscosity	**cSt @ 40°C**	74.3
	cSt @ 100°C	9.5
	SUS @ 100°F	385
	SUS @ 210°F	58
Viscosity Index		104
Flash Point, °C / °F		229/444
Pour Point, °C / °F		-33/-27
Stick-slip No.		0.78
Weld Point, kg / lb		200/441

PC WAYLUBE - MACHINE TOOL LUBRICANT

PC Waylube is formulated for the lubrication of the slideways of modern machine tools. It is approved against Cincinnati Machine Standard P-47 and GM LS2. PC Waylube is also approved for Bijur systems and passes Bijur's filtration test #2107.

Where greater oil adhesion is required, such as with vertical ways, we recommend Petro-Canada's ACCUFLO™ TK machine tool lubricants.

Typical characteristics are shown below:

		PC Waylube 68
Viscosity	**cSt @ 40°C**	69.7
	cSt @ 100°C	9.5
	SUS @ 100°F	360
	SUS @ 210°F	58
Viscosity Index		115
Flash Point, °C / °F		235/455
Pour Point, °C / °F		-27/-17
Stick-slip No.		0.79
Weld Point, kg / lb		200/441

ARDEE™ - ROCK DRILL OIL

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 for winter conditions, ARDEE™ 68 to 150 for underground operations, with the 150 grade being favoured in SECAN drills and in mining operations trying to reduce oil consumption and misting. ARDEE™ 220 is normally used in summer, in open pit operations using drills with a bore larger than 10 cm / 4 inches.

ARDEE™ 32 is recommended for use in plant air-line lubricators, especially where the air is water laden.

Typical Characteristics are shown below:

		ARDEE™ Oil					
		32	**46**	**68**	**100**	**150**	**220**
Viscosity	**cSt @ 40°C**	31.8	45.0	71.7	96.4	149	207
	cSt @ 100°C	6.0	7.4	9.9	11.5	15.0	19.0
	SUS @ 100°F	163	230	369	500	778	1089
	SUS @ 210°F	46	51	60	66	80	97
Viscosity Index		137	129	119	107	101	103
Flash Point, °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, kg/lb		20/9	30/14	30/14	30/14	30/14	30/14
Weld Point, kg		200	200	200	200	250	250

CALFLO™, PETROTHERM™ AND PURITY™ FG – HEAT TRANSFER FLUIDS

CALFLO™ is a line of specialty heat transfer fluids produced from Petro-Canada's 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 Petro-Canada 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.
- 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 while remaining 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 with outstanding oxidative stability and volatility control. CALFLO™ Synthetic can also be used as a 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 may be found on **page 165**.
- PETRO-THERM™ and PETRO-THERM™ PPD Heat Transfer Fluid are general purpose fluids which provide economical service in various industrial processes. More details on these fluids may be found on **page 115**.

In addition to heat transfer fluids, Petro-Canada offers two additional products for servicing heat transfer systems: Petro-Canada Cleaning Fluid and Petro-Canada Flushing Fluid. Details regarding the use of these fluids may be found on **pages 112 and 113**.

Typical Characteristics are shown below:

	CALFLO™ Heat Transfer Fluid			Synthetic	PURITY™ FG
	HTF	AF	LT		HTF
Viscosity cSt @ 40°C	35.9	32.1	7.5	5.3	37.1
cSt @ 100°C	6.0	5.4	2.2	1.75	5.9
SUS @ 100°F	185	166	52.1	44.2	191.4
SUS @ 210°F	45.9	43.9	33.5	31.9	45.6
Viscosity Index	100	99	103	N/A	98
Flash Point, COC, °C / °F	231/448	225/437	176/349	163/325	237/459
Pour Point, °C / °F	-18/0	-42/-44	<-57°C/<-70°F	<-57°C/<-70°F	-18/0
Autoignition Temp, °C / °F	352/666	343/649	323/613	320/608	354/669
Max Bulk Temp °C / °F	326/619	316/600	288/550	N/A	326/619

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 four viscosity grades to cover a majority of air compressor requirements. 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 reciprocating compressors to a maximum of 500 hours at air discharge temperatures up to 150°C/302°F, in vane compressors to a maximum of 500 hours at air discharge temperatures up to 85°C/185°F, and in centrifugal compressors for 2 years at air discharge temperatures up to 50°C/122°F.

Air-cooled screw compressors in continuous service or operating at elevated discharge temperatures should use COMPRO XL-S or COMPRO™ Synthetic or SYNDURO™ SHB 32 or 46 Fluids for extended life.

		COMPRO™ Compressor Fluid			
		32	**68**	**100**	**150**
Viscosity	**cSt @ 40°C**	36	68	101	150
	cSt @ 100°C	5.7	8.7	11.2	14.3
	SUS @ 100°F	186	353	527	790
	SUS @ 210°F	45	55	64	76
Viscosity Index		96	98	97	93
Flash Point, °C / °F		215/419	238/460	260/500	264/507
Pour Point, °C / °F		-39/-38	-30/-22	-18/0	-12/+10
Conradson Carbon No., % Wt		0.01	0.02	0.03	0.06

NOTE: 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.**

COMPRO™ XL-S - ROTARY SCREW AIR COMPRESSOR FLUID

COMPRO™ XL-S Compressor Fluids are formulated to extend compressor fluid life in rotary screw industrial 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. 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 reciprocating compressors to a maximum of 500 hours at air discharge temperatures up to 150°C, rotary vane compressors to a maximum of 1,000 hours at air discharge temperatures up to 85°C, and in centrifugal compressors for 3 years at air discharge temperatures up to 50°C.

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	14.1	16.1
	SUS @ 100°F	188	243	363	517	763
	SUS @ 210°F	46.0	50.2	65.6	75.0	83.6
Viscosity Index		107	114	157	143	115
Flash Point, °C / °F		243/469	241/466	271/520	263/505	287/549
Pour Point, °C / °F		-42/-44	-42/-44	-36/-33	-27/-17	-24/-11
Ramsbottom Carbon, % Wt		0.04	0.05	0.02	0.05	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™ XL-R - RECIPROCATING AIR COMPRESSOR FLUID

COMPRO™ XL-R has been specifically developed for single and multi-stage reciprocating air compressors, particularly those with high air-discharge temperatures.

COMPRO™ XL-R is recommended for use in both the cylinder and crankcase of air compressors, where it may reduce varnish and carbon build up on valves and inter-coolers. COMPRO™ XL-R matches or exceeds the service intervals of competitive diester lubricants, but without their obnoxious odours. It is also fully compatible with petroleum oils and diesters, although significant dilution will reduce its performance.

COMPRO™ XL-R is recommended for use in reciprocating compressors to a maximum of 2,000 hours at air discharge temperatures up to 150°C.

COMPRO™ XL-R meets the requirements of DIN 51506 VDL.

Typical Characteristics are shown below:

		COMPRO™ XL-R Compressor Fluid
Viscosity	**cSt @ 40°C**	67
	cSt @ 100°C	8.3
	SUS @ 100°F	348
	SUS @ 210°F	53.8
Viscosity Index		91
Flash Point, °C / °F		236/457
Pour Point, °C / °F		-18/0
Conradson Carbon No., % Wt		0.01

Note: Do not use in breathing air apparatus or medical equipment. COMPRO™ XL-R reciprocating 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 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. COMPRO™ Synthetic will last four times longer than a conventional mineral oil based fluid - up to one year continuous service or 8,000 hours. (NOTE: This is a Polyalkylene Glycol / ester blend and should never be mixed with conventional mineral oils or Poly Alpha Olefin synthetics.)

Typical Characteristics are shown below:

		COMPRO™ Synthetic Compressor Fluid
Viscosity	**cSt @ 40°C**	40.7
	cSt @ 100°C	7.6
	SUS @ 100°F	207.0
	SUS @ 210°F	51.3
Viscosity Index		157
Flash Point, °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.**

COMPRESSOR OIL RP
NATURAL GAS COMPRESSOR OIL

Compressor Oils RP 268 and RP 460 are specially designed for the lubrication of cylinders and rod packings in natural gas 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 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	252	405
cSt @ 100°C	20.9	28.6
SUS @ 100°F	1335	2163
SUS @ 210°F	105	140
Viscosity Index	98	98
Flash Point, °C / °F	270/518	280/536
Pour Point, °C / °F	-18/0	-15/+5
Conradson Carbon No., % Wt	1.04	1.14

Note: In selecting a compressor oil it is important to know not only the equipment manufacturer and model, but also the gas being compressed. 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
• Inert – Argon, Carbon Dioxide, Carbon Monoxide, Hydrogen, Helium, Neon, Nitrogen, Blast Furnace Gas.	Same as for air.
• Hydrocarbon Gases – Methane, Acetylene, Ethane, Propane, Butane, Coke Oven Gas.	Same as for natural gas.
• Chemically Active – Chlorine, Oxygen, Hydrogen Chloride.	No petroleum lubricant.
• Ammonia	REFLO™ 46A, 68A, REFLO™ 68 Synthetic REFLO™ XL Synthetic Blend

COMPRESSOR CLEANER

Compressor Cleaner is a synthetic fluid, formulated to dissolve the varnish and sludge found in air compressors. Compressor Cleaner may also be used as an air compressor lubricant for up to 400 hours. It is an ideal flushing fluid for older heavily varnished air compressors using mineral oils or diester fluids, and highly recommended when converting to Petro-Canada's COMPRO™ XL-S Compressor Fluid from non-compatible fluids such as polyglycol synthetics.

Typical Characteristics are shown below:

		Compressor Cleaner
Viscosity	**cSt @ 40°C**	42.6
	cSt @ 100°C	5.9
	SUS @ 100°F	221
	SUS @ 210°F	45.7
Flash Point, °C / °F		230/446
Pour Point, °C / °F		-27/-17

Note: Do not use in breathing air apparatus or medical equipment. COMPRESSOR CLEANER 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 COMPRESSOR CLEANER must not be used.**

CON-REL-EZE™ – CONCRETE FORM OIL

CON-REL-EZE™ oils are formulated to provide an excellent stain-free finish on concrete and clean, quick release characteristics for plywood, metal, fibreglass and plastic forms. These products afford excellent rust protection to metal forms and are compatible with most caulking compounds.

CON-REL-EZE™ 40 and 60 grades are ready-to-use, light viscosity oils for spraying on forms.

CON-REL-EZE™ 40 and 60 may also be used for rust protection of machinery and as penetrating oils on nuts and bolts.

Typical Characteristics are shown below:

		CON-REL-EZE™	
		40	**60**
Viscosity	**cSt @ 40°C**	3.7	4.1
	SUS @ 100°F	37	39.5
Flash Point, °C / °F		52/126	53/127
Pour Point, °C / °F		-45/-49	-30/-22
Rust Test		pass	pass

Note: The flash point method used for CON-REL-EZE™ 40 & 60 is ASTM D56

DURATAC™ OILS

DURATAC™ Oils are an economical, tacky, “once-through” line of lubricants for use in hand oiling of drive chains, log decks, waste conveyors, infeed and other sawmill chains as well as chain saw bars, or in lubricating leaky, slow-speed journal bearings. Their tackiness helps to reduce dripping and throw-off whilst in use.

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 °C / °F	190/374	210/410	210/410	210/410
Colour	Dark Red	Brown	Brown	Dark Red
Rust, A & B, 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

DURATAC™ NON-DRIP OILS – CHAIN OIL

Petro-Canada Non-Drip Oil is a high quality lubricant, formulated with a tackiness additive that adheres strongly to metal surfaces. This feature, together with anti-wear plus rust and oxidation protection, makes it an ideal lubricant for use where oil control is required, such as conveyor chains. Because of its light colour it can also be used where the use of a dyed chain oil is undesirable.

Due to its tacky nature, it is not recommended for use in drip-feed oilers.

Typical Characteristics are shown below:

	Non Drip Oil				
	32	**68**	**100**	**150**	**220**
Viscosity cSt @ 40°C	29	69	105	155	220
cSt @ 100°C	6.0	10.3	13.1	17.4	21.1
SUS @ 100°F	137	320	487	718	1019
SUS @ 210°F	46	60	71	88	103
Viscosity Index	159	135	121	123	114
Flash Point, °C / °F	204/339	220/428	256/493	255/491	265/509
Pour Point, °C / °F	-39/-38	-27/-17	-27/-17	-27/-17	-24/-11

ENDURATEX™ EP & ENDURATEX™ XL SYNTHETIC BLEND

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

ENDURATEX™ XL Synthetic Blend are multi-grade EP gear oils designed to eliminate seasonal change-outs and provide equipment protection all year long-available in 68/150 and 68/220 grades. 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 68 has Metso Paper approval and is recommended for pulp and paper companies using thermo-mechanical pulping processes (TMP).

ENDURATEX™ EP Gear Oils are typically suitable for use in situations requiring DIN 51517 Part 3, ISO 12925 – Type 1 CKC or AGMA 9005-E02, and US Steel 224 specifications.

Typical Characteristics are shown below:

	32	68	100	150	220	320	460	680	1000	XL Syn BL 68/150	XL Syn BL 68/220
AGMA Number	-	2EP	3EP	4EP	5EP	6EP	7EP	8EP	8AEP	3EP	4EP
Density, kg/L @ 15°C/59°F	0.847	0.863	0.872	0.879	0.884	0.895	0.902	0.909	0.902	0.868	0.869
Colour	1.0	1.0	1.0	2.5	3.0	3.5	4.0	8.0	8.0	<1.0	1.0
Viscosity											
cSt @ 40°C	32.0	68.0	101	150	220	320	452	666	990	98	152
cSt @ 100°C	6.0	9.1	11.3	14.7	19.0	23.8	29.7	34.5	55	14.3	22.2
SUS @ 100°F	166	351	527	776	1163	1750	2425	3695	5340	503	784
SUS @ 210°F	46	56	64	77	96	118	145	174	265	76	110
Viscosity Index	136	109	97	97	97	94	94	82	100	149	174
Flash Point, °C/°F	224/435	240/464	240/464	260/500	262/500	252/486	261/502	249/480	249/480	250/482	251/484
Pour Point, °C/°F	-51/-60	-39/-38	-33/-27	-33/-27	-27/-17	-21/-6	-15/5	-15/5	5/41	-39/-38	-33/-27
FZG (stages)	12+	12+	12+	12+	12+	12+	12+	12+	13	12+	12+
Oxidation Stability % Viscosity Increase 312 hours, 121°C / 250°F	3.7	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™ WG Oils		
	460	**680**	**1000**
Viscosity cSt @ 40°C	459	676	892
cSt @ 100°C	28.2	34.8	41.2
SUS @ 100°F	2,270	3,495	4,729
SUS @ 210°F	129	162	189
Viscosity Index	83	82	82
Flash Point, °C / °F	305/582	315/601	311/594
Pour Point, °C / °F	-3/+27	-3/+27	-3/+27
AGMA No.	7 Comp	8 Comp	
Compounding, % Wt	5	5	5

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ENDURATEX™ SYNTHETIC EP

ENDURATEX™ Synthetic EP are premium performance, extreme pressure lubricants designed for enclosed industrial gears and bearings operating under severe load conditions and in wide extremes of temperature. 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 temperatures. This often allows the use of a lower ISO grade than with conventional gear oils. ENDURATEX™ Synthetic EP gear lubricants meet the requirements of US Steel 224, DIN 51517-3, David Brown S1.53.101 Type E, Cincinnati Machine P-74, Eickhoff Gear, Jahnel Kestermann, Flender Industrial Gear and qualify as premium synthetic EP gear lubricants. ENDURATEX™ Synthetic EP oils can be used when AGMA antiscuff/antiwear Extreme Pressure (EP) Gear lubricants are required.

ENDURATEX™ Synthetic EP oils are listed on Flender's BA7300 Recommended Lubricants List and are suitable for use in GE787/788 and GA880 units.

Typical Characteristics are shown below:

	ENDURATEX™ Synthetic EP			
	150	**220**	**320**	**460**
AGMA No.	4EP	5EP	6EP	7EP
Viscosity cSt @ 40°C	150	223	323	501
cSt @ 100°C	19.5	26.4	34.9	49.9
SUS @ 100°F	772	1,152	1,676	2,607
SUS @ 210°F	98	130	169	241
Viscosity Index	148	151	153	160
Temp for 150,000 cP, °C/ °F	-41/-42	-36/-33	-32/-26	-24/-11
Flash Point, °C / °F	232/450	235/455	237/459	237/459
Pour Point, °C / °F	-54/-65	-48/-54	-42/-44	-42/-44
Timken OK Load, kg/lb	48/106	48/106	48/106	48/106
FZG Load Stage Pass (A/8.3/90)	14	14	14	14

ENVIRON™ AW HYDRAULIC FLUIDS

Petro-Canada's ENVIRON™ AW monograde 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 reduces sludge and varnish deposits.

ENVIRON™ AW fluids are approved against the following hydraulic equipment manufacturers' specifications: Parker/Denison HF-0, Cincinnati-Machine P-68 (AW 32), P-69 (AW 68) and P-70 (AW 46) and Bosch-Rexroth.

ENVIRON™ AW is recommended for use in equipment manufactured by Eaton/Vickers M-2950-S and I-286-S, Parker/Denison, Sauer-Danfoss, (Mannesman) Bosch-Rexroth, Racine, Oilgear, Hydreco, Dynex and others. It is also recommended against GMLS2 specifications.

ENVIRON™ AW 32, 46, 68 are suitable for use when a DIN 51524 Part 2 HLP or ISO 6743/4 Type HM fluid is called for.

Typical Characteristics are shown below:

		ENVIRON™ AW		
		32	**46**	**68**
Viscosity	**cSt @ 40°C**	32.2	46.1	67.9
	cSt @ 100°C	5.4	6.8	8.7
	SUS @ 100°F	166	237	352
	SUS @ 210°F	44	49	55
Viscosity Index		101	101	101
Flash Point, °C / °F		233/451	227/441	253/487
Pour Point, °C / °F		-42/-44	-36/-27	-33/-27
Oxidation Stability, hours to 2.0 TAN		10,000+	10,000+	5,000+

ENVIRON™ MV WIDE TEMPERATURE HYDRAULIC FLUIDS

Petro-Canada's ENVIRON™ MV multigrade 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 viscometric, energy conserving formula helps your bottom line.

ENVIRON™ MV are recommended for use in equipment manufactured by Eaton/Vickers(M-2950-S and I-286-S), Parker/Denison, Sauer-Danfoss, (Mannesman) Bosch-Rexroth, Racine, Oilgear, Hydreco, Dynex and others. ENVIRON™ MV 32, 46 are suitable for use when a DIN 51524 Part 3 HVLP or ISO 6743/4 Type HV fluid is called for.

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 reduces sludge and varnish deposits.

ENVIRON™ MV fluids are approved against the following hydraulic equipment manufacturers' specifications: Parker/Denison HF-0 and Bosch-Rexroth. They are also classified as NSF International H2 fluids.

Typical Characteristics are shown below:

		ENVIRON™ MV 32	ENVIRON™ MV 46
Viscosity cSt @ 40°C		34	44
cSt @ 100°C		6.5	8.0
SUS @ 100°F		166	222
SUS @ 210°F		48	52
Viscosity Index		159	156
Flash Point, °C / °F		220/428	250/482
Pour Point, °C / °F		-45/-49	-45/-49
Oxidation Stability, hours to 2.0 TAN		10,000+	10,000+
Min. Start-up Temperature[1], °C / °F		-34/-29	-30/-22
Operating Temp. Range[2],			
Mobile Equipment	**°C**	-15 to 76	-10 to 84
	°F	5 to 169	14 to 183
Industrial Machinery	**°C**	-15 to 66	-10 to 78
	°F	5 to 151	14 to 172

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

[2]Operating temperature limits are determined by the equipment manufacturer. Petro-Canada 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.

HARNEX™ WIND TURBINE GEAR OIL

HARNEX™ is a premium ISO 320 synthetic gear lubricant designed to provide exceptional anti-wear/EP performance and protection from salt water corrosion in wind turbine applications. The product uses synthetic PAO base oils, known for their excellent viscosity index and low pour point properties. With its outstanding protection, HARNEX™ can be used for lubricating both onshore and offshore wind turbine gearboxes.

HARNEX™ meets the following industry requirements: AGMA 9005-E02, DIN 51517-3 (CLP 320), ISO 12925-1 Type CKD, ISO 12925 Type CDK, Eickhoff, Hansen Transmissions, Bosch Rexroth Getriebetechnik, Jahnel Kestermann, Moventas & Winergy AG (Wind Turbine Division of Flender).

Typical Characteristics are shown below:

	HARNEX™ 320
Density@15°C	0.862
Viscosity cSt @ 40°C	323
cSt @ 100°C	34.9
SUS @ 100°F	1,677
SUS @ 210°F	168
Viscosity Index	153
Flash Point, COC, °C/°F	237/458
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, mm	0.33
FZG Scuffing Test A/8.3/90	14
FZG Scuffing Test A/16.6/90	14
FZG Micropitting Test @ 60°C	Fail 10
FZG Micropitting Test @ 90°C	Fail 10
FAG FE8 Test (Stages 1,2,3,4)	Pass

Note: Users should refer to Tech Bulletin **TB-1257** for detailed change-out procedure and **TB-1263** for the list of recommended lubricants for wind turbines.

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 extends drain intervals and protects against corrosion and varnish. They also minimizes harmful sludge build up in the reservoir that can lead to shortened oil life and equipment wear. Rust protection properties minimize the possibility of corrosion and reduce equipment maintenance and downtime, while excellent water separability and hydrolytic stability allows the oil to be reused.

HYDREX™ AW fluids are approved against the following hydraulic equipment manufacturers' specifications: Parker/Denison HF-0 (AW 32, 46, 68, 80, 100), Eaton/Vickers M-2950-S and I-286-S, Cincinnati-Machine P-68 (AW 32), P-69 (AW 68) and P-70 (AW 46), Bosch-Rexroth (AW 22, 32, 46, 68, 100), and Marlen Hydraulic Power Unit (AW 68).

HYDREX™ AW fluids are recommended for use in equipment manufactured by Eaton/Vickers, Parker/Denison, Sauer-Danfoss, Bosch-Rexroth, Racine, Oilgear, Hydreco, Dynex and others.

HYDREX™ AW 46 is recommended for use in injection moulding equipment manufactured by: Husky, Krauss-Maffei, Battenfeld, Demag, Soplar, Engel and Nestal.

HYDREX™ AW 32, 46, and 68 are GMLS2 approved and classified as CFIA Type N2 (AW 80 and 100 are also CFIA Type N2).

HYDREX™ AW fluids are classified as NSF International H2.

HYDREX™ is suitable for use where the following specifications are required: DIN 51524 Part 1 HL (AW 22), DIN 51524 Part 2 HLP (AW 32, 46, 68, 80, and 100), ISO 6743/4 Type HM, and USS 127.

Typical Characteristics are shown below:

	HYDREX™ AW					
	22	**32**	**46**	**68**	**80**	**100**
Viscosity cSt @ 40°C	21.6	31.5	45.7	67.6	80	100
cSt @ 100°C	4.3	5.3	6.7	8.9	9.7	11.3
SUS @ 100°F	106	151	219	350	389	440
SUS @ 210°F	40	43	49	56	60	63
Viscosity Index	101	103	105	115	99	99
Flash Point, °C / °F	207/405	217/423	227/441	225/437	245/473	250/482
Pour Point, °C / °F	-45/-49	-39/-38	-33/-27	-33/-27	-24/-11	-30/-22
Oxidation Stability, hours to 2.0 TAN	6500+	6500+	6500+	6500+	6500+	6500+

HYDREX™ MV- WIDE TEMPERATURE RANGE HYDRAULIC FLUIDS

HYDREX™ MV are premium performance, 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. Its viscometric energy efficient formula helps your bottom line.

HYDREX™ MV fluids are approved for use in equipment manufactured by Bosch-Rexroth (MV 22, 36, 60) and are recommended for use in equipment manufactured by Eaton/Vickers, Parker/Denison, Sauer-Danfoss, Oilgear, Hydreco, Dynex and others. HYDREX™ MV fluids meet the following manufacturers' specifications: Parker/Denison HF-0 and Eaton/Vickers M-2950-S and I-286-S. HYDREX™ MV is suitable for use where the following specifications are required: USS 127, ISO 6743/4 Type HV, DIN 51524 Part 3 HLVP (MV 22 & 36), and DIN 51524 Part 2 HLP (MV 60). All HYDREX™ MV fluids are classified as NSF International H2, and HYDREX™ MV 36 is classified as CFIA Type N2.

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 -45°C (-49°F) under no-load conditions. It is also readily biodegradeable as measured by the CEC L-33-A-93 test 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 36**	**MV 60**
Viscosity cSt @ 40°C		13.4	21.7	32.3	58
cSt @ 100°C		5.16	5.0	6.3	9.0
SUS @ 100°F		73.6	112	165	297
SUS @ 210°F		43.1	42.7	47.3	56.5
Viscosity Index		383	168	148	132
Flash Point, °C / °F		128/262	208/406	226/439	214/417
Pour Point, °C / °F		-48/-54	-51/-60	-48/-54	-42/-44
Oxidation Stability hours to 2.0 TAN		3000	7000+	7000+	7000+
Min. Start-up Temperature[1], °C / °F		-45/-49	-41/-42	-35/-31	-26/-15
Operating Temp. Range[2]					
Mobile Equipment	**°C**	-44 to 23	-25 to 64	-18 to 77	-5 to 91
	°F	-47 to 73	-13 to 147	0 to 171	23 to 196
Industrial Machinery	**°C**	-44 to 23	-25 to 57	-18 to 66	-5 to 83
	°F	-47 to 73	-13 to 135	0 to 151	23 to 181

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

[2]Operating temperature limits are determined by the equipment manufacturer. Petro-Canada 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.

HYDREX™ XV – ALL SEASON HYDRAULIC FLUID

HYDREX™ XV All Season is an advanced formula, long life, 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 -40°C (-40°F) and it will continue to perform well at operating temperatures as high as 79°C (174°F). HYDREX™ XV gives excellent results in a wide range of industrial machinery and mobile equipment used in such industries as woodlands, construction, mining, public utility and marine operations. Its viscometric energy efficient formula helps your bottom line.

HYDREX™ XV helps eliminate the need to change hydraulic oil seasonally. HYDREX™ XV is approved for use in equipment manufactured by Bosch-Rexroth and is recommended for use in equipment manufactured by Eaton/Vickers, Parker/Denison, Sauer-Danfoss, Racine, Oilgear, Hydreco, Dynex and others.

HYDREX™ XV is suitable for use where the following specifications are required: Parker/Denison HF-0, Eaton/Vickers M-2950-S and I-286-S, USS 127 Specification, DIN 51524 Part 3 HVLP, and ISO 6743/4 Type HV.

Typical Characteristics are shown below:

		HYDREX™ XV
Viscosity	**cSt @ 40°C**	43.2
	cSt @ 100°C	10.5
	SUS @ 100°F	215
	SUS @ 210°F	61
Viscosity Index		245
Flash Point, °C / °F		245/473
Pour Point, °C / °F		-48/-54
Oxidation Stability, hours to 2.0 TAN		10,000+
Min. Start-up Temperature[1], °C / °F		-40/-40
Operating Temperature Range[2],		
Mobile Equipment	**°C**	-18 to 79
	°F	0 to 174
Industrial Machinery	**°C**	-18 to 75
	°F	0 to 167

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

[2]Operating temperature limits are determined by the equipment manufacturer. Petro-Canada 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 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 for high and severe low temperatures. 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 (SUS @ 100°F)		33.6 (167)
cSt @ 100°C (SUS @ 210°F)		13.0 (76.6)
cP @ -45°C (-49°F)		2985
Viscosity Index		403
Flash Point, °C (°F)		141 (285)
Pour Point, °C (°F)		-54 (-65)
Oxidation Stability, hours to 2.0 TAN		5000+
Start-up Temperatures[1], °C (°F)		-45 (-49)
Operating Temp. Range[2],		
Mobile Equipment	**°C**	-32 to 79
	°F	-26 to 174
Industrial Machinery	**°C**	-32 to 64
	°F	-26 to 147

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

[2]Operating temperature limits are determined by the equipment manufacturer. Petro-Canada 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 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 contains a detergent/dispersant package to keep systems clean. 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	46.1
cSt @ 100°C	6.8
SUS @ 100°F	215
SUS @ 210°F	49
Viscosity Index	102
Flash Point, °C / °F	225/437
Pour Point, °C / °F	-30/-22
Oxidation Stability, Hours to 2.0 TAN	5000+

LUMINOL™ ELECTRICAL INSULATING FLUIDS

Petro-Canada's LUMINOL™ family of electrical insulating fluids represents a breakthrough in electrical insulating fluids technology. Unlike naphthenic mineral oils, LUMINOL™ uses Petro-Canada's ultra-pure severely hydrotreated isoparaffin base fluids to deliver worry-free, corrosive sulphur-free performance in your transformer.

LUMINOL™ TR, LUMINOL™ TRi and LUMINOL™ Bi are ideal for use in large power and distribution transformers operating at peak capacity as well as free-breathing units, pole and pad mount transformers. LUMINOL™ electrical insulating fluids are suitable for commercial, industrial and institutional applications:

- LUMINOL™ TR and LUMINOL™ TRi meet or exceed the performance requirements of CAN/CSA-C50 (Class A and B), ASTM D3487 standards, and DOBLE TOPS specifications.
- LUMINOL™ TR is designed for Type I and Type III applications and meets International Electrotechnical Commission, IEC 60296 General specifications for trace inhibited transformer oil.
- LUMINOL™ TRi is designed for Type II and Type IV applications and meets IEC 60296 General specifications for inhibited transformer oil.
- LUMINOL™ Bi is designed for Type II applications and meets or exceeds the performance requirements of ASTM D3487, CAN/CSA-C50 Class B Standards, and DOBLE TOPS specifications.
- LUMINOL™ Bi meets IEC 60296 General specifications for inhibited transformer oil.
- LUMINOL™ is approved for applications requiring Ontario Hydro M-104.

Typical Characteristics are shown below:

	LUMINOL™ TR	LUMINOL™ TRi	LUMINOL™ Bi
Viscosity cSt @ 40°C	9.2	9.2	9.0
cSt @ 0°C	53	53	48
cSt @ -40°C	1,230	1,230	<2,500
Flash Point, °C/°F	170/338	170/338	>160/>320
Pour Point, °C/°F	-60/-76	-60/-76	<-40/<-40
Dielectric breakdown voltage @ 60Hz,kV	55	55	55
Power Factor @ 60Hz, 100°C	0.01	0.01	0.01
Interfacial Tension, 25°C, mN/m	48	48	48

NGS SYNTHETIC BLEND COMPRESSOR FLUIDS

NGS Synthetic Blend compressor fluids are a combination of hydrotreated (HT) and polyalphaolefin (PAO) base fluids, fortified with corrosion inhibitor, lubricity improver and antifoam additives. It is specifically designed for flooded screw compressors handling the lightest hydrocarbon gases, (methane and ethane) where the expected dilution is **less than** 10% by weight, and where natural gas liquids are not significantly present. NGS 1000 and NGS 1500 will handle sour gas systems, and have excellent low temperature properties. By contrast, our SPX 5000 and 7000 compressor lubricants are designed for use where propanes and butanes or some natural gas liquids may be present alongside methane and ethane. SPX 5000 is designed for compression of sweet hydrocarbon gas mixtures and SPX 7000 and 7068 can be used for sour natural gas.

Typical Characteristics are shown below:

	NGS 1000	NGS 1500
Viscosity cSt @ 40°C	101	160
cSt @ 100°C	13.2	19.5
SUS @ 100°F	519	826
SUS @ 210°F	72.4	98.1
Viscosity Index	129	140
Flash Point, °C / °F	249/480	261/502
Pour Point, °C / °F	-43/-45	-42/-44

PETRO-CANADA CLEANING FLUID FOR HEAT TRANSFER SYSTEMS

Petro-Canada Cleaning Fluid is specially designed to clean dirty or heavily carbonized systems which have been operating on aromatic based or mineral based heat transfer fluids. 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 Petro-Canada Cleaning Fluid is 100°C (212°F). It should be used along with Petro-Canada Flushing Fluid to thoroughly clean and rinse dirty systems.

Typical Characteristics are shown below:

	CLEANING FLUID
Density, kg/L @ 15°C	0.924
Colour	<2
Flash Point, COC, °C / °F	145/293
Viscosity cSt @ 40°C	4.7
cSt @ 100°C	1.6
SUS @ 100°F	42.2
SUS @ 210°F	31.2
Pour Point, °C / °F	-15/-5
Water Separability, 54°C, ml water, (min)	40/5
GC Distillation, 10% °C / °F	263/505
GC Distillation, 90% °C / °F	335/635

PETRO-CANADA FLUSHING FLUID

Petro-Canada Flushing Fluid is 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. It operates effectively as a mechanical flushing agent for heat transfer systems changing over to CALFLO™ from other non-compatible materials. It is completely compatible with hydrocarbon based lubricants and with all grades of CALFLO™ Heat Transfer Fluids.

Typical Characteristics are listed below:

	Flushing Fluid
Density, kg/l @ 15°C	0.864
Flash Point, COC, °C / °F	222/432
Viscosity cSt @ 40°C	35.6
SUS @ 100°F	184
Pour Point, °C / °F	-18/0

PETROGLIDE™ - SAW GUIDE OIL

Petro-Canada's 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 excellent extreme pressure properties reduce friction and metal to metal contact decreasing heat build-up and wear on both saw guides and blades to help minimize saw deviation.

Typical Characteristics are shown below:

	PETROGLIDE™		
	68	**100**	**150**
Viscosity cSt @ 40°C	75.1	114	175
cSt @ 100°C	10.8	14.1	17.3
SUS @ 100°F	375	591	918
SUS @ 210°F	86.2	75.8	89.2
Viscosity Index	133	123	106
Flash Point, °C / °F	230/456	268/514	252/486
Pour Point, °C / °F	-42/-44	-36/-33	-36/-33
Four Ball EP Weld Load, kg	200	200	200

PETROGLIDE™ MC 32 - BANDSAW OIL

Petro-Canada's PETROGLIDE™ MC 32 is a premium quality bandsaw oil specially designed for mist lubricated bandsaws. Its tackiness and mist control is carefully balanced to effectively lubricate without excessive stray mist minimizing oil usage and contributing 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 guide oil.

Typical Characteristics are shown below:

	PETROGLIDE™ MC 32
Viscosity cSt @ 40°C	32
cSt @ 100°C	6.0
SUS @ 100°F	164
SUS @ 210°F	46
Viscosity Index	130
Flash Point, °C/°F	190/374
Pour Point, °C/°F	<-54/<-65
Four Ball EP Weld Point, kg	200
Tackiness Level, %	3

PETROGLIDE™ XP 90 - HIGH PERFORMANCE SAW GUIDE OIL

Petro-Canada's PETROGLIDE™ XP 90 is a premium quality, inherently biodegradable and environmentally sensitive saw guide oil designed for use with multi-blade gang saws and edgers to provide increased recovery and productivity. PETROGLIDE™ XP 90 is formulated to provide optimum tackiness for less wash-off and better lubricity to reduce oil consumption and increase energy efficiency. PETROGLIDE™'s excellent extreme pressure properties reduce friction and metal to metal contact decreasing heat build-up and wear on both saw guides and blades to help minimize saw deviation.

Typical Characteristics are shown below:

	PETROGLIDE™ XP90
Viscosity cSt @ 40°C	91
cSt @ 100°C	16.7
SUS @ 100°F	459
SUS @ 210°F	86
Viscosity Index	200
Flash Point, °C / °F	209/408
Pour Point, °C / °F	-48/-54
Four Ball EP Weld Load, kg	400
Tackiness Level, %	71

PETRO-THERM™ / PETRO-THERM™ PPD – HEAT TRANSFER OIL

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

PETRO-THERM™ PPD is recommended for initial start-ups in cold temperatures down to -16°C (3°F) (based on a 2000 cSt maximum viscosity).

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™	PETRO-THERM™ PPD
Viscosity	**cSt @ 40°C**	35.8	34.8
	cSt @ 100°C	5.7	5.7
	SUS @ 100°F	185	179
	SUS @ 210°F	44.9	44.9
Viscosity Index		95	100
Flash Point, COC, °C / °F		225/437	225/437
Pour Point, °C / °F		-18/0	-33/-27
Autoignition Temp, °C / °F		351/663	351/663

For applications where specialty heat transfer fluids are required, see CALFLO™ on **page 95**.

REFLO™ – REFRIGERATION COMPRESSOR OILS

The REFLO™ line of refrigeration compressor fluids were 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 also be used in ammonia refrigeration systems. REFLO™ CFC can also be used at moderate temperarure 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 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. Its excellent thermal and oxidative stability can 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 Group II, solvent refined paraffinic and naphthenic refrigerant oils by extending service life while significantly reducing operating costs. It is designed to have 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 (REFLO™ for screw compressors, REFLO™ XL for screw and reciprocating compressors), 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 representative for details.

Typical Characteristics are shown below:

	REFLO™ CFC	REFLO™ 46A	REFLO™ 68A	REFLO™ XL Synthetic Blend
Viscosity cSt @ 40°C	55	46.0	57.8	59.3
cSt @ 100°C	5.8	6.9	7.9	8.5
SUS @ 100°F	290	237	290	306
SUS @ 210°F	45.4	49.1	52.3	54.4
Viscosity Index	0	106	101	115
Flash Point, °C / °F	189/372	222/432	236/457	227/441
Pour Point, °C / °F	-36/-33	-42/-44	-42/-44	-45/-49
Floc Point, °C / °F	-50/-58	NA	NA	NA

Food Industry Registration

- REFLO™ XL and REFLO™ 68A are NSF H2 registered
- REFLO™ XL and REFLO™ 68A are CFIA n-1 registered

REFLO™ SYNTHETIC

REFLO™ SYNTHETIC 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 can be used in ammonia refrigeration systems where evaporator temperatures are as low as -51ºC/-60ºF.

REFLO™ SYNTHETIC is miscible with mineral oils such as hydro treated (HT) and solvent refined (SR) paraffinics as well as napthenics.

REFLO™ SYNTHETIC is designed to have good compatibility with seal materials; it contains a seal swell agent to help reduce fluid leaks when napthenic oils were used previously in the compressors.

REFLO™ SYNTHETIC is compatible with materials such as NBR, FKM, SBR, CR, NR, MVQ.

Typical Characteristics are shown below:

		REFLO™ Synthetic
Viscosity	**cSt @ 40°C**	61.8
	cSt @ 100°C	8.9
	SUS @ 100°F	318
	SUS @ 210°F	55.8
Viscosity Index		119
Flash Point, °C / °F		245/473
Pour Point, °C / °F		-54/-65

ROTARY COOKER FLUID

Rotary Cooker Fluid is designed for lubrication of continuous rotary cookers and sterilizers, and similar applications operating under high temperature and high humidity conditions. Rotary Cooker Fluid protects equipment from wear and corrosion, has excellent detergency and dispersancy to prevent clogged lines. Rotary Cooker Fluid is free of heavy metals, including zinc.

Food Industry Registration

• NSF H2

Typical Characteristics are shown below:

		Rotary Cooker Fluid
Viscosity	**cSt @ 40°C**	151
	cSt @ 100°C	15.2
	SUS @ 100°F	792
	SUS @ 210°F	80
Viscosity Index		101
Flash Point, °C / °F		267/512
Pour Point, °C / °F		-21/-6

SPX 5000, 7000, 7068 – COMPRESSOR OILS

SPX 5000, 7000 and 7068 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, these polyglycol synthetic lubricants have a much lower gas solubility, which reduces dilution and viscosity change and greatly improves separation of the lubricant from the process gas.

SPX 5000 is recommended for use in:
* Compression of sweet hydrocarbon gas mixtures

SPX 7000 and 7068 are recommended for use in:
* Compression of sour hydrocarbon gas mixtures
* Sour natural gas and acid gas compression
* Gas re-injection service

NGS Synthetic Blend Compressor Fluids (page 112) are recommended for:
* Compression of light hydrocarbon gases (methane, ethane) where expected dilutions is <10% wt.
* Lubrication and cooling in process and gas rotary screw compressors
* Natural gas field booster service

Typical Characteristics are shown below:

		SPX 5000	SPX 7000	SPX 7068
Viscosity	**cSt @ 40°C**	153	145	65
	cSt @ 100°C	23.5	28	14.7
	SUS @ 100°F	779	734	325
	SUS @ 210°F	116	136	77
Viscosity Index		196	233	238
Flash Point, °C / °F		260/500	246/475	224/435
Pour Point, °C / °F		-34/-29	-42/-44	-43/-43
ISO Grade		150	150	68

SENTRON™ - NATURAL GAS ENGINE OIL

SENTRON™ Natural Gas Engine Oils are premium performance, long life, engine oils specifically designed to lubricate large natural gas engines and their integrated compressors, running at gas plants and pipeline compression stations, as well as in cogeneration, landfill and sewage gas operations.

SENTRON™ Natural Gas Engine Oils are formulated with three different sulphated ash levels:

SENTRON™ 541C ..... Ashless - less than 0.1% wt ash
SENTRON™ 445, MG 440, 470, LD 5000,
LD SYNTHETIC BLEND, 590, FLEET 10W-40,
FLEET 0W-30 ..... Low Ash - 0.1 to 0.6% wt ash
SENTRON™ 840, CG 40..... Medium Ash - 0.6 to 1.0 % wt ash

SENTRON™ 541C

SENTRON™ 541C is an SAE 40 oil containing an *ashless* additive package and is the prime recommendation for 2-stroke cycle engines, but may also be used in certain 4-stroke cycle engines.

SENTRON™ 445

SENTRON™ 445 is a *low ash* SAE 40 oil that gives excellent performance in most 4-stroke cycle gas engines and is also recommended for some 2-stroke cycle engines. It may also be recommended for high power engines that encounter high temperatures and heat soak conditions. SENTRON™ 445 is suitable for use in engines equipped with catalytic converters. It is approved by MWM for all gases, and by Wartsila for Type 34SG engines fuelled by natural gas.

SENTRON™ MG 440

SENTRON™ MG 440 is a *low ash,* multigrade (15W-40) version of SENTRON™ 445. The multigrade feature permits faster starting and improved lubricant flow at low ambient temperatures. SENTRON™ MG 440 is suitable for use in engines fitted with catalytic converters.

SENTRON™ 470

SENTRON™ 470 is a *low ash* SAE 40 oil especially designed for severe service conditions imposed by high power output and extreme heatsoak. An additive boost provides the extra performance required for severe service applications, including high output turbocharged engines with high exhaust gas temperatures. SENTRON™ 470 is suitable for use in engines equipped with catalytic converters.

SENTRON™ LD 5000

SENTRON™ LD 5000 is a low ash SAE 40 oil recommended by Petro-Canada for use in Caterpillar, Superior, Waukesha and other turbocharged, naturally aspirated and lean burn engines that require low ash natural gas engine oils. 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 revolutionary performance for up to 200%* longer drain interval and exceptional overall engine protection for maximum reliability and savings. It can be used in Bio Gas /Digestor Gas applications if the fuel sources are pre-treated to minimize harmful acidic constituents that a higher TBN based product may be more successfull at neutralizing. It is recommended by Waukesha for co-generation engines fuelled by pipeline gas, Perkins, MWM for all gases, MAN for natural gas applications, MTU for Series 400 engines in natural gas applications, Guascor for models FGLD and SFGLD in natural gas applications and GE Jenbacher Class A and Types 2, 3 and 6, Wartsila 25SG, 28SG, 175SG, 220SG, 34SG, 32DF, 50DF in pipeline gas, Rolls Royce BV-G Engines in pipeline gas, Waukesha GL 220 Engines in pipeline gas.

* 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 is a low ash synthetic blend oil that is recommended for use in the same equipment that is noted under SENTRON™ LD 5000 where excellent deposit control is required due to engine operational factors such as lower loaded, higher oil consumption but supporting other features and benefits of SENTRON™ LD 5000. It is suited for colder environments where start up temperatures fall as low as -25°C/-13°F.

SENTRON™ 590

SENTRON™ 590 is a specialty product recommended for selected 4-stroke natural gas engines experiencing nitrating conditions. It is suitable for use in engines fitted with catalytic converters. SENTRON™ 590 provides a high level of performance in high output turbo-charged engines that prefer a low ash oil. It provides excellent control of engine deposits, and is especially catered towards engines that operate in severe nitrating conditions. Combined with Petro-Canada's engine optimization recommendations, and in severe nitrating conditions, SENTRON™ 590 can deliver up to 200%* longer drain intervals.

* 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™ FLEET 10W-40

SENTRON™ FLEET 10W-40 is a low ash oil that is recommended for use in natural gas fuelled engines in industrial applications that require high zinc for improved valve train wear control. It is also recommended for agricultural irrigation. Best for cold starts. In addition, SENTRON FLEET 10W-40 meets Cummins CES 20074 specifications. SENTRON™ Fleet 10W-40 may be suitable for use in engines equipped with certian on-road catalytic converters. Check with your service rep for suitability.

SENTRON™ FLEET 0W-30

SENTRON™ FLEET 0W-30 is a low ash synthetic blend oil that is recommended for use in specific natural gas fuelled engines in industrial applications that requires high zinc for improved valve train wear control and a SAE 30. It is most suited in extreme cold environments where the environmental temperatures go to below -48°C. SENTRON™ Fleet 0W-30 may be suitable for use in engines equipped with certian on-road catalytic converters. Check with your service rep for suitability.

SENTRON™ 840

SENTRON™ 840 is a medium ash SAE 40 oil recommended for use in 4-stroke cycle gas engines requiring medium ash oils.

SENTRON™ CG 40

SENTRON™ CG 40 is a medium ash SAE 40 oil, that is specifically designed for 4-stroke cycle gas engines running in severe service, such as cogeneration, bio gas, digestor and low halogen landfill or sewage gas operations. SENTRON™ CG 40 gives exceptional performance in turbocharged, lean-burn and naturally aspirated gas engines. It is recommended by Waukesha for co-generation engines fuelled by pipeline gas, MAN for biogases including landfill gas and MTU for Series 400 engines powered by biogases. SENTRON™CG 40 may be suitable for use in engines equipped with certian stationary catalytic converters. Check with your service rep for suitability.

Typical Characteristics for the SENTRON™ family are shown below:

	541C	445	MG 440	470	10W-40	0W-30	LD 5000	LD SYN. BLEND	590	840	CG 40
Ash Type	Ashless	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Medium
Sulphated Ash, % Wt	0.07	0.45	0.45	0.51	0.54	0.54	0.57	0.51	0.59	0.73	0.92
SAE Grade	40	40	15W-40	40	10W-40	0W-30	40	15W-40	40	40	40
Viscosity,											
cSt @ 40°C	118	126	105	124	111	61.7	124	106	121	120	128
cSt @ 100°C	13.4	13.4	14.2	13.3	16	11.1	13.4	15.1	13.5	13.1	13.3
SUS @ 100°F	614	570	505	575	514	286	575	491	249	556	593
SUS @ 210°F	73	71	75	71	82	63	71	78	72	71	71
Pour Point, °C/°F	-21/-6	-24/-11	-33/-27	-24/-11	-33/-27	-48/-54	-30/-22	-45/-49	-30/-22	-24/-11	-24/-11
Total Acid No.	0.7	0.6	.09	1.6	1.4	1.6	1.1	1.02	0.98	2.0	0.7
Total Base No.	1.6	5.0	5.0	5.7	5.3	5.1	4.9	4.7	6.0	5.3	8.5

PETRO-CANADA NATURAL GAS ENGINE OILS SELECTION TABLE™

Manufacturer	Engine Type	Fuel Gas	Engine Model	Manufacturer's Ash Level Requirements	Recommendation
Ajax (Cooper Energy Service)	2-stroke cycle	natural	All – Ashless preferred	<0.1%	SENTRON™ 541C
Cooper Bessemer	2-stroke cycle	natural	All – Ashless preferred	<0.1%	SENTRON™ 541C
(Cooper Energy Service)	4-stroke cycle	natural	All	Low Ash Acceptable	SENTRON™ 445, 470, 590, LD 5000
Caterpillar	4-stroke cycle	natural	G3300, G3400,G3500, G3600,	0.4%min - 0.6%max	SENTRON™ 445, MG 440, 470 LD 5000 590, LD SYNTHETIC BLEND
		natural	G3600 field trial proven		SENTRON™ LD 5000
		biogas	All		SENTRON™ LD 5000
Superior	4-stroke cycle	natural	All except 1700 and 2400	0.4% - 1.0%	SENTRON™ 445, 840, CG 40, 470, LD 5000, 590
(Cooper Energy Service)	4-stroke cycle	natural	1700 and 2400 series	0.4% - 0.6%	SENTRON™ 445, MG 440, 470, LD 5000, 590, LD SYNTHETIC BLEND
Superior (White)	4-stroke cycle	natural	G825	0.4% - 1%	SENTRON™ 445, 470, LD 5000, SENTRON™ 840
	4-stroke cycle	natural	GT825	0.4% - 1%	SENTRON™ 840
Clark Brothers (Dresser Rand)	2-stroke cycle	natural	All	Ashless Low Ash Acceptable	SENTRON™ 541C SENTRON™ 445
Cummins	4-stroke cycle 4-stroke cycle 4-stroke cycle	natural natural natural	L10G, QSK19G, K19G, G19, G38, G50, G28 G855, G14	<0.5%	SENTRON™ MG440, LD SYNTHETIC BLEND
	4-stroke cycle	natural	B, C, G5.9, G8.3	CES 20074 Approved	SENTRON™ Fleet 10W-40
	4-stroke cycle	natural	All QSV, QSK except 19G		SENTRON™ 445, 470
	4-stroke cycle	natural	All QSV, QSK except 19G	Premium grade long change interval	SENTRON™ LD 5000
Detroit Diesel	4-stroke cycle	natural	50G and 60G	<0.8%	SENTRON™ MG440
MWM	4-stroke cycle 4-stroke cycle	natural biogas	All All	0.5% max. 0.5% to 1.0%	SENTRON™ LD 5000, 470, 445 SENTRON™ CG40
Guascor	4-stroke cycle	natural	All	0.9% max.	SENTRON™ 445, 840, LD 5000 MG 440, 470, 590, LD SYNTHETIC BLEND
Iveco	4-stroke cycle	natural	All	0.45% max.	SENTRON™ 445, MG 440
Ingersoll-Rand (Dresser Ind.)	4-stroke cycle	natural	Category I	Approval based on field performance	SENTRON™ 541C, SENTRON™ 445, MG 440, 470 LD 5000, LD SYNTHETIC BLEND
	4-stroke cycle	natural	Category II - III	Approval based on field performance	SENTRON™ 445, MG 440, 470, LD 5000, LD SYNTHETIC BLEND
GE Jenbacher	4-stroke cycle	Class A	2&3		SENTRON™ LD 5000, 445, 470
		Class A	4&6		SENTRON™ LD 5000, 445, 470
		Class B	2&3		SENTRON™ CG 40
		Class B	4&6		SENTRON™ LD 5000, 445, 470
		Class C	2&3		SENTRON™ CG 40
		Class C	4&6		NONE
M.E.P., Fairbanks Morse	2-stroke cycle 4-stroke cycle	natural natural	All	0.2% - 0.5%	SENTRON™ 445, MG 440
MAN	4-stroke cycle	natural	All	0.4% - 0.7%	SENTRON™ 445, MG 440, 470, LD 5000, 590, LD SYNTHETIC BLEND
		biogas	All	0.4% - 1.0%	SENTRON™ CG 40
Perkins	4-stroke cycle	natural	All	0.5%min - 1.0%max	SENTRON™ 840, 470, LD 5000, 590
RRMEB	4-stroke cycle	natural	All		SENTRON™ 445, LD 5000
Wärtsilä	4-stroke cycle	natural & periodic LFO	150SG, 175SG, 220SG 25SG, 28SG, 34SG 32DF, 34DF, 50DF	0.6% max	SENTRON™ 445, 470, LD 5000, 590
Waukesha Engine Div. (Dresser Ind.)	4-stroke cycle	natural	VSG F11, G, GSI, GSID	0.35% - 1.0%	Primary – SENTRON™ 445, CG 40, LD 5000, MG 440, 470, 590,

					LD SYNTHETIC BLEND Secondary – SENTRON™ 840
	4-stroke cycle	natural	F817, F1197	0.35% - 1.0%	Primary – SENTRON™ 445, CG 40, LD SYNTHETIC BLEND, LD 5000 MG 440, 470, 590 Secondary – SENTRON™ 840
	4-stroke cycle	natural	Clinton, G2476, L3711, F1850, H884	Ashless preferred	SENTRON™ 541C
	4-stroke cycle	natural	VHP F2895, F3521, L5108, L5790, L7042, P9390, G GSI	0.35% - 1.0%	Primary – SENTRON™ 445, CG 40, LD 5000, MG 440, 470, 590, LD SYNTHETIC BLEND Secondary–SENTRON™ 840
	4-stroke cycle	natural	VHP GL,	0.35% - 1.0%[1]	SENTRON™ LD SYNTHETIC BLEND
	4-stroke cycle	natural	VGF, F-18, H-24, L-36, P-48, GSI, GSID	0.35% - 0.5%[1]	SENTRON™ 445, MG 440
	4-stroke cycle	natural	VGF, F-18, H-24, L-36, P-48, G, GL, GLD	0.45% - 0.75%[1]	SENTRON™ 445, MG 440, 470, LD 5000, 590, LD SYNTHETIC BLEND
	4-stroke cycle	natural	AT 25/27GL Series	0.35% – 1.0%[1]	Primary – SENTRON™ 445, CG 40, LD 5000, MG 440, 470, 590 LD SYNTHETIC BLEND Secondary – SENTRON™ 840
	4-stroke cycle		VHP F3524, L5794, L7044, GSI, L5774, LT	0.45% – 0.75%[1]	Primary – SENTRON™ 445, MG 440, 470, LD 5000, 590 LD SYNTHETIC BLEND Secondary – SENTRON™ 840
	4-stroke cycle	natural	16V150LTD, 220GL	0.40% - 0.55%	SENTRON™ 445, LD 5000
MTU	4-stroke cycle	natural	28XX & 30XX		SENTRON™ LD 5000
	4-stroke cycle	biogas	28XX & 30XX		SENTRON™ CG40
GM	4-stroke cycle	natural	350		SENTRON™ Fleet 10W-40, 0W-30
BU Drive	4-stroke cycle	natural	All		SENTRON™ LD 5000
		biogas	All		SENTRON™ LD 5000
Schnell	4-stroke cycle	biogas	All		SENTRON™ LD 5000

[1] 0.1% wt. Zn max. is recommended.

*The above table can be used as a guideline for product selection. Each natural gas engine has unique characteristics and variations in operating parameters, and therefore, it is recommended to consult with a Technical Representative to ensure the most appropriate lubricant selection is made.

FUEL APPLICATION GUIDE

FUEL GAS	RECOMMENDED PRODUCT
Natural Gas – "Premium" product "Light" Biogas Sewage Gas - Treated	SENTRON™ LD 5000
Natural Gas – "Better" product	SENTRON™ 470
Natural Gas – "Good" product	SENTRON™ 445
Landfill Gas – Some treated, lower chlorine 5000	Preferred: SENTRON™ LD Secondary: SENTRON™ CG 40
Landfill Gas – Severe, untreated, high chlorine	N/A

RECIPROCATING COMPRESSOR CYLINDER PACKING LUBE OIL RECOMMENDATIONS FOR VARIOUS GAS STREAM COMPONENTS

Gas Stream	<1000 psig (70 bar-g)	1000<>2000 psig (70<>140 bar-g)	2000<>3500 psig (140<>240 bar-g)	3500<>5000 psig (240<>345 bar-g)	>5000 psig (345 bar-g)
Pipeline Quality Natural Gas	SENTRON™ Gas Engine Oil *Base Case*	SENTRON™ Gas Engine Oil Or Compressor Oil RP 268 *Increase rate[1] 25%*	Compressor Oil RP 268 *Increase rate[1] 50%*	Compressor Oil RP 460 *Increase rate[1] 100%* Or SPX 5000	Compressor Oil RP 460 *Increase rate[1] 200%* Or SPX 5000
Natural Gas with Water and Heavy Hydrocarbons including conditions where Methane <90%, H_2S >0.7%, or Propane >8%	SENTRON™ Gas Engine Oil Or Compressor Oil RP 268 *Increase rate[1] 25%*	Compressor Oil RP 268 *Increase rate[1] 50%*	Compressor Oil 460 *Increase rate[1] 100%*	SPX 5000	SPX 5000
Carbon Dioxide >2% but <10%	SENTRON™ Gas Engine Oil Or Compressor Oil RP 268 *Increase rate[1] 25%*	Compressor Oil RP 268 *Increase rate[1] 50%*	Compressor Oil RP 460 *Increase rate[1] 100%* Or SPX 5000	SPX 5000	SPX 5000
Carbon Dioxide >10%	SENTRON™ Gas Engine Oil Or Compressor Oil RP 268 *Increase rate[1] 50%*	Compressor Oil RP 268 *Increase rate[1] 100%*	Compressor Oil RP 460 *Increase rate[1] 200%* Or SPX 5000	SPX 5000	SPX 5000
H_2S >2% but <30%	SENTRON™ Gas Engine Oil *Increase rate[1] 25%*	SENTRON™ Gas Engine Oil Or Compressor Oil RP 268 *Increase rate[1] 50%*	Compressor Oil RP 268 *Increase rate[1] 100%*	Compressor Oil RP 460 *Increase rate[1] 200%* Or SPX 7000	Compressor Oil RP 460 *Increase rate[1] 500%* Or SPX 7000
H_2S >30%	SENTRON™ Gas Engine Oil Or Compressor Oil RP 268 *Increase rate[1] 50%*	Compressor Oil RP 268 *Increase rate[1] 100%*	Compressor Oil RP 268 *Increase rate[1] 150%*	Compressor Oil RP 460 *Increase rate[1] 300%* Or SPX 7000	Compressor Oil RP 460 *Increase rate[1] 500%* Or SPX 7000
Propane Refrigerant	SENTRON™ Gas Engine Oil *Increase rate[1] 100%* Or SPX 5000	SENTRON™ Gas Engine Oil *Increase rate[1] 200%* Or SPX 5000	SPX 5000	SPX 5000	SPX 5000

[1]**Lubrication Rate Increases:** The recommendation to "increase rate" is relative to the *Base Case* – Pipeline Quality Natural Gas at <1000 psig.

The above information should be regarded as guidelines only. For recommendations specific to your compressor and operating conditions, please contact a Petro-Canada Technical Services Advisor. If the recommended lubricants or flow rates do not appear to work, flow rates and/or lubricant types may need to be changed.

SEPRO™ XL PAPER MACHINE OILS

For use in the wet and dry ends of paper machine circulating systems, SEPRO™ XL also provides excellent oxidation stability for extended drain intervals and excellent water separation for better equipment protection from rust, corrosion and wear.

Petro-Canada's SEPRO™ XL paper machine oils are particularly recommended for situations where there are environmental concerns regarding the quality of discharged waste water. SEPRO™ XL paper machine oils are free of heavy metals, recyclable and non-toxic to water inhabiting species such as algea and fish in low concentrations (100 mg/L).

Typical Characteristics are shown below:

	SEPRO™ XL	
	150	**220**
Viscosity cSt @ 40°C	151	221
cSt @ 100°C	15.2	19.2
SUS@100°F	794	1167
SUS @ 210°F	81	98
Viscosity Index	101	97
Flash Point, °C / °F	272/522	272/529
Pour Point, °C / °F	-21/-6	-21/-6
Oxidation Stability, Time to TAN of 2.0 hours	2000+	1500+
Rust Test, Procedure A&B, 24 hours	pass	pass
FZG Load Stage Pass	12	12+
Zinc (ppm)	0	0
Barium (ppm)	0	0
Copper Corrosion @ 100°C/3 hr.	1b	1b
Water separability (time) 82°C	40-40-0 (10 min)	40-39-1 (30 min)

SUPER VAC - VACUUM PUMP FLUID

Super Vac Fluids are specially designed to cool, lubricate and provide a seal in piston and rotary-vane air vacuum pumps. Blended with Petro-Canada's 99.9% pure base oils and incorporating a unique additive system, Super Vac Fluids allow for extremely low vapour pressures resulting in maximum 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 products. They can be used at higher operating temperatures (100-130°C) 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 and sulphuric acid, chlorine, hydrogen sulphide or glacial acetic acid.

Food Industry Registration

Super Vac 15,19, and 20 are NSF H2 registered

Typical Characteristics are shown below:

	Super Vac 15	Super Vac 19	Super Vac 20
Viscosity cSt @ 40°C	38.1	55	103.1
cSt @ 100°C	6.2	7.6	11.4
SUS @ 100°F	196	284	538
SUS @ 210°F	46.7	51.4	65.0
Viscosity Index	110	100	97
Flash Point, °C / °F	220/428	225/437	260/500
Pour Point, °C / °F	-18/0	-15/+5	-12/+10
Oxidation Stability, RPVOT minutes	800	800	800
Calculated Vapour Pressure, mBar @ 25°C	$3x10^{-5}$	$5x10^{-6}$	$3x10^{-6}$

SYNDURO™ SHB SYNTHETIC LUBRICANTS

SYNDURO™ SHB Fluids are a family of multi-functional lubricants designed to deliver excellent component protection for equipment operating at high speed or mild 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 as synthetic hydraulic fluids. SYNDURO™ SHB Fluids offer the potential to consolidate lubricants over many different applications and a wide range of environmental conditions.

Typical Characteristics are shown below:

		SYNDURO™ SHB					
		32	**46**	**68**	**150**	**220**	**460**
Viscosity	**cSt @ 40°C**	33	47	68	148	219	452
	cSt @ 100°C	6.2	8.3	11.1	20.3	27.4	46.9
	SUS @ 100°F	177	240	352	760	1,130	2,350
	SUS @ 210°F	47.1	53.6	63.7	101	133	225
Viscosity Index		142	151	155	159	160	162
Flash Point, °C / °F		237/458	254/488	235/455	237/459	243/469	266/511
Pour Point, °C / °F		<-60/-76	<-60/<-76	-54/-65	-45/-49	-42/-44	-39/-38
Oxidation Stability, 24h, 200°C (TAN)		0.4	0.4	0.5	0.5	0.7	0.7
FZG Load Stage Pass		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.

TURBOFLO™ XL – TURBINE FLUID

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 or 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 32568F, GEK 46506E, GEK 28143A
Siemens	TLV 9013 04 (non EP)
Westinghouse	1500 0020, 55125Z3
Solar	ES 9-224V
Cooper	SE 1144
Alstom (ABB)	HTGD 90117, K 110 812101
Blohm & Voss	DIN 51515
DIN	DIN 51515
ASTM	D4304 Type I (non-EP)
JIS	K 2213 Type 2

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
	SUS@ 100°F	175	239	353
	SUS@ 210°F	45	49	56
Viscosity Index		101	100	102
Flash Point, °C / °F		220/428	235/455	247/477
Pour Point, °C / °F		-30/-22	-30/-22	-24/-11
RPVOT, minutes		2,700+	2,700+	2,700+
Oxidation Stability (D943), hours to 2.0 TAN		10,000+	10,000+	10,000+

TURBOFLO™ EP – TURBINE FLUID

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 32568F, GEK 46506E
Siemens	TLV 9013 04 (EP)
Westinghouse	1500 0020, 55125Z3
Solar	ES 9-224V
Alstom (ABB)	HTGD 90117, K 110 812101
DIN	DIN 51515
ASTM	D4304 Type II (EP)
JIS	K 2213 Type 2

Typical Characteristics are shown below:

	TURBOFLO™ EP	
	32	**46**
Viscosity cSt @ 40°C	34.2	46.4
cSt @ 100°C	5.6	6.8
SUS@ 100°F	176	239
SUS@ 210°F	45	49
Viscosity Index	100	101
Flash Point, °C / °F	220/428	237/459
Pour Point, °C / °F	-33/-27	-30/-22
RPVOT, minutes	2,000+	2,000+
Oxidation Stability (D943), hours to 2.0 TAN	10,000+	10,000+
FZG, passing load stage	11	11

TURBOFLO™ – TURBINE FLUID

Petro-Canada's TURBOFLO™ Fluids are specifically designed to lubricate and cool steam, hydraulic and gas turbines and deliver excellent lubrication to bearings. TURBOFLO™ Fluids demonstrate exceptional oxidative and thermal stability providing protection against breakdown caused by air and high temperatures.

TURBOFLO™ Fluids are suitable for use in steam and gas turbines requiring the following major manufacturer and industry specifications:

General Electric	GEK 32568F, GEK 46506D
Siemens	TLV 9013 04 (non-EP)
Westinghouse	1500 0020, 55125Z3
Solar	ES 9-224V
Alstom (ABB)	HTGD 90117, K 110 812101
DIN	DIN 51515
ASTM	D 4304 Type I (non- EP)
JIS	K 2213 Type 2

Typical Characteristics are shown below:

	TURBOFLO™		
	32	**46**	**68**
Viscosity cSt @ 40°C	34.0	46.6	68.4
cSt @ 100°C	5.6	7.0	8.9
SUS@ 100°F	175	240	354
SUS@ 210°F	45	50	56
Viscosity Index	110	107	103
Flash Point, °C / °F	220/428	216/421	232/450
Pour Point, °C / °F	-30/-22	-24/-11	-21/-6
RPVOT, minutes	1,000+	1,000+	1,000+
Oxidation Stability (D943), hours to 2.0 TAN	10,000+	10,000+	10,000+

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. These oils are designed to minimize rust and oxidation with blends of ultra pure Petro-Canada HT Severely Hydrocracked base oils and specially selected additives. In addition, they offer excellent water separability.

Premium R&O 77 is approved against Canadian General Standards Board (CGSB) specification 3-GP-357c for Steam Turbine Oils. It also meets NATO O-240 and British DEF-STAN 91-25.

TURBOFLO™ R&O is approved against GM LS-2.

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
Siemens	TLV 9013 04 (non-EP)
Westinghouse	1500 0020
Alstom (ABB)	HTGD 90117, K 110 812101
Solar	ES 9-224V
ASTM	D 4304 Type I (non- EP)
JIS	K 2213 Type 2

Typical Characteristics are shown below:

	TURBOFLO™ R&O					
	10	**22**	**32**	**46**	**68**	**Premium R&O 77**
Viscosity						
cSt @ 40°C	10.2	21.8	31.1	44.8	66.1	76.7
cSt @ 100°C	2.7	4.3	5.3	6.6	8.3	9.4
SUS@ 100°F	62	114	161	231	343	398
SUS@ 210°F	35	40	44	48	54	58
Viscosity Index	102	98	100	99	100	97
Flash Point, °C / °F	185/365	195/383	210/410	214/417	232/450	240/464
Pour Point, °C / °F	-57/-71	-39/-38	-36/-33	-33/-27	-30/-22	-27/-17
RPVOT, minutes	N/A	N/A	400+	400+	400+	400+
Oxidation Stability (D943)						
hours to 2.0 TAN	5,000+	5,000+	4,500+	4,000+	4,000+	4,000+

	TURBOFLO™ R&O			
	100	**150**	**220**	**320**
Viscosity				
cSt @ 40°C	94.6	136	202	297
cSt @ 100°C	10.7	14.0	18.0	23.0
SUS@ 100°F	494	712	1,066	1,579
SUS@ 210°F	62	75	92	114
Viscosity Index	97	99	97	96
Flash Point, °C / °F	259/498	279/534	281/538	275/527
Pour Point, °C / °F	-18/0	-12/10	-12/10	-9/16
RPVOT, minutes	400+	300+	300+	300+
Oxidation Stability (D943)				
hours to 2.0 TAN	4,000+	2,000+	2,000+	2,000+

TURBONYCOIL 600 - LAND BASED AERODERIVATIVE GAS TURBINE FLUID

Rolls Royce approved TURBONYCOIL 600 (registered trademark of Nyco SA) is specially designed to effectively lubricate land based aeroderivative gas turbines operating under extreme conditions. The fluid resists heat soak-backup to 350 degrees C. TURBONYCOIL 600 is non-toxic, based on polyol esters with high thermal stability and fortified with anti-oxidant, anti-wear and anti-corrosion additives. TURBONYCOIL 600 is approved by the following engine manufacturers for use in land based industrial and marine gas turbine applications where a MIL-PRF-23699F Standard Classification or Rolls Royce approved lubricant is required: Rolls Royce, Allison, CFM International, Turbomeca, Pratt & Whitney Canada, Hamilton Sundstrand/APIC and General Electric.

Typical Characteristics are shown below:

		TURBONYCOIL 600
Viscosity	**cSt @ 40°C**	25.6
	cSt @ 100°C	5.1
	cSt @ -40°C	9,468
	SUS @ 100°F	133
	SUS @ 210°F	43.4
	SUS @ -40°F	44,187
Flash Point, °C / °F		270/518
Pour Point, °C / °F		-57/-71
6½h @ 204°C, % Wt		3.4
Total Acid No., mg KOH/g		0.16

METALWORKING OILS

Petro-Canada offers a competitive line of metalworking fluids that cover the major metalworking operations.

The main functions of a metalworking fluid is to lubricate or reduce friction between the tool and work piece and act as a coolant by rapidly removing heat generated at the tool work-piece interface.

Petro-Canada's soluble and neat cutting oils are specially formulated to provide maximum performance for a wide range of metal removing operations.

Proper lubrication reduces friction, and as a result:

- less coolant is required to absorb heat
- less cutting energy is required
- tool wear is reduced
- improved surface finishes are obtained

NEAT CUTTING OILS

Neat Cutting Oils are designed for use as they are received and are non-miscible in water. They have excellent lubricity and anti-wear characteristics, assist in extending tool life and produce a quality finish on machined parts. Petro-Canada's Neat Cutting oils contain ultra pure hydrocracked base oils with varying amounts of extreme pressure additives such as sulphur and chlorine and/or lubricity agents.

TRANSICUT™

TRANSICUT™ Oils are non-stain, transparent cutting oils intended for use in high-speed automatic screw machining and simple turning. They are primarily recommended for machining low carbon steels and non-ferrous metals such as copper, aluminum and magnesium.

Typical Characteristics are shown below:

		TRANSICUT™	
		25	**32**
Viscosity	**cSt @ 40°C**	25.3	31.6
	cSt @ 100°C	4.7	5.5
	SUS @ 100°F	131	163
	SUS @ 210°F	42	44
Flash Point, COC, °C / °F		213/415	221/430
Colour, ASTM		<1.0	5.5
Sulphur, % Wt		0.30	0.44
Chlorine, % Wt		2.0	1.0
Fatty Ester, % Wt		0.5	3.0

SUPERCUT™

SUPERCUT™ Oils are designed for use in heavy duty cutting and grinding operations on high strength ferrous alloys and tough-to-machine nickel/cobalt alloys. These operations include; tapping, threading, broaching, and conventional turning. SUPERCUT™13 is a low viscosity oil, specially suited for use in thread cutting and deep-hole drilling.

Typical Characteristics are shown below:

		SUPERCUT™		
		13	**25**	**45**
Viscosity	**cSt @ 40°C**	13.5	24.1	45.1
	cSt @ 100°C	3.2	4.6	7.0
	SUS @ 100°F	76	126	232
	SUS @ 210°F	37	41	49
Flash Point, COC, °C / °F		177/351	191/376	215/419
Colour, ASTM		7.0	7.0	7.0
Sulphur, % Wt		2.3	2.3	2.4
Chlorine, % Wt		1.1	2.7	2.6
Fatty Ester, % Wt		5.0	5.0	5.0

ALUCUT™

ALUCUT™ is a light coloured, low viscosity oil specifically developed for machining aluminum and magnesium alloys. Lubricity and wetting agents assist in producing excellent surface finishes and rapidly removing the heat generated during high speed machining.

Typical Characteristics are shown below:

		ALUCUT™
Viscosity	**cSt @ 40°C**	10.7
	cSt @ 100°C	2.8
	SUS @ 100°F	64
	SUS @ 210°F	35
Flash Point, COC, °C / °F		178/352
Colour, ASTM		< 0.5
Fatty Ester, % Wt		1.2
Saponification No.		4.9

ALUDRAW™ 850 – WIRE DRAWING OIL

ALUDRAW™ 850 is a drawing oil used in processes such as drawing, forming, stamping, extrusion, forging and rolling. It is designed for drawing aluminum wire, providing good die life, material finish and dimensional accuracy. This drawing oil is most effective when it contains 1-2% of aluminum fines, which produce a synergistic effect with ALUDRAW™ 850 thus improving the drawing characteristics.

The life of this oil is extremely good, with normal top up as required. Yearly check of the oil will determine at which time it should be replaced.

A rule of thumb that should be used for changing the oil is as follows:
1. Viscosity @ 100°C has increased from 24 cSt to 60 cSt
2. Solids have increased to 10%
3. Ash has increased to 20%

The aluminum fines are removed from the sump and approximately 50% of the oil is replaced with new ALUDRAW™ 850.

Typical Characteristics are shown below:

		ALUDRAW™ 850
Viscosity	**cSt @ 40°C**	317.8
	cSt @ 100°C	25.8
	SUS @ 100°F	1,683
	SUS @ 210°F	127
Viscosity Index		106
Pour Point, °C / °F		-3/26
Saponification Number		21
Total Acid No., mg KOH/g		0.12

SOLUBLE CUTTING OILS

Petro-Canada Soluble Cutting Oils are used where rapid heat removal is the main criteria. They are formulated with mineral oils, emulsifiers, rust inhibitors, EP additives and other coupling agents. Soluble Oils are mixed with water in normal starting proportions of 3% to 10% for most operations.

Petro-Canada Soluble Cutting Oils produce stable emulsions which have excellent cooling ability and the necessary balance of lubricity and extreme pressure characteristics required for proper machining conditions. They are not recommended for use with nitrile seals, as they will cause weakening over time.
Important Note: ALWAYS ADD OIL TO WATER

CUTSOL™ / CUTSOL™ HD

CUTSOL™ is a specially designed for general machining operations. Applications include cutting, drilling, milling, and grinding. CUTSOL™ is ideal for all machining operations where cooling and rust protection are of prime importance. The product contains a biocide (anti-microbial agent).

CUTSOL™ HD is a heavy-duty oil which contains extreme pressure additives for use in metal removal operations where a high degree of surface finish and long tool life are desired. CUTSOL™ HD is intended for difficult machining operations. The product provides good rust protection and contains a biocide (anti-microbial agent).

Typical Characteristics are shown below:

	CUTSOL™	CUTSOL™ HD
Viscosity cSt @ 40°C	38	34.5
Oil Appearance	Clear Amber	Clear Amber
Sulphur, %Wt	0.79	1.4
Chlorine, %Wt	nil	10.4
Water to Oil Mix Ratio	10:1/30:1	10:1/20:1
Emulsion Appearance	Milky White	Milky White
pH Emulsion (5% tap water)	8.9	9.5


MAXIMUM PERFORMANCE
PATENTED PURITY PROCESS
TM

GREASES

INTRODUCTION

Greases are designed to lubricate bearing and gear applications where a continuous oil supply cannot be retained. 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, calcium or aluminum and has an important impact on the characteristics of the grease.

Simple lithium greases provide good temperature capabilities with good water resistance. Simple calcium greases provide good water resistance, but don't perform as well at high temperatures. Simple aluminum greases have inherent stringiness making them a good choice for semi-fluid greases and applications where adhesion is of primary importance.

COMPLEX GREASE

Complex greases are made with two or more carboxylic acids similar to a regular grease except that the thickener contains two dissimilar fatty acids, one of 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 – Calcium sulphonate complex grease is miceller in nature rather than a complex soap per se.

LUBRICATING OIL

The high percentage of oil by weight (75-95%) in a grease requires the oil to be of high quality and proper viscosity for the intended application. Light viscosity or synthetic oils are normally used for low temperature, low load and high speed applications. Conversely a heavy viscosity oil is generally used for high temperature, high load and slow speed applications.

ADDITIVES

The most common additives found in grease are as follows:

- Oxidation Inhibitors – prolong the life of a grease
- EP Agents – guard against scoring and galling
- 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 become softer).
- **Oil Separation** – is the percentage of oil which separates from the grease under static (eg. 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.

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, designed 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.

GREASE COMPATIBILITY

Occasionally, grease substitution in an application may be necessary to correct problems arising from the original product in service. If the thickeners 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 before a new one is introduced. However, 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 greases. Competitors' products should be treated as incompatible with Petro-Canada greases unless strong evidence exists to the contrary.

		Aluminum Complex	Lithium	Polyurea	Lithium Complex	Barium Complex	Silica	Clay
		VULTREX™ MPG	PRECISION™ General Purpose EP2	Chevron SRI 2	PRECISION™ XL EP 2		THERMEX™	
Lithium	PRECISION™ General Purpose EP 2	Yes 140						
Polyurea	Chevron SRI 2	Yes 130	Yes 145					
Lithium Complex	PRECISION™ XL EP 2	Yes 150	Yes 170	Yes 158				
Barium Complex		Yes 168	Yes 153	Yes 173	Yes 160			
Silica	THERMEX™	Yes 115	No (*)	No 80	No (*)	Yes 173		
Clay		No 58	No 95	No (*)	Yes 183	Yes 173	No 75	
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 is designed to help you select a type of grease that will satisfy the intended application.

	REGULAR GREASES			COMPLEX			SYNTHETIC		CLAY
Properties	**Calcium**	**Lithium**	**Sodium**	**Aluminum**	**Calcium**	**Barium**	**Lithium**	**Polyurea**	**Bentone**
Dropping Point °C	80-100	175-205	170-200	260+	260+	200+	260+	250+	None
*Max Temp °C	65	125	125	150	150	150	160	150	150
High Temp Use	V. Poor	Good	Good	Exc	Exc	Good	Exc	Exc	Exc
Low Temp Mobility	Fair	Good	Poor	Good	Fair	Poor	Good	Good	Good
Mech. Stability	Fair	Good	Fair	Exc	Good	Fair	Exc	Good	Fair
Water Resist.	Exc	Good	Poor	Exc	Exc	Exc	Exc	Exc	Fair
Oxidation Stability	Poor	Good	Good	Exc	Exc	Poor	Good	Exc	Good
Texture	Smooth	Smooth	Fibrous or Smooth	Smooth	Smooth	Fibrous	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. When packing a split housing pillow block bearing ensure that the grease cavity is **only one-third full.**

Re-greasing intervals are determined from:

• severity of service • environment • condition of seals • shock loading

REGREASING AMOUNTS FOR BEARINGS

Typically, 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 Goz = .114* W (bearing width in inches) * OD (bearing outer diameter in inches).

Metric Equivalent = Ggm=.503*W (in cm) * OD (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 to 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
1⅛-1¼	30	0.47	7.7	6	6	4	4	2	2	1	1	1	1
1⅜-1½	35	0.56	9.2	6	4	4	2	2	1	1	1	1	½
1⅝-1¾	40	0.80	13.1	6	4	2	2	1	1	1	1	½	
1 15/16-2	45 - 50	0.89	14.6	6	4	2	1	1	1	1	½		
2 3/16-2¼	55	1.09	17.9	6	4	2	1	1	1	½			
2 7/16-2½	60	1.30	21.3	4	2	1	1	1	½				
2 11/16-3	65 - 75	2.42	39.7	4	2	1	1	½					
3 3/16-3½	80 - 85	3.92	64.2	4	2	1	½						
3 11/16-4	90 - 100	5.71	93.6	4	1	½							
4 3/16-4½	110 - 115	6.50	106.5	4	1	½							
4 15/16-5	125	10.00	163.9	2	1	½							

TEMPERATURE 90°C (200°F) HORIZONTAL SHAFT EQUIPMENT

GREASES

Petro-Canada greases are listed according to their performance or application, as follows:

- Regular Performance Greases
- Premium Performance Greases
- Synthetic Greases
- Specialty Greases
- Food Grade Greases
- Mining Greases
- Drilling Compounds
- Non-Melting Greases

• REGULAR PERFORMANCE GREASES

MULTI-APPLICATION LITHIUM GREASES

PRECISION™* GENERAL PURPOSE greases are a series of high quality, cost effective, 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 EP1 grease is recommended for centralized grease systems to lubricate heavily loaded conveyor bearings, mobile mining and forestry equipment and high speed industrial bearings.

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PRECISION™ GENERAL PURPOSE MOLY EP2 grease is a high quality lithium based, dark grey multi-application grease incorporating molybdenum disulphide/graphite and EP additives. Molybdenum disulphide/graphite interact with metal surfaces to provide a protective barrier against wear even when other grease components are depleted. It is ideally suited for applications in truck fleets, mobile equipment and plant machinery which require a grease with good extreme pressure (EP) and shock resistant properties.

Typical Characteristics for **PRECISION™** GENERAL PURPOSE Greases are shown below:

	PRECISION™ GENERAL PURPOSE		
	EP2	**EP1**	**MOLY EP2**
Soap Type	Lithium	Lithium	Lithium
Colour	Brown	Brown	Grey
Worked Penetration @ 25°C	265	310	272
Dropping Point, °C/°F	198/388	191/376	191/376
Base Oil Viscosity			
cSt @ 40°C	159	159	159
cSt @ 100°C	14.9	14.9	14.9
SUS @ 100°F	737	737	737
SUS @ 210°F	78	78	78
Timken OK Load, kg/lb	18/40	18/40	18/40
Weld Point, kg	250	250	315
Operating Range, °C	-25 to 135	-30 to 135	-25 to 135
°F	-13 to 275	-22 to 275	-13 to 275
Minimum Dispensing Temperature, °C/°F	-25/-13	-30/-22	-25/-13

• PREMIUM PERFORMANCE LITHIUM / LITHIUM COMPLEX GREASES

PRECISION™ XL GREASES

PRECISION™ XL greases are versatile premium performance, long-life, lithium-complex/lithium greases designed to lubricate and protect automotive and industrial equipment over a very 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 & steel mills and mineral extraction equipment.

PRECISION™ XL EMB Grease – is an NLGI #2 non EP rust and oxidation inhibited lithium complex grease with a medium/low oil viscosity and is coloured blue for identification purposes. It is designed primarily to lubricate high speed ball and roller bearings, including those on high temperature electric motors and generators with Class H insulation.

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 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 be used also as a gear drive lubricant, where a high viscosity gear oil with 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 was 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 a NLGI #1 EP lithium complex grease designed for use in heavy duty and general purpose bearing applications served 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 a NLGI #2 EP lithium complex grease designed for use in all types of heavy duty and general purpose bearings operating at both low or high speeds. PRECISION™ XL EP2 can be used for grease-gun application to 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 with the EP2 containing a more viscous oil while the EP1 has the same base oil viscosity as PRECISION™ XL greases and are compounded with 3% molybdenum disulphide. 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. Meets the Bucyrus International MPG - Multi Purpose Grease (SD 4711) specification.

PRECISION™ XL 3 Moly Arctic Grease – is a lithium grease recommended for heavy duty applications particularly where shock loading or vibration is encountered in industrial machinery or in off-highway equipment. 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 disulphide and 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 base oil and additive package are selected to meet Bucyrus International grease standard SD 4711 (Multi-Purpose Grease). Not recommended for applications requiring a tackified grease.

PRECISION™ XL HEAVY DUTY – This robust lithium complex grease is formulated for use in centralized lubrication systems found on steel-rolling mills, but also is very capable of handling many other applications including heavy duty, slow moving and operating at high temperatures.

PRECISION™ XL RAIL CURVE GREASE – is a water-resistant lithium grease compounded with graphite and is suitable for All Season use in mechanical applicators of trackside lubrication, as well as on-board lubrication systems. It offers improved wear protection, excellent adhesion and the benefit of being able to perform over a wide temperature range. It is recommended for the following applications: Track-side mechanical lubricators systems such as Portec and Lincoln, on-board lubrication systems such as the Clicomatic system, switches, switch plates (hand applied/brushed), fish plates and joint bars, and other railway applications where graphite greases are recommended.

Typical Characteristics of our PRECISION™ XL line of are shown below:

	PRECISION™ XL				
	EP2	**EP1**	**EP00**	**EP000**	**EMB**
Soap Type	Lithium Complex	Lithium Complex	Lithium	Lithium	Lithium Complex
Colour	Green	Green	Dark Amber	Dark Amber	Blue
Worked Penetration @ 25°C	274	312	401	452	291
Dropping Point, °C/°F	302 (576)	307 (585)	191 (376)	185 (365)	298 (568)
Base Oil Viscosity					
cSt @ 40°C	220	220	120	325	110
cSt @ 100°C	17.9	17.9	13.7	24	12
SUS @ 100°F	1019	1019	555	1,506	510
SUS @ 210°F	90	90	73	115	66
Timken OK Load, kg/lb	27 (60)	27(60)	18(40)	18(40)	-
Weld Point, kg	315	315	250	250	-
Operating Range, °C	-20 to 160	-25 to 160	-35 to 100	-25 to 100	-25 to 160
°F	-4 to 320	-13 to 320	-31 to 212	-13 to 212	-13 to 320
Minimum Dispensing Temperature, °C/°F	-20/-4	-20/-4	-35/-31	-25/-13	-20/-4

	PRECISION™ XL				
	HEAVY DUTY (STEEL MILL)	RAIL CURVE	3 MOLY EP2	3 MOLY EP1	3 MOLY ARCTIC
Soap Type	Lithium Complex	Lithium	Lithium	Lithium	Lithium
Colour	Brown	Black/Grey	Grey	Grey	Grey
Worked Penetration @ 25°C	284	322	287	336	320
Dropping Point, °C/°F	284/543	186/367	241/466	220/428	185/365
Base Oil Viscosity					
cSt @ 40°C	420	27.5	403	210	34
cSt @ 100°C	25.6	5.3	25.1	17.3	6.1
SUS @ 100°F	1946	142	1867	1114	174
SUS @ 210°F	123	44	212	89	47
Timken OK Load, kg/lb	27(60)	18(40)	27(60)	27(60)	18(40)
Weld Point, kg	315	400	800	800	250
Operating Range, °C	-10 to 160	-50 to 120	-15 to 135	-25 to 135	-45 to 135
°F	14 to 320	-58 to 248	5 to 275	-13 to 275	-49 to 275
Minimum Dispensing Temperature, °C/°F	-10/14	-45/-49	-15/5	-25/-13	-45/-49

	PRECISION™ XL		
	5 MOLY EP0	5 MOLY EP1	5 MOLY EP2
Soap Type	Lithium	Lithium	Lithium
Colour	Grey	Grey	Grey
Worked Penetration @ 25°C	359	331	282
Dropping Point, °C/°F	218/424	227/441	187/369
Base Oil Viscosity			
cSt @ 40°C	134	159	195
cSt @ 100°C	14	14.9	18.2
SUS @ 100°F	698	737	1,026
SUS @ 210°F	76	78	93
Timken OK Load, kg/lb	23(50)	23(50)	20(45)
Weld Point, kg	620	620	620
Operating Range, °C	-50 to 120	-30 to 135	-25 to 135
°F	-58 to 248	-22 to 275	-13 to 275
Minimum Dispensing Temperature, °C/°F	-45/-49	-25/-13	-25/-13

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• SYNTHETIC GREASES

PRECISION™ SYNTHETIC GREASE

PRECISION™ Synthetic – is a long-life, premium performance, all-season, extreme pressure lithium complex 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 Moly – like PRECISION™ Synthetic this is an NLGI #1 lithium complex grease, but contains 3% Molybdenum Disulphide for protection against vibration and shock loading. This extra component renders the grease 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 a synthetic, high temperature EP lithium complex grease, containing a very viscous base oil, with a NLGI #1 grade. It is designed primarily for the lubrication of dryer felt-roll bearings in paper machines, where extended life at high temperatures is needed and frequent replenishment is not possible.

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 gear-cases.

PRECISION™ Synthetic EMB – is a synthetic electric motor bearing grease formulated for long service life and excellent high and low temperature performance. It is designed to lubricate bearings over a wide temperature range in applications where shock loading is absent and an extreme pressure (EP) grease is not required. It meets CGE specification 6298 for Class B or F insulation.

Typical Characteristics are shown below:

	PRECISION™ Synthetic				
		Moly	**Heavy**	**EP 00**	**EMB**
Soap Type	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex	Lithium Complex
Colour	Gold	Grey	Gold	Gold	Blue
Worked Penetration @ 25°C	320	322	315	415	293
Dropping Point, °C/°F	271/520	266/511	304/579	293/559	309/589
Base Oil Viscosity					
cSt @ 40°C	128	128	488	488	114
cSt @ 100°C	15	15	44	44	15.6
SUS @ 100°F	666	666	2,261	2,261	588
SUS @ 210°F	79	79	207	207	81
Timken OK Load, kg/lb	27/60	27/60	27/60	25/55	N/A
Weld Point, kg	250	400	315	315	N/A
Operating Range, °C	-40 to 170	-40 to 170	-30 to 170	-40 to 170	-40 to 170
°F	-40 to 338	-40 to 338	-22 to 338	-40 to 338	-40 to 338
Min. Dispensing Temperature, °C/°F	-35/-31	-35/-31	-25/-13	-35/-31	-35/-31

• SPECIALTY GREASES FOR EXTREME TEMPERATURES

PEERLESS™ GREASES

PEERLESS™ LLG™ is our superior, high performance, calcium sulphonate complex grease, specifically formulated for high temperature and very long life applications. It has a distinctive burgundy colour and is designed to match the performance of polyurea thickened greases.

PEERLESS™ LLG has a NLGI No. 2 consistency 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, such as kilns and ovens, 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/Carbonate Complex
Colour	Burgundy
Worked Penetration @ 25°C	284
Dropping Point, °C/°F	314(597)
Base Oil Viscosity	
cSt @ 40°C	100
cSt @ 100°C	10.8
SUS @ 100°F	523
SUS @ 210°F	63
Timken OK Load, kg/lb	27(60)
Weld Point, kg	500
Operating Range, °C	-20 to 200
°F	-4 to 392
Minimum Dispensing Temperature, °C/°F	-20/-4

• SPECIALTY GREASES FOR WATER RESISTANCE

PEERLESS™ OG GREASE

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. These unusual properties are enhanced by their capabilities as EP multipurpose, high temperature greases.

PEERLESS™ OG2 – is an NLGI #2 grade with excellent adhesiveness and is ideally suited for all types of industrial and automotive bearings, for 5th 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 PEERLESS™ OG2, dyed a red colour for applications requiring the same product qualities, but also requiring greater grease visibility It also meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PEERLESS™ OG1 – is an NLGI #1 grade with lower oil viscosity and thickener content for ease of pumpability under cooler ambient conditions. PEERLESS™ OG1 meets the NLGI GC-LB standard for wheel bearing and chassis lubrication.

PEERLESS™ OG0 – is an NLGI #0 grade designed for use in low ambient temperature conditions.

PEERLESS™ OG Plus is an NLGI #2.5 grade which is particularly recommended for the wet end bearings of paper mills with its exceptional sealing properties and extremely low water washout. It is designed to prevent the bearing/grease failures in the paper mills to provide longer re-lubrication intervals and excellent equipment protection. The base oil is polymer enhanced making this grease suitable for heavily loaded bearings like those in paper mills.

Typical Characteristics are shown below:

	OG0	OG1	PEERLESS™ OG2	OG2 Red	OG PLUS
Soap Type	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex	Calcium Sulphonate/ Carbonate Complex
Colour	Tan	Tan	Tan	Red	Tan
Worked Penetration @ 25°C	366	329	276	270	245
Dropping Point, °C/°F	284/543	310/590	304/579	300/572	304/579
Base Oil Viscosity					
cSt @ 40°C	38	53	73	73	78
cSt @ 100°C	7.3	8.9	9.4	9.4	9.4
SUS @ 100°F	193	270	378	378	405
SUS @ 210°F	50	56	58	58	58
Timken OK Load, kg/lb	23/50	27/60	27/60	27/60	27/60
Weld Point, kg	315	400	400	500	500
Operating Range, °C	-35 to 163	-30 to 163	-25 to 163	-25 to 163	-20 to 163
°F	-31 to 325	-22 to 325	-13 to 325	-13 to 325	-4 to 325
Minimum Dispensing Temp °C/°F	-30/-22	-25/-13	-18/0	-18/0	-15/5
NLGI # grade	0	1	2	2	3

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 sulphide present in these gas streams. 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 a 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.

These properties make XCG-Flex 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 potentially high gear tooth loadings and vibration. XCG-Flex meets AGMA coupling grease specifications CG-1 and CG-2.

Typical Characteristics are shown below:

	PEERLESS™ XCG-Flex	PEERLESS™ SVG-102 VALVE GREASE
Thickener Type	Calcium Sulphonate/Carbonate Complex	Calcium Sulphonate/Carbonate Complex
Colour	Tan	Green/Grey
Worked Penetration @ 25°C	335	324
Dropping Point, °C/°F	290/554	262/503
Base Oil Viscosity		
cSt @ 40°C	329	80
cSt @ 100°C	22.5	11.2
SUS@ 100°F	1,764	412
SUS@ 210°F	112	64
Weld Point, kg	500	620
Timken OK Load, kg/lb	30(65)	27(60)
Oil Separation, %	0.1	–
Water Wash-out, %	1.5	1.5
Operating Range, °C	-20 to 163	-35 to 163
°F	-4 to 325	-31 to 325
Minimum Dispensing Temp °C/°F	-20/-4	-35/-31

• FOOD GRADE GREASES

PURITY™ FG2 and PURITY™ FG00 greases are advanced food grade lubricants specially formulated to deliver exceptional performance and food grade purity 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, guides and couplings found on 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 exceptional anti-wear and EP properties, protect against rust and corrosion and are cream in colour.

PURITY™ FG2 Synthetic grease is specially formulated to provide outstanding lubrication in food processing applications running under heavier loads or subject to high and low temperature extremes. It is recommended as a multiservice or multi-application lubricant across all food processing applications including mixing, cooking, stirring, baking, frying, packaging, canning and bottling.

PURITY™ FG2 Extreme grease is a high viscosity, semi synthetic, heavy duty 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 heavily loaded while operating continuously, such as Animal Feed Pellet Mills and continuous rotary cookers. PURITY™ FG2 Extreme is best suited for applications under 1000 RPM's.

PURITY™ FG2 Clear grease is an advanced colourless lubricant specially formulated to deliver superior performance and food grade purity under the highly demanding conditions of food processing operations when compared to other clear food grade greases. PURITY™ FG2 Clear grease was designed

for use in anti-friction bearings, slides, guides and couplings throughout food processing plants. It is specifically formulated for beverage production machinery such as canning and bottling equipment.

PURITY™ FG2 with **MICROL**† and **PURITY FG2** with **MICROL**† **MAX** greases are a new generation of lubricants specially formulated to inhibit the growth of microbes that cause product degradation in lubricants. PURITY™ FG2 with MICROL† and PURITY FG2 with MICROL MAX are NSF registered H1 lubricants with EPA registered antimicrobial preservatives.

Food Industry Approvals	PURITY™ FG2	PURITY™ FG2 with MICROL	PURITY™ FG2 with MICROL† MAX	PURITY™ FG00	PURITY™ FG2 Synthetic	PURITY™ FG2 Extreme	PURITY™ FG2 CLEAR
NSF H1 registered	✔	✔	✔	✔	✔	✔	✔
complies with FDA 21 CFR 178.3570 "Lubricants with incidental food contact"	✔	✔	✔	✔	✔	✔	✔
Acceptable for use in food processing facilities in Canada	✔	✔	pending	✔	✔	✔	✔

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Typical Characteristics are shown below:

	PURITY™ FG2	PURITY™ FG2 with MICROL	PURITY™ FG2 with MICROL MAX	PURITY™ FG00	PURITY™ FG2 Synthetic	PURITY™ FG2 Extreme	PURITY™ FG2 Clear
Thickener Type	Aluminum Complex	Polyurea	Aluminum Complex	Aluminum Complex	Calcium Sulphonate Complex/ Carbonate	Aluminum Complex	Aluminum Complex
Colour	Cream	Cream	Cream	Cream	Tan	Cream	Clear
Worked Penetration @ 25°C	283	293	292	420	294	276	293
Dropping Point, °C/°F	277/531	309/588	287/549	211/412	304/579	264/507	277/530
Base Oil Viscosity							
cSt @ 40°C	182	182	182	182	50	469	185
cSt @ 100°C	17	17	17	17	8	33	18
SUS @ 100°F	958	958	958	958	233	2,502	971
SUS @ 210°F	88	88	88	88	52	162	92
Timken OK Load, kg/lb	16/35	14/30	27/60	16/35	27/60	23/50	9/20
Weld Point, kg	500	250	315	620	500	400	200
Operating Range, °C	-20 to 160	-20 to 70	-20 to 160	-35 to 120	-40 to 200	-20 to 160	-20 to 160
°F	-4 to 320	-4 to 158	-4 to 320	-31 to 248	-40 to 392	-4 to 320	-4 to 320
Minimum Dispensing Temperature, °C/°F	-20/-4	-20/-4	-20/-4	-30/-22	-35/-31	-20/-4	-20/-4

†MICROL is antimicrobial product protection.

VULTREX™ OGL AND EGF GREASES

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, excavators and draglines. The VULTREX™ OGL line of greases are 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 higher viscosity aluminum complex environmentally-friendly, 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 -30°C/-22°F. It meets the P&H 520 Multiservice Mining Lubricant specification and the P&H 464 Open Gear Lubricant specification. It is on the Certified Lubricants Listing for the Bucyrus International SD 4713 specification.

VULTREX™ OGL Synthetic All Season 680 is an aluminum complex environmentally-friendly, solvent-free, open gear lubricant. Its wide operating temperature range allows it to be used year-round at most mines. VULTREX™ OGL Synthetic All Season 680 resists water wash-off from the shovel stick under all weather conditions, and has a low temperature limit of -40°C/°F. It meets the P&H 464 Open Gear Lubricant specification and is on the Certified Lubricants Listing for the Bucyrus International SD 4713 specification.

VULTREX™ OGL Synthetic Arctic is a similar aluminum complex environmentally-friendly, solvent-free product, with a proven track record in the very cold temperatures encountered during the winter season in sub-arctic regions. It meets the P&H 464 Open Gear Lubricant specification and is on the Certified Lubricants Listing for the Bucyrus International SD 4713 specification.

VULTREX™ OGL Heavy 3600 is an aluminum complex, 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 is on the Certified Lubricants Listing for the Bucyrus International SD 4713 specification.

VULTREX™ EGF 1000 (Enclosed Gear Fluid) - is a semi-fluid aluminum complex grease intended for use in heavily loaded enclosed gear-boxes found on mining shovels, draglines and excavators. It is also recommended for use in the enclosed gear drives of underground mining locomotives, as a ball-mill gear lubricant and on open gears in heavily loaded mills and tumblers.

Typical Characteristics are shown below:

	VULTREX™				
	OGL Synthetic 2200	**OGL Synthetic All Season 680**	**OGL Synthetic Arctic**	**OGL Heavy 3600**	**EGF 1000**
Soap Type	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex
Worked Penetration @ 25°C	376	405	378*	369	451
Dropping Point °C/°F	238/460	243/469	202/396	223/433	205/401
Apparent Viscosity cSt @ 40°C**	20,400	10,710	4,230	26,800	5,880
Timken OK Load, kg/lb	25/55	18/40	18/40	–	23/50
Weld Point, kg	800	800*****	800*****	>800	400
Operating Range, °C	-30 to 50	-40 to +40	-50 to +10	-10 to 50	-40 to 100****
°F	-22 to 122	-40 to 104	-58 to 50	23 to 122	-40 to 212
Minimum Dispensing,* Centralised System °C/°F**	-30/-22	-40/-40	-50/-58	-10/+23	-30/-22

* Plastic cone used

** Viscosity as applied – apparent viscosity is the ratio of shear stress to shear rate of a non-Newtonian fluid – this information can be valuable in predicting the ease of pumping and dispensing of greases.

*** Based on pumpablity 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.

**** Once the gear case is filled, the gearing system can operate at temperatures as low as -40°C/°F based on actual operation.

***** Measured before the addition of diluent, as per the 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 EP, antiwear and water resistance properties. Meets the P&H 472 Multi-purpose grease specification.

VULTREX™ MPG EP1 is recommended for heavy-duty gear and bearing applications served by centralized greasing systems or requiring greater grease mobility than VULTREX™ MPG EP 2. Meets the P&H 472 Multi-purpose grease specification.

VULTREX™ MPG EP2 is recommended for heavy-duty gear and bearing applications operating at low speed and high temperatures. Meets the P&H 472 Multi-purpose grease specification.

VULTREX™ G-123 and G-124 are red tacky greases designed for visibility 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:

	MPG SYNTHETIC ARCTIC	MPG EP1	VULTREX™ MPG EP2	G-123	G-124
Soap Type	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex	Aluminum Complex
Colour	Brown	Green-Brown	Green-Brown	Red	Red
Worked Penetration @ 25°C	368	328	272	323	279
Dropping Point, °C/°F	238/460	275/527	288/550	271/520	277/531
Base Oil Viscosity					
cSt @ 40°C	138	403	403	220	220
cSt @ 100°C	19.4	25.1	25.1	17.9	17.9
SUS @ 100°F	705	2,170	2,170	1,168	1,168
SUS @ 210°F	97.3	124	124	91	91
Timken OK Load, kg/lb	23/50	20/45	20/45	23/50	23/50
Weld Point, kg	400	250	250	315	315
Operating Range, °C	-45 to 120	-25 to 160	-20 to 160	-25 to 160	-20 to 160
°F	-49 to 248	-13 to 320	-4 to 320	-13 to 320	-4 to 320
Minimum Dispensing Temperature, °C/°F	-45/-49	-20/-4	-15/5	-20/-4	-15/5

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VULTREX™ SPECIALTY GREASES

VULTREX™ ROLLING CAM AND VULTREX™ ROLLING CAM LIGHT are designed for use on Bucyrus International Inc., draglines incorporating the Rolling (Monighan) Cam mechanism. They conform to Bucyrus International Inc.,specification X-2640, Scope B.

VULTREX™ SLIDE CAM AND VULTREX™ SLIDE CAM LIGHT are designed to lubricate the Cam and Slide Walking Mechanisms found on Bucyrus International Inc., draglines. They conform to Bucyrus International Inc., specification X-2636, Scope A and B and have an NLGI #00 consistency.

VULTREX™ GEAR SHIELD NC and VULTREX™ GEAR SHIELD P are semi-fluid lubricants designed for the open gear systems found in many types of ore-crushing mills, including ball, rod and sag mills, as well as kilns and dryers. They meet the requirements of most major mill and gear manufacturers, including UBE, Koppers, Falk, Dominion, Boliden-Allis, Metso (Svedala) and Fuller.

VULTREX™ GEAR DRESSING EP is a high quality water and heat resistant lubricant with very tenacious film characteristics. Having this feature provides increased protection against abnormally heavy loads and pressures. It is specially formulated for the lubrication of industrial open gears and chains when applied by a caulking gun.

VULTREX™ ROCK DRILL EP000 is a lithium semi-fluid grease specially formulated for mist-free operation when used in air-operated rock drills and similar mining equipment. It meets the requirements of rock drill manufacturers, such as Ingersoll-Rand, Worthington, Joy and Parts Headquarters. VULTREX™ ROCK DRILL EP 000 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 will still flow 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 tenaceous, long fibre barium grease, has lubricated successfully to more than 2000 foot drill depths without wash off, or wipe off.

VULTREX™ API MODIFIED THREAD COMPOUND is an aluminum complex grease which contains 64% solids (graphite, lead, zinc and copper) and conforms to API Bulletin 5A2 on “Thread Compounds for Casing, Tubing and Line Pipe.” It is designed to protect threads from galling and to provide a positive seal against drilling fluids.

VULTREX™ TOOL JOINT COMPOUND is an aluminum complex grease which contains 51% of finely powdered zinc and conforms to API Specification 7, Appendix F “Recommended Thread Compounds for Rotary Shouldered Connections.” It is applied to pipe connections to prevent galling and provide a positive seal against drilling mud pressure.

Typical Characteristics are shown below:

	VULTREX™			
	ROLLING CAM	**ROLLING CAM LIGHT**	**SLIDE CAM**	**SLIDE CAM LIGHT**
Thickener Type	Clay	Clay	Clay	Clay
Colour	Black	Black	Grey-Black	Grey-Black
Worked Penetration @ 25°C	338	356	406	412
Dropping Point, °C/°F	>304/>579	>304/>579	>304/>579	>304/>579
Base Oil Viscosity				
cSt @ 40°C	588	75	576	185
cSt @ 100°C	31.1	10	31.8	17.3
SUS @ 100°F	3,195	387	3,124	972
SUS @ 210°F	152	58	155	89
Timken OK Load, kg/lb	23/50	23/50	23/50	25/55
Weld Point, kg	800	800	800	620
Operating Range, °C	-20 to >100	-35 to >100	-25 to >100	-35 to >100
°F	-4 to >212	-31 to >212	-13 to >212	-31 to >212
Minimum Dispensing Temperature, °C/°F	-15/+5	-30/-22	-20/-4	-30/-22

	GEAR SHIELD NC	VULTREX™ GEAR SHIELD P	GEAR DRESSING EP
Thickener	-	-	Clay
Colour	Black	Black	Black
Worked Penetration @ 25°C	395	447	305
Dropping Point, °C/°F	26/79	24/75	>300/>572
Base Oil Viscosity			
cSt @ 40°C (with diluent)	4,931	6,342	-
cSt @ 40°C (without diluent)	-	-	26,554
SUS @ 100°C (without diluent)	1,620	1,300	646
SUS @ 100°F (with diluent)	26,000	34,000	-
SUS @ 100°F (without diluent)	-	-	148,600
SUS @ 212°F (without diluent)	7,650	6,200	3,006
Timken OK Load, kg/lb	18/40	20/45	20/45
Weld Point, kg	400	400	315

	VULTREX™ ROCK DRILL EP000	DRILL ROD HEAVY
Soap Type	Lithium	Barium Complex
Colour	Dark Amber	Green/Brown
Worked Penetration @ 25°C	458	234
Dropping Point, °C °F	158/316	201/393
Base Oil Viscosity		
cSt @ 40°C	129	156
cSt @ 100°C	13.1	14
SUS @ 100°F	679	820
SUS @ 210°F	72	77
Timken OK Load, kg/lb	18/40	-
Weld Point, kg	200	-
Operating Range, °C	-30 to 100	-12 to 135
°F	-22 to 212	10 to 275
Minimum Dispensing Temperature, °C/°F	-30/-22	-

	VULTREX™ API MODIFIED THREAD COMPOUND	TOOL JOINT COMPOUND
Soap Type	Aluminum Complex	Aluminum Complex
Worked Penetration @ 25°C	325	280
Dropping Point, °C/°F	138/280	196/385
Base Oil Viscosity		
cSt @ 40°C	103	103
cSt @ 100°C	11.5	11.5
SUS @ 100°F	539	539
SUS @ 210°F	65	65

THERMEX™

THERMEX™ grease is a red NLGI #2 grade formulated with a silica gel thickener, a synthetic oil and an oxidation inhibitor. THERMEX™ grease has excellent shear stability and has a good service life at temperatures in excess of 260°C.

When exposed to high temperatures it neither softens nor melts as conventional greases do. It does not harden or carbonize at these extreme temperatures because the fluid component vaporizes slowly, leaving little or no deposit. Regular greasing intervals replaces the normal evaporation loss. The required interval varies by application.

Typical Characteristics are shown below:

	THERMEX™
Thickener Type	Silica Gel
Worked Penetration @ 25°C	280
Dropping Point, °C/°F	260+/500+
Base Oil Viscosity	
cSt @ 40°C	227
cSt @ 100°C	37
SUS @ 100°F	1,146
SUS @ 210°F	174
Weld Point, kg	160


MAXIMUM PERFORMANCE
PATENTED PURITY PROCESS
TM

FOOD GRADE LUBRICANTS

Petro-Canada 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.

Blended from 99.9% pure, crystal clear base oils produced from a patented HT Purity process, PURITY™ FG products are fortified with specially selected additives to protect against wear, shock loading, and corrosion. They are highly resistant to the harsh conditions found in most food and beverage processing operations, including high pressure water sprays and water contamination, exposure to fats, acids, cleaning and sanitizing solutions.

PURITY™ FG with MICROL™† lubricants now feature MICROL antimicrobial preservative to inhibit the growth of microbes that can cause product degradation. This new generation of lubricants is the first NSF registered H1 lubricants with an EPA registered antimicrobial preservative to protect the lubricant.

PURITY™ FG Synthetic products are blended with PAO and PIB synthetic base stocks to provide the same outstanding lubrication performance over an even wider range of operating temperatures.

All PURITY™ FG products are among the highest food industry purity standards and fit perfectly in HACCP (Hazard Analysis Critical Control Point) and GMP (Good Manufacturing Practice) plans.

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 adherence to metal surfaces and resistance to dripping; throw-off; and water spray loss.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG Chain Fluid	
	Light	**Heavy**
Viscosity cSt @ 40°C	151	370
cSt @ 100°C	20	44
SUS @ 100°F	777	1,908
SUS @ 210°F	100	212
Viscosity Index	150	175
Flash Point, °C/°F	230/446	240/464
Pour Point, °C/°F	-12/10	-12/10
4 Ball Wear Scar Diam., mm	0.41	0.39

†MICROL is an antimicrobial product protection agent.

PURITY™ FG COMPRESSOR FLUIDS

PURITY™ FG Compressor Fluids are formulated to deliver excellent performance and increased service life. Typical applications include the lubrication of air compressors and vacuum pumps used for producing, manufacturing, packaging, 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.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG Compressor Fluids			
	32	**46**	**68**	**100**
Viscosity cSt @ 40°C	31	44	67	101
cSt @ 100°C	5.2	6.6	8.6	11.4
SUS @ 100°F	160	227	347	527
SUS @ 210°F	43	48	55	65
Viscosity Index	100	98	100	98
Flash Point, °C/°F	219/426	249/480	257/495	285/545
Pour Point, °C/°F	-18/0	-18/0	-15/5	-15/5
Oxidation stability RPVOT, minutes	1000+	1000+	1000+	1000+

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

PURITY™ FG SYNTHETIC FLUID

PURITY™ FG Synthetic Fluid is a synthetic PAO based product formulated with selective additives to protect against wear, oxidation, rust and corrosion. Tough enough to handle wet food processing environments with wide temperatures, PURITY™ FG Synthetic Fluid can be used in compressor, vacuum pump, pneumatic and hydraulic applications, as well as in low temperature applications such as freezers.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG Synthetic 46 Fluid	PURITY™ FG Synthetic 100 Fluid
Viscosity cSt @ 40°C	46	98.7
cSt @ 100°C	7.7	14.2
SUS @ 100°F	235	506
SUS @ 210°F	52	76
Viscosity Index	134	147
Flash Point, COC, °C/°F	269/516	269/516
Pour Point, °C/°F	<-57/<-70	-57/-70
Oxidation stability RPVOT, minutes	~4500	~4500

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

PURITY™ FG GREASES

PURITY™ FG Greases are advanced food grade lubricants specially formulated to deliver exceptional performance and food grade purity 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, guides and couplings found on 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 and EP properties, protect against rust and corrosion and are cream in colour.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG Greases	
	FG2	**FG 00**
Soap Type	Aluminum Complex	Aluminum Complex
NGLI Grade	2	00
Colour	Cream	Cream
Worked Penetration @ 25°C	283	420
Dropping Point, °C/°F	277/531	211/412
Base Oil Viscosity		
cSt @ 40°C	182	182
cSt @ 100°C	17.0	17.0
SUS @ 100°F	958	958
SUS @ 210°F	88	88
Timken OK Load, kg/lb	16/35	16/35
Weld Point, kg	500	620
Operating Temperature Range		
min, C°/F°	-20/-4	-35/-31
max, C°/F°	160/320	120/248

PURITY™ FG2 WITH MICROL™†

PURITY™ FG2 with MICROL and PURITY™ FG2 with MICROL MAX greases are a new generation of lubricants specially formulated to inhibit the growth of microbes that can cause product degradation in PURITY™ FG greases. PURITY™ FG2 with MICROL and PURITY™ FG2 with MICROL MAX are NSF registered H1 lubricants with an U.S. EPA registered antimicrobial preservatives.

PURITY™ FG2 with MICROL and PURITY™ FG2 with MICROL MAX exhibits good low temperature pumpability and excellent resistance to water washout and water spray loss. They also have excellent antiwear and EP properties and protects against rust and corrosion.

†MICROL is antimicrobial product protection.

Typical Characteristics are shown below:

	PURITY™ FG2	
	with MICROL	**with MICROL MAX**
NGLI Grade	2	2
Soap Type	Polyurea	Aluminum Complex
Colour	Cream	Cream
Worked Penetration @ 25°C	293	292
Dropping Point, °C/°F	309/588	287/549
Base Oil Viscosity		
cSt @ 40°C	182	182
cSt @ 100°C	17	17
SUS @ 100°F	958	958
SUS @ 210°F	88	88
Timken OK Load, kg/lb	14/30	27/60
Weld Point, kg	250	315
Operating Temperature Range	-20°C (-4°F) to 160°C (320°F)	-20°C (-4°F) to 160°C (320°F)
Antimicrobial Protection Temperature Range	-20°C (-4°F) to 70°C (158°F)	-20°C (-4°F) to 160°C (320°F)

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PURITY™ FG2 SYNTHETIC GREASE

PURITY™ FG2 Synthetic grease is specially formulated to provide outstanding lubrication in food processing applications running under heavier loads or subject to high and low temperature extremes. It is recommended as a multipurpose lubricant across all food processing applications including mixing, cooking, stirring, baking, frying, packaging, canning and bottling.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG2 Synthetic
NGLI Grade	2
Soap Type	Calcium Sulphonate/ Carbonate Complex
Colour	Tan
Worked Penetration @ 25°C	294
Dropping Point, °C/°F	304/579
Base Oil Viscosity	
cSt @ 40°C	50.0
cSt @ 100°C	7.8
SUS @ 100°F	233
SUS @ 210°F	52
Timken OK Load, kg/lb	27/60
Weld Point, kg	500
Operating Temperature Range	-40°C (-40°F) to 200°C (392°F)

PURITY™ FG2 EXTREME GREASE

PURITY™ FG2 EXTREME grease is a high viscosity, semi synthetic, heavy duty 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 while operating continuously, such as animal feed pellet mills and continuous rotary cookers. PURITY™ FG2 Extreme is best suited for applications under 1000 RPM's.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG2 EXTREME
Soap Type	Aluminum Complex
NGLI Grade	2
Colour	Cream
Worked Penetration @ 25°C	276
Dropping Point, °C/°F	264/507
Base Oil Viscosity	
cSt @ 40°C	469
cSt @ 100°C	33.2
SUS @ 100°F	2,502
SUS @ 210°F	162
Timken OK Load, kg/lb	23/50
Weld Point, kg	400
Normal Operating Temperature Range	-20°C (-4°F) to 160°C (320°F)

PURITY™ FG2 CLEAR GREASE

PURITY™ FG2 CLEAR grease is an advanced colourless lubricant specially formulated to deliver superior performance and food grade purity under the highly demanding conditions of food processing operations when compared to other CLEAR food grade greases. PURITY™ FG2 CLEAR grease was designed for use in anti-friction bearings, slides, guides and couplings throughout food processing plants. It is specifically formulated for beverage production machinery such as canning and bottling equipment.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on page 170.

Typical Characteristics are shown below:

	PURITY™ FG2 CLEAR
Soap Type	Aluminum Complex
NGLI Grade	2
Colour	Clear
Worked Penetration @ 25°C	293
Dropping Point, °C/°F	277/531
Base Oil Viscosity	
cSt @ 40°C	185
cSt @ 100°C	18
SUS @ 100°F	971
SUS @ 210°F	92
Timken OK Load, kg/lb	9/20
Weld Point, kg	200
Normal Operating Temperature Range	-20°C (-4°F) to 160°C (320°F)

PURITY™ FG EP GEAR FLUIDS

PURITY™ FG EP Gear Fluids are advanced food grade lubricants formulated to deliver exceptional, longer lasting protection of enclosed gear drives (worm, helical, bevel and spur) used in food processing machinery. They can also be used in bearings and chain drives. PURITY™ FG EP Gear fluids are non-reactive to yellow metals.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG EP Gear Fluid				
	100	**150**	**220**	**320**	**460**
Viscosity cSt @ 40°C	103	144	206	327	462
cSt @ 100°C	11.6	14.2	17.6	23.2	30.3
SUS @ 100°F	538	757	1,089	1,750	2,477
SUS @ 210°F	66	76	91	116	148
Viscosity Index	100	95	92	89	98
Flash Point, °C/°F	269/516	247/477	233/451	223/433	189/372
Pour Point, °C/°F	-15/5	-18/0	-18/0	-21/-6	-27/-17
AGMA No.	3	4	5	6	7

PURITY™ FG EP GEAR FLUIDS with MICROL™†

PURITY™ FG EP Gear Fluids with MICROL are advanced food grade lubricants formulated to deliver exceptional, longer lasting protection of enclosed gear drives (worm, helical, bevel and spur) used in food processing machinery. They can also be used in bearings and chain drives. PURITY™ FG EP Gear Fluids with MICROL have the added advantage of an antimicrobial preservative to further protect the lubricant and reduce product degradation caused by microbes.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG EP Gear Fluid with MICROL		
	100	**150**	**220**
Viscosity cSt @ 40°C	101	143	224
cSt @ 100°C	11.4	14.3	18.9
SUS @ 100°F	528	749	1,184
SUS @ 210°F	65	76	96
Viscosity Index	99	97	94
Flash Point, °C/°F	271/520	219/426	211/412
Pour Point, °C/°F	-12/10	-15/5	-18/0
AGMA No.	3	4	5

†MICROL is an antimicrobial product protection agent.

PURITY™ FG SYNTHETIC EP GEAR FLUID

PURITY™ FG Synthetic EP Gear Fluid is 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. They can also be used as as a blower lobe lubricant. PURITY™ FG Synthetic EP Gear Fluid is 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.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

	PURITY™ FG Synthetic EP Gear Fluid 220
Viscosity cSt @ 40°C	213
cSt @ 100°C	26.4
SUS @ 100°F	1,098
SUS @ 210°F	129
Viscosity Index	158
Flash Point, °C/°F	273/523
Pour Point, °C/°F	-40/-40
AGMA No.	5

PURITY™ FG HEAT TRANSFER FLUID

PURITY™ FG Heat Transfer Fluid is a food grade 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 manufacture of plastic bottles, films and containers for the packaging of food products.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG Heat Transfer Fluid
Viscosity cSt @ 40°C	37.1
cSt @ 100°C	5.9
SUS @ 100°F	191
SUS @ 210°F	45.6
Viscosity Index	98
Flash Point, COC, °C/°F	237/459
Pour Point, °C/°F	-18/0
Autoignition Temp, °C / °F	354/669
Max Bulk Temp, °C / °F	326/619

For details on the complete line of Heat Transfer Fluids, see CALFLO™ on page 95.

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 effective equipment performance.

PURITY™ FG Seamer-E Fluid is recognized by Pneumatic Scale Angelus®, one of the world's largest manufacturers of can seamer machines. PSAngelus has shown no objection for the fluids use in seamers of the series: 61/62H, 80/81L, 100/101L, 120/121L, 140S, 180S and 12M.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG Seamer-E Fluid
Viscosity cSt @ 40°C	131
cSt @ 100°C	14.9
SUS @ 100°F	679
SUS @ 210°F	79
Viscosity Index	116
Flash Point, COC, °C/°F	243/469
Pour Point, °C/°F	-15/5
4-Ball Wear, mm	0.5
4-Ball EP Weld Load, kgf	200

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 (airline) oilers in pneumatic systems commonly found in food packaging applications.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG AW Hydraulic Fluid			
	32	**46**	**68**	**100**
Viscosity cSt @ 40°C	29.8	45.4	63.3	102
cSt @ 100°C	5.2	6.8	8.4	11.5
SUS @ 100°F	154	234	328	529
SUS @ 210°F	44	49	54	66
Viscosity Index	101	102	102	99
Flash Point, °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
FZG Stage Pass	12	12	12	12

PURITY™ FG AW HYDRAULIC FLUIDS WITH MICROL†

PURITY™ FG AW Hydraulic Fluids with MICROL 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 the same excellent performance as our PURITY™ FG AW Hydraulic Fluids with the added advantage of an antimicrobial preservative to protect the lubricant and further prevent product degradation by microbes.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG AW Hydraulic Fluid with MICROL			
	32	**46**	**68**	**100**
Viscosity cSt @ 40°C	30.5	45.7	64.5	98.2
cSt @ 100°C	5.3	6.8	8.6	11.3
SUS @ 100°F	157	236	334	511
SUS @ 210°F	44	49	55	65
Viscosity Index	102	104	104	101
Flash Point, °C/°F	215/419	241/466	253/487	275/527
Pour Point, °C/°F	-18/0	-18/0	-18/0	-15/+5
Four-Ball Wear (mm) (40kg, 1200 rpm, 1 hr., 75°C)	0.43	0.45	0.49	0.50

†MICROL is an antimicrobial product protection agent.

PURITY™ FG SPRAY

PURITY™ FG Spray is an advanced multipurpose food grade lubricant packaged in a convenient 290 gram / 400 mL aerosol can. Typical applications include chains, rails and guides, slides, pivots, cables and linkages, gears, hinges and small bearings used in food processing operations. It is also an excellent release agent for gaskets and seals.

PURITY™ FG Spray contains special tackifiers to reduce drips and 'fling off' from moving parts. PURITY™ FG Spray uses a environmentally-friendly, non-ozone depleting propellent (CFC free).

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical characteristics are shown below:

	PURITY™ FG Spray (without propellent)
Viscosity cSt @ 40°C	151
cSt @ 100°C	19.8
SUS @ 100°F	777
SUS @ 210°F	100
Viscosity Index	150
Pour Point, °C/°F	-12/10

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 protect against oil drips. PURITY™ FG Trolley Fluid can also be utilized as a light chain oil in either a drip or atomized application.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG Trolley Fluid 46
Viscosity cSt @ 40°C	43.7
cSt @ 100°C	7.3
SUS @ 100°F	224
SUS @ 210°F	50.4
Viscosity Index	131
Flash Point, °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 food processing, and agricultural industries. Blended with Vitamin E as a stabilizer for extended shelf life, PURITY™ FG WO white mineral oils are ideally suited for applications that require a straight, non-toxic white mineral oil. These applications include direct and indirect food contact in the production, packaging, and processing of food.

Food Industry Approvals

Please see Food Industry Approvals/Credentials on **page 170.**

Typical Characteristics are shown below:

	PURITY™ FG WO Fluids					
	10	**15**	**35**	**40**	**68**	**90**
Viscosity, cSt @ 40°C	12.7	15.0	36.1	40.2	68	103
cSt @ 100°C	3.1	3.4	5.8	6.2	8.9	11.8
SUS @ 100°F	72	82	186	207	351	535
SUS @ 210°F	36.6	37.5	45.4	46.6	55.7	66.5
Viscosity Index	100	98	105	100	100	104
Density, kg/L @ 15°C	0.846	0.859	0.864	0.865	0.866	0.870
Flash Point, °C/°F	190/374	175/347	220/428	240/464	>200/>392	266/510
Pour Point, °C/°F	-24/-11.2	-18/0	-18/0	-18/0	-18/0	-15/5
Colour, Saybolt	30	30	30	30	30	30

Food Industry Approvals/Credentials

	NSF Registrations			Acceptable for use in food processing facilities in Canada			Kosher and Pareve by Star K			IFANCA	Food Allergens and GMS		
Product Name	**H1**	**3H**	**HT1**	**	**		**Approved for the preparation of Kosher Foods**	**Kosher and Pareve**	**Kosher for Passover***	**Halal**	**Allergens*****	**Gluten**	**Free of Genetically Modified Substances (GMS)**
PURITY FG AW Hydraulic Fluid	X			X			X			X	X	X	X
PURITY FG AW Hydraulic Fluid with MICROL	X			X			X			X	X	X	X
PURITY FG EP Gear Fluid	X			X			X			X	X	X	X
PURITY FG EP Gear Fluid with MICROL	X			X			X			X	X	X	X
PURITY FG Synthetic EP Gear Fluid	X			X				X		X	X	X	X
PURITY FG Chain Fluid	X			X				X	X	X	X	X	X
PURITY FG Compressor Fluid	X			pending			X			X		X	
PURITY FG Synthetic Compressor Fluid	X			X				X		X	X	X	X
PURITY FG Seamer-E Fluid	X			X				X		X	X	X	X
PURITY FG Spray	X			X				X	X	X	X	X	X
PURITY FG Trolley Fluid	X			X				X	X	X	X	X	X
PURITY FG Heat Transfer Fluid			X			X		X	X	X			
PURITY FG White Oils	X	X		X	X			X	X	X	X	X	X
PURITY FG2	X			X				X		X	X	X	
PURITY FG2 with MICROL	X			X			X			X	X	X	X
PURITY FG2 with MICROL MAX	X			pending				X		X	X	X	
PURITY FG 00	X			X				X		X	X	X	
PURITY FG2 Synthetic	X			X				X		X	X	X	
PURITY FG2 Extreme	X			X				X		X	X	X	
PURITY FG2 Clear	X			X				X		X	X	X	

NOTES: Regardless of the absence of these allergens in the lubricants, Purity FG lubricants are approved for use only as Lubricants with Incidental Food Contact as per 21CFR 178.3570. They are not food additives and are not to be added to food products.
*PURITY FG White Oil 10, 40 & 68 grades pending approval.
**PURITY FG White Oil 10 & 40 grade are pending approval.
***The following allergens were reviewed: fish, eggs/egg products, milk/milk products, nuts/nut derivatives, sesame seeds, shellfish, soybeans/soybean products, sulphites and wheat/wheat products. For a complete list of PURITY FG approvals, consult a Petro-Canada Technical Service Representative.
†MICROL is antimicrobial product protection.

PROCESS FLUIDS

INTRODUCTION

Petro-Canada's line of Process Fluids are select blends of high quality base fluids, designed for use by industry in a wide range of finished products.

Petro-Canada's line of Process Fluids includes:

- PARAFLEX™ HT Fluids
- PUREDRILL™ Drilling Mud Base Fluids
- VHVI Specialty Base Fluids

PARAFLEX™ HT FLUID

PARAFLEX™ HT Fluids are carefully controlled blends of the advanced base oils produced from Petro-Canada's HT Purity Process, which removes undesirable polar and aromatic compounds from the product. Composed of saturated hydrocarbons, PARAFLEX™ HT Fluids are crystal clear and have low toxicity.

PARAFLEX™ HT Fluids are recommended for use as raw materials in the manufacture of a wide range of chemical, elastomer, lubricant and specialty products.

Typical Characteristics are shown below:

	PARAFLEX™ HT					
	3	**4**	**5**	**9**	**10**	**15**
Density, kg/l @ 15°C	0.845	0.825	0.855	0.830	0.857	0.851
Colour, ASTM	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Viscosity						
cSt @ 40°C	3.6	3.7	5.7	9.8	11.0	15.5
cSt @ 100°C	1.3	1.4	1.8	2.6	2.8	3.5
SUS @ 100°F	38	39	46	61	65	85
SUS @ 210°F	<32	<32	32	35	35	38
Viscosity Index	–	–	–	98	83	100
Pour Point, °C/°F	-24/-11	-57/-71	-12/+10	-39/-38	-24/-11	-24/-11
Aromatics, %Wt	2.2	<0.5	1.5	<0.5	<0.5	<0.5

	PARAFLEX™ HT				
	22	**32**	**46**	**68**	**100**
Density, kg/l @ 15°C	0.842	0.864	0.865	0.867	0.870
Colour, ASTM	<0.5	<0.5	<0.5	<0.5	<0.5
Viscosity					
cSt @ 40°C	20.7	35.6	46.0	68.4	101
cSt @ 100°C	4.2	5.7	6.8	8.9	11.5
SUS @ 100°F	106	184	237	354	526
SUS @ 210°F	40	45	49	56	65
Viscosity Index	114	97	103	103	101
Pour Point, °C/°F	-21/+6	-18/0	-15/5	-15/+5	-15/+5
Aromatics, % Wt	<0.5	<0.5	<0.5	<0.5	<0.5

PUREDRILL™ DRILLING MUD BASE FLUIDS

Petro-Canada PUREDRILL™ onshore and offshore drilling mud base fluids are specifically designed to provide significant improvements in drilling efficiency and reduced bit wear. PUREDRILL™ minimizes the environmental impact on natural habitats and improves rig worker health and safety.

PUREDRILL™ IA-35 is an ultra-pure synthetic isoalkane fluid developed for off-shore drilling operations, ideally suited for use where regulations require environmentally friendly products. PUREDRILL™ IA-35 is also readily biodegradable.

PUREDRILL™ IA-35LV is an ultra-pure low-viscosity synthetic isoalkane fluid specifically developed for off-shore, ultra-deep, cold-water drilling operations. PUREDRILL™ IA-35LV is also readily biodegradable.

PUREDRILL™ HT-30 is a low viscosity, severely hydrocracked, low toxicity mineral oil, specially formulated as a safer, more environmentally friendly option to diesel fuel for onshore drilling and offshore zero discharge drilling.

PUREDRILL™ HT-40 is specifically developed for onshore drilling and is also suitable for offshore zero-discharge drilling. It is a severely hydrocracked low-toxicity mineral oil representing a much safer, odourless replacement for diesel fuel.

Typical properties for these fluids are given below:

	PUREDRILL™ IA-35	PUREDRILL™ IA-35LV	PUREDRILL™ HT-30	PUREDRILL™ HT-40
Density, kg/l @ 15°C	0.83	0.80	0.82	0.84
Colour, ASTM	<0.5	<0.5	<0.5	<0.5
Appearance	Water White	Water White	Water White	Water White
Kinematic Viscosity, cSt @ 40°C	3.5	2.6	2.6	3.5
SUS @ 100°F	37.6	34.6	34.6	37.6
Flash Point, ASTM D93, °C/°F	134/273	94/201	94/201	104/219
Pour Point, °C/°F	-57/-71	-54/-65	-36/-33	Smr-18/-0.4 Wtr-33/-27
Aniline Point, °C/°F	90/194	82/180	83/181	78/172
Polynuclear Aromatics, ppm	<10	<10	<10	<10

VHVI SPECIALTY BASE FLUIDS

Petro-Canada Specialty Base Fluids are a series of severely hydrocracked, very high VI mineral base fluids of exceptionally high purity.

Typical characteristics for these fluids are as follows:

	VHVI 2	VHVI 4	VHVI 6	VHVI 8
Density, kg/l @ 15°C	0.832	0.832	0.839	0.847
Colour, ASTM	<0.5	<0.5	<1.0	<1.5
Kinematic Viscosity, cSt @ 40°C	9.7	21.1	33.1	50.6
cSt @ 100°C	2.6	4.5	6.0	8.2
SUS @ 100°F	60	110	170	259
Viscosity Index	100	127	128	127
Flash Point, COC, °C/°F	185/365	230/446	240/464	258/496
Pour Point, °C/°F	-39/-38	-24/-11	-18/0	-15/+5
Aromatics, Wt %	0.10	0.10	0.10	0.10


MAXIMUM PERFORMANCE
PATENTED PURITY PROCESS
TM

FUELS & REFINERY PRODUCTS

In addition to our world scale Lubricants base oil manufacturing and blending plant in Mississauga, Ontario, which produces Ultra Low Sulphur Diesel fuel, Suncor Energy, the proud owner of Petro-Canada, operates **modern refineries in:**

- Montreal, Quebec
- Edmonton, Alberta
- Sarnia, Ontario
- Denver, Colorado

All refineries produce **gasolines** and **diesel fuels,** as Petro-Canada refineries produce certain specialty products such as aviation fuels, solvents, petrochemical feedstocks and asphalts.

GASOLINES

Petro-Canada's branded gasolines come in **4 octane grades:**

87 octane regular:	**RegularClean**
89 octane mid-grade:	**PlusClean**
91 octane premium:	**SuperClean**
94 octane super premium:	**SuperClean 94** (available in Montreal and Southern Ontario)

While 87 octane RegularClean is satisfactory for 75% of all vehicles, about 25% of Canadian vehicles require a higher octane fuel for proper performance for routine operation or during heavy load applications (towing, etc.). Most service stations offer 3 grades of gasoline to meet virtually all customer needs. Stations in Montreal and Southern Ontario also carry SuperClean 94, a 94 octane super premium gasoline. The primary purpose of the octane quality of gasolines is to prevent pre-ignition of fuels, allowing proper combustion of the fuel and preventing knocking or pinging, which may lead to poor performance and engine damage.

TACTROL™ DEPOSIT CONTROL ADDITIVE (GASOLINE DETERGENT)

TACTROL™ is Petro-Canada's own unique and exclusive **Deposit Control Additive** that acts as a detergent to prevent the build up of harmful deposits and clean-up deposits in fuel injectors and intake valves. Most vehicle manufacturers recommend using a gasoline with a detergent, and Petro-Canada's branded gasolines meet and exceed this requirement. Petro-Canada gasolines meet Top Tier requirements.

All of Petro-Canada branded gasolines contain increasing levels of Tactrol™, from a basic level in RegularClean and PlusClean to higher levels in SuperClean and SuperClean 94. Basic Tactrol™ levels in RegularClean and PlusClean will keep a fuel system clean, while higher levels in SuperClean and SuperClean 94 will reduce deposits from fuel injectors and intake valves.

More information on TactrolTM is available at Petro-Canada's website: www.Petro-Canada.ca

WinterGas

During winter months (in most of Canada), Petro-Canada offers **WinterGas** for superior cold weather protection and performance. **WinterGas** is **specially formulated** for winter conditions, to allow easier starting in very cold weather. It contains a **de-icer** to reduce the possibility of fuel line freeze-up due to condensation in vehicle fuel tanks, and, of course, it contains **TACTROL**™ to keep fuel systems clean.

Marine Gasoline

Petro-Canada's Marine Gasoline on the West Coast of Canada is an 89 octane product which should meet the needs of most marine applications. It is generally dyed red.

DIESEL FUELS

All of Petro-Canada's regular diesel fuels are **seasonally adjusted** – to meet low temperature operability requirements for different geographic areas. The fuel is designed for 97.5% of low winter temperatures that may be encountered, based on 25 years of historic temperature data. Seasonal adjustment occurs as frequently as bi-monthly, through periods of seasonal transition.

All diesel fuel sold for '**on-road**' and '**off-road**'use is **Ultra Low Sulphur diesel fuel** – with a maximum of 15 parts per million (ppm) sulphur, to reduce diesel engine emissions and comply with federal environmental regulations.

All Petro-Canada diesel fuels have **suitable lubricity** for both new and older diesel engines. "Lubricity" is the ability of a diesel fuel to lubricate fuel-wetted parts of fuel pumps and fuel injectors to reduce wear. All low sulphur diesel fuel is treated with lubricity additive to ensure that it has adequate lubricity to protect equipment from undue wear.

Petro-Pass is Petro-Canada's chain of truck stops, offering fuel, supplies and facilities for truckers across Canada. **SuperPass** is Petro-Canada's commercial credit card, fuel and information management system, and may be used across Canada and at many locations in the United States. More information is available at Petro Canada's internet web site:

www.petro-canada.ca

Petro-Canada also offers specialty diesel fuels at selected locations across Canada, such as **No. 1 Ultra Low Sulphur Diesel** for urban buses, underground mines and low temperature applications, and **Diesel 50** for very cold applications (down to -40°C or -43°C depending on supply point) in northern and arctic locations.

FURNACE FUEL / FUEL OIL

Petro-Canada offers furnace fuel oil for both residential and commercial heating. Similar to diesel fuel, furnace fuels are formulated to be suitable for different geographic regions, to meet local needs. **Stove Oil** is available in some locations, for use in stoves and small heaters, especially in mobile homes.

ThermaClean™ is Petro-Canada's home heating fuel that burns cleaner, with less smoke and soot deposits than regular furnace oil and is available in British Columbia, Ontario, Quebec, New Brunswick and Nova Scotia.

AVIATION FUELS

Jet A-1 and F-34 are turbine fuels. Jet A-1 is produced at the Edmonton and Sarnia refineries and F-34 is produced at the Edmonton refinery. Jet A-1 is used in most commercial jets and is shipped by pipeline or truck to major local airports. Jet A-1 is a kerosene-type fuel. F-34 is Jet A-1 with De-icer (fuel system icing inhibitor) and CI (corrosion inhibitor) and is the version of Jet A used by the Military. Jet A-1 and F-34 are available at the Edmonton Truck Rack.

Jet B and Jet B-DI are turbine fuels produced at Edmonton Refinery. Jet B is a 'gasoline-like' fuel, composed mostly of naphtha (wide-cut fuel) and is used by helicopters and aircraft in the north (because of it's ease of engine starting, especially in cold weather). Jet B-DI, is Jet B with De-icer (fuel system icing inhibitor). Jet B and Jet B-DI are available at the Edmonton Truck Rack.

Aviation Gasoline 100LL is also produced at Edmonton Refinery. This product is a high octane, leaded fuel designed for high compression ratio and supercharged piston aero engines. Many multiple-engine planes require this fuel. Because this is a leaded fuel it is restricted to aviation use. AvGas 100LL is available at the Edmonton Truck Rack.

Special Training is required for the loading of aviation fuels and is available at the Edmonton Terminal.

ALTERNATIVE FUELS

Propane (automotive, HD-5 quality) is sold at many Petro-Canada service stations.

Compressed Natural Gas (CNG) / Natural Gas for Vehicles (NGV) is sold at selected service stations in the Vancouver area. Petro-Canada is a major Canadian producer of **natural gas,** and sells significant volumes of natural gas into the bulk wholesale market.

Ethanol Blended gasoline (E-10) with up to 10% ethyl alcohol has varying availably across the country. In the Montreal and southern Ontario areas, SuperClean 94 and regular gasoline contain ethanol. Saskatchewan, Manitoba and Ontario have mandated the use of ethanol in gasoline and regular gasoline in these areas may contain ethanol. Pumps will be clearly labelled if the gasoline contains ethyl alcohol. As more Provincial governments mandate, and future Federal fuel standards require the use of ethanol, customers should check gasoline pumps for ethanol content warning labels.

SPECIALTY PRODUCTS

Most of the specialty products produced are sold in commercial quantities by pipeline shipment, rail car or truck loads. Petro-Canada does not offer many of these specialty products such as kerosene or PETROSOL™ 3139 in retail package sizes, but sells to other companies that package and distribute these products.

Kerosene 1-K is produced in Edmonton and Montreal. The 1-K grade is a very low sulphur, low odour product designed for use in kerosene heaters and lamps.

Montreal Refinery produces a PETROSOL™ 3355 solvent for specialty applications.

Petrochemicals: Montreal Refinery produces **benzene, toluene, xylene,** and **nonenes** for the petrochemical industry.

Other specialty products may be produced at some refineries, and these products are usually of limited or special commercial interest:

Sulphur, a basic industrial chemical, is produced at natural gas plants in Western Canada.

Coke, black carbon looking like lava rock, is used to make carbon electrodes for smelting bauxite to make aluminum.

Carbon black feedstock is a heavy, black aromatic oil used to make carbon black (finely powered carbon) for use in tire manufacture.

Suncor Energy, the proud owner of Petro-Canada, is a major producer and marketer of **asphalt** to the transportation and road building industry, to the manufacturers of asphalt shingles and roofing products, and to the construction of built-up roofing (BUR).

Asphalt is produced at our Montreal and Sarnia refineries. Asphalt is sold in tanker truckload quantities. Water access also provides the ability to load vessels at this facility.

Petro-Canada manufactures 55 performance grades (PG-grades) of Asphalt Cement to satisfy the requirements of the Ministry of Transportation of Ontario, the Quebec Ministry of Transportation, the Maritimes, Newfoundland, as well as New York State, Vermont, and New Hampshire DOTs, for the construction of asphalt pavements, parking lots and driveways.

Petro-Canada also manufactures 2 penetration and viscosity grades of Asphalt Cement to satisfy the requirements of the paving contractors for the manufacture of asphalt emulsions or other industrial applications, such as the production of asphalt shingles, and bulk or packaged BUR's.

Petro-Canada has ISO 9000 registration for the supply of asphalt.

ISO FUEL CLASSIFICATION

A simplified description is appended overleaf.

For further information on Petro-Canada Fuels or Specialty Products please contact your local Petro-Canada representative.

This section gives a simplified description of ISO 8216, Classification of Petroleum Fuels.

Under the international ISO standards, all petroleum fuels are designated by the letter “F”. The ‘code’ to describe fuels consists of the initials “ISO” followed by “**F**” and the specific category of fuel consisting of 3 letters. The first of the 3 letters is the general category described in the following paragraph.

Within the class of petroleum, there are **5 categories** defined according to the type of fuel listed in decreasing order of volatility:

- **G:** **Gaseous fuels,** generally natural gas.
- **L:** **Liquefied petroleum gases,** generally propane, butane and mixtures of the two.
- **D:** **Distillate fuels** (meaning that they have been distilled from crude oil), Sub-groups:
  - **D(L): gasoline** – light, highly volatile fuels with low flash points (hence, highly flammable); flash point below ambient temperature.
  - **D(M): middle distillate fuels,** including normal diesel fuels, furnace fuels, kerosene and stove oil; flash point above 38°C.
  - **D(H): heavy distillate,** such as heavy gas oil, may contain some residue; flash point usually above 60°C.
- **R:** **Residual fuels –** heavy fuels such as ‘bunker’ which contain the heaviest components of crude oil.
- **C:** **Petroleum coke.**

Thus a gasoline would have the following designation: **ISO-F-D(L)-yy,** where “yy” would be a specific type of gasoline.

MARINE DIESEL FUELS

(ISO 8217) have the designation: ISO-F-DMx-yy, or ISO-F-RMx-yy, where DM stands for Diesel Marine, and RM stands for Residual Marine.

- **DMX:** marine diesel fuel, for emergency purposes.
- **DMA:** marine diesel fuel, general purpose, contains no residuum.
- **DMB:** marine diesel fuel, general purpose, may contain trace.
- **DMC:** marine diesel fuel, general purpose, contains trace residuum.

- **RMA:** RMB, RMD, RME, RMF, RMG, RMH, RMK: various residual marine diesel fuels.

The number following these codes represents the maximum kinematic viscosity at 50°C. For example: ISO-F-RMA 30 and ISO-F-RMB 30 are two residual marine fuels with maximum 30 cSt viscosity at 50°C, but differ in other characteristics such as maximum density and maximum pour point.


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GLOSSARY OF TERMS

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 give 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 – (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 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 sulphurized 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 sulphur, 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 centipoises, 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 Method 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 blend 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, thus forming an inert film in these areas.

DEMULSIBILITY – test time required for a specified oil-water emulsion to break, using ASTM D1401 test method. Highly refined, unadditized mineral oils have inherently good demulsibility. Even after violently shaking 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 of oils such as 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.

DETERGENT – an additive in crankcase oils 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. DISPERSANTS operate to break up insoluble contaminant particles already formed. Particles are kept finely divided so that they can remain "dispersed" or colloidally suspended in the oil.

DISPERSANT – (see DETERGENT)

DROPPING POINT – the temperature at which a grease changes from semi-solid to a liquid state under test conditions. It may be considered an indication of the high temperature limitation for application purposes.

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. Two values are generally reported – LOAD WEAR INDEX (formerly mean Hertz load) and WELD POINT.

HYDROCRACKING – is a process, which is used by a few manufacturers of superior quality lubricant basestock. In the process, a petroleum feedstock is reacted with hydrogen, in the presence of a catalyst, at very high temperatures (400-425°C) and pressures (3000 plus psi). Under these severe conditions, virtually all the aromatic hydrocarbons present are isomerized and saturated to yield a basestock containing 96% to 99.5+% saturated hydrocarbons. The process also virtually eliminates all traces of sulphur, nitrogen and oxygen-containing impurities. Hydrocracking produces very high quality, synthetic-like basestocks, which when blended with carefully selected additives, give extremely stable lubricants of a synthetic level performance.

HYDROFINISHING – (see HYDROTREATING)

HYDROISOMERIZATON – 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 conventinal 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 poly-alpha-olefins (PAO).

HYDROTREATING – a generic name for a refinery process for treating fuels and lubricant feedstocks, at elevated temperatures, in the presence of pressurized hydrogen and a catalyst. This process may be high severity, or it may be a relatively low severity process sometimes called "Hydrofinishing" and is used to improve the colour and odour of fuels and lubricant basestocks.

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 D-445. 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 the ASTM Method 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 sulphur, 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/cm^2. 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.)

and is 3°C above the temperature to 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

POUR POINT – is a widely used low-temperature flow indicator and is 3°C above the temperature to 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 lowest 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 D-88. This test method has largely been replaced by the kinematic viscosity method. As a rule of thumb, the comparable KINEMATIC VISCOSITY of a given product whose viscosity in SUS at 100F is known can be determined by using the following conversion formula: SUS @ 100F / 5 ~ cSt @ 40C. 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 sulphur 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)

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:
- Polyalpha olefins
- Hydrocracked/HydroIsomerized Unconventional Base Oils (UCBOs)
- Organic esters
- Polyglycols

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 starting to replace 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.

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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 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 now commonly reported in CENTISTOKES (cSt), measured at either 40°C or 100°C (ASTM Method 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 Method 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 (V.I.) – 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 V.I., the less the tendency for the viscosity to change. V.I. is determined by formula from the viscosities at 40°C and 100°C in accordance with the ASTM Test Method D567 or D2270. The latter test is required for V.I.'s above 100. High V.I. 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 V.I., and the V.I. of any petroleum oil can be increased by the addition of a V.I. improver. Naphthenic oils are inherently low in V.I. and aromatic oils are still lower – often having negative numbers.

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

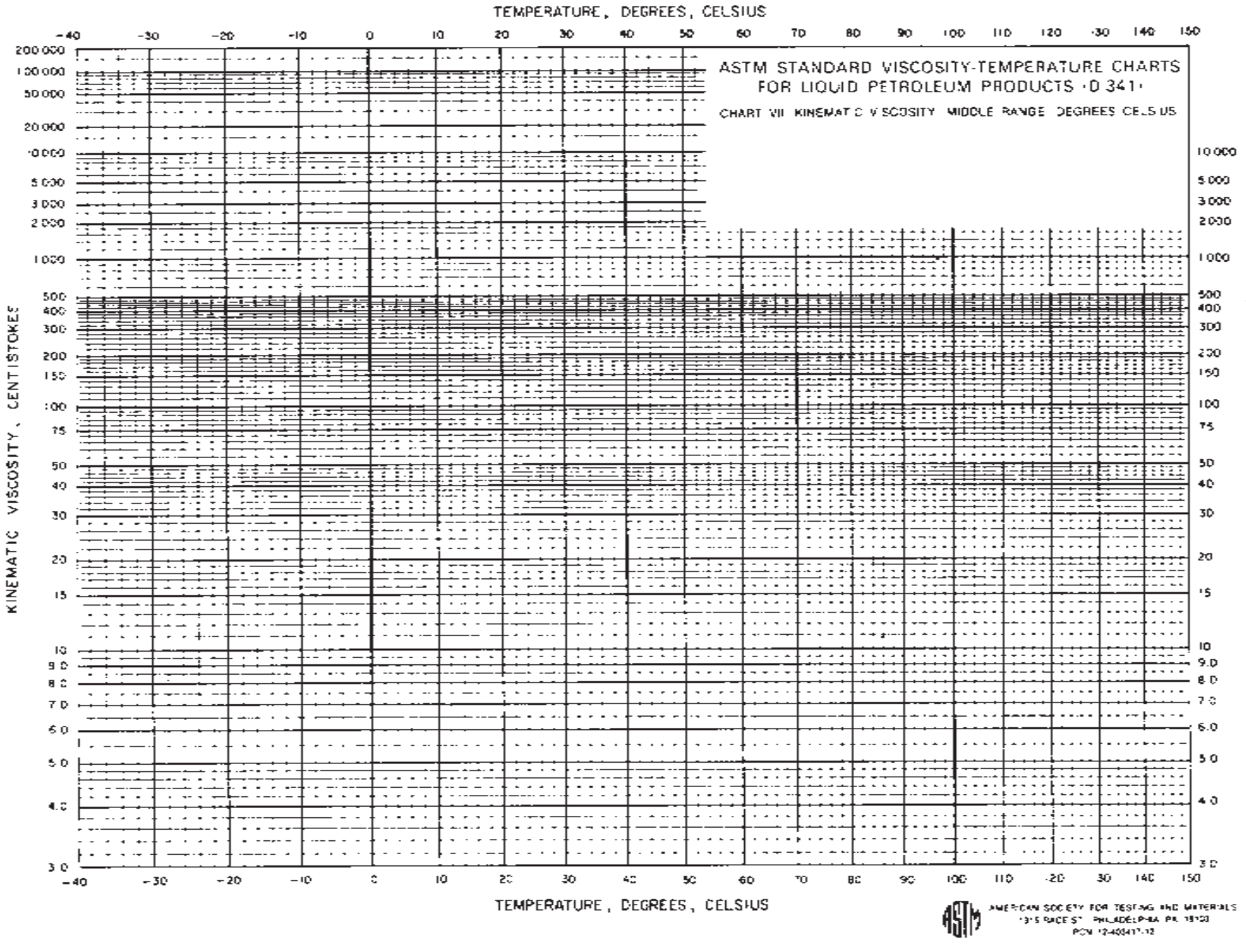
Centistokes	(At Operating Temperature)
33	For gear lubrication.
30	For a gear pump.
21	Spherical roller bearings.
13	Other rolling element bearings.
13	Hydraulic systems to prevent excessive pump wear and slippage.
13	Plain bearings.
4	Minimum viscosity to support a dynamic load.

OPTIMUM VISCOSITIES

The optimum viscosity is the ideal allowable at the operating temperature.

Centistokes

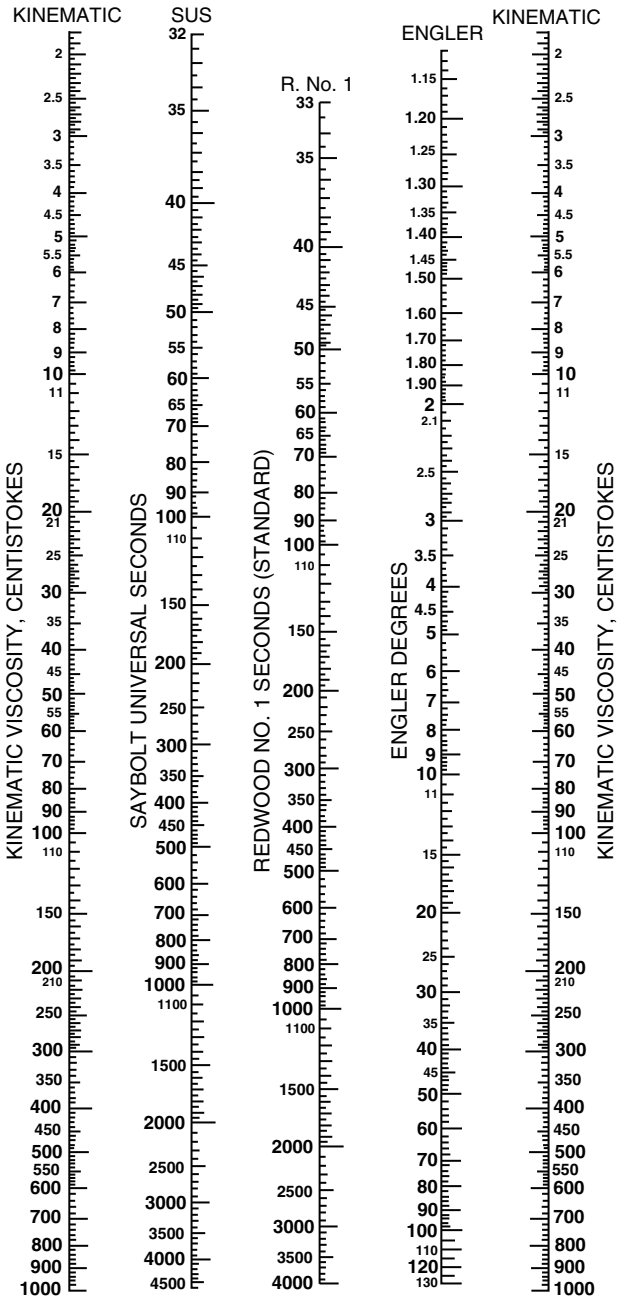
25	Hydraulic systems
30	Plain Bearings
40	Spur & Helical Gears (e.g. ISO-VG 150 @ 60°C)
75	Worm Gears (e.g. 460 @ 75°C)


TEMPERATURE, DEGREES, CELSIUS
ASTM STANDARD VISCOSITY-TEMPERATURE CHARTS
FOR LIQUID PETROLEUM PRODUCTS (D 341)
CHART VII KINEMATIC VISCOSITY MIDDLE RANGE DEGREES CELSIUS
KINEMATIC VISCOSITY, CENTISTOKES
TEMPERATURE, DEGREES, CELSIUS
AMERICAN SOCIETY FOR TESTING AND MATERIALS

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.

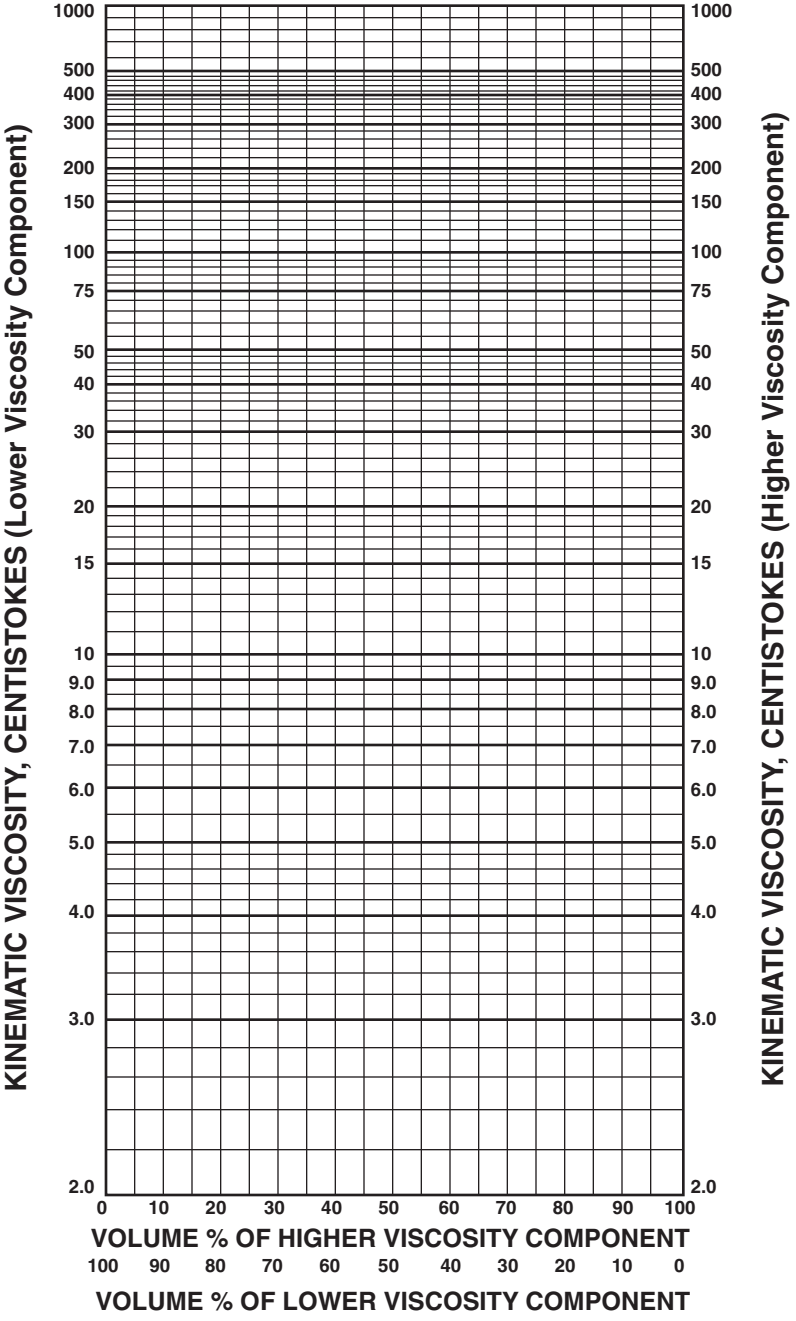
Example: 3000 centistokes = 300 cSt x 10 and is approximately equivalent to 1400 x 10 = 14000 SUS.



To convert from dynamic or absolute viscosity in centiPoise (cP) to kinematic viscosity in centiStokes (cSt), at a given temperature, use the following equation:

cSt = cP / 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 our example, if plotted, we could obtain 20 cSt @ 40°C oil with a 60/40 blend of the two base oils.

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.

ISO 4406:1999 Scale Number Table		
Number of particles per millilitre		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 ≥.

EXAMPLE: A code of 14/12/≥ 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, ≥ 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 COLOUR SCALE EQUIVALENTS

ASTM Colour D 1500	Union (N.P.A.) Colorimeter ASTM D 155	N.P.A. Colour Descriptions
0	—	Standard White
0.5	1	Lily White
1.0	1 1/2	Cream White
1.5	1 3/4	—
2.0	2	Extra Pale
2.5	2 1/2	Extra Pale Lemon
3.0	3	Lemon Pale
3.5	3 1/2	Extra Orange Pale
4.0	4	Orange Pale
4.5	4 1/2	—
5.0	5	Pale
5.5	5 1/2	Light Red
6.0	6	—
6.5	6 1/2	Dark Red
7.0	7	Claret Red
7.5	7 1/2	—
8.0	8	—

VAPOUR PRESSURE OF LUBRICATING OIL

The vapour 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.

Oil Viscosity @ 40°C	30-35 cSt 150 SUS	65-70 cSt 300 SUS	80-85cSt 400 SUS
Oil Temp °C	Vapour Pressure, millimetres 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 °C	From °T	To °F	To °C	From °T	To °F	To °C	From °T	To °F
–40.0	–40	–40.0	6.7	44	111.2	53.3	128	262.4
–38.9	–38	–36.4	7.8	46	114.8	54.4	130	266.0
–37.8	–36	–32.8	8.9	48	118.4	55.6	132	269.6
–36.7	–34	–29.2	10.0	50	122.0	56.7	134	273.2
–35.6	–32	–25.6	11.1	52	125.6	57.8	136	276.8
–34.4	–30	–22.0	12.2	54	129.2	58.9	138	280.4
–33.3	–28	–18.4	13.3	56	132.8	60.0	140	284.0
–32.2	–26	–14.8	14.4	58	136.4	61.1	142	287.6
–31.1	–24	–11.2	15.6	60	140.0	62.2	144	291.2
–30.0	–22	–7.6	16.7	62	143.6	63.3	146	294.8
–28.9	–20	–4.0	17.8	64	147.2	64.4	148	298.4
–27.8	–18	–0.4	18.9	66	150.8	65.6	150	302.0
–26.7	–16	+3.2	20.0	68	154.4	66.7	152	305.6
–25.6	–14	6.8	21.1	70	158.0	67.8	154	309.2
–24.4	–12	10.4	22.2	72	161.6	68.9	156	312.8
–23.3	–10	14.0	23.3	74	165.2	70.0	158	316.4
–22.2	–8	17.6	24.4	76	168.8	71.1	160	320.0
–21.1	–6	21.2	25.6	78	172.4	72.2	162	323.6
–20.0	–4	24.8	26.7	80	176.0	73.3	164	327.2
–18.9	–2	28.4	27.8	82	179.6	74.4	166	330.8
–17.8	0	32.0	28.9	84	183.2	75.6	168	334.4
–16.7	+ 2	35.6	30.0	86	186.8	76.7	170	338.0
–15.6	4	39.2	31.1	88	190.4	77.8	172	341.6
–14.4	6	42.8	32.2	90	194.0	78.9	174	345.2
–13.3	8	46.4	33.3	92	197.6	80.0	176	348.8
–12.2	10	50.0	34.4	94	201.2	81.1	178	352.4
–11.1	12	53.6	35.6	96	204.8	82.2	180	356.0
–10.0	14	57.2	36.7	98	208.4	83.3	182	359.6
–8.9	16	60.8	37.8	100	212.0	84.4	184	363.2
–7.8	18	64.4	38.9	102	215.6	85.6	186	366.8
–6.7	20	68.0	40.0	104	219.2	86.7	188	370.4
–5.6	22	71.6	41.1	106	222.8	87.8	190	374.0
–4.4	24	75.2	42.2	108	226.4	88.9	192	377.6
–3.3	26	78.8	43.3	110	230.0	90.0	194	381.2
–2.2	28	82.4	44.4	112	233.6	91.1	196	384.8
–1.1	30	86.0	45.6	114	237.2	92.2	198	388.4
0	32	89.6	46.7	116	240.8	93.3	200	392.0
+1.1	34	93.2	47.8	118	244.4	94.4	202	395.6
2.2	36	96.8	48.9	120	248.0	95.6	204	399.2
3.3	38	100.4	50.0	122	251.6	96.7	206	402.8
4.4	40	104.0	51.1	124	255.2	97.8	208	406.4
5.6	42	107.6	52.2	126	258.8	98.9	210	410.0

To °C	From °T	To °F	To °C	From °T	To °F	To °C	From °T	To °F
100.0	212	413.6	248.9	480	896	482.2	900	1652
101.1	214	417.2	254.4	490	914	487.8	910	1670
102.2	216	420.8	260.0	500	932	493.3	920	1688
103.3	218	424.4	265.6	510	950	498.9	930	1706
104.4	220	428.0	271.1	520	968	504.4	940	1724
105.6	222	431.6	276.7	530	986	510.0	950	1742
106.7	224	435.2	282.2	540	1004	515.6	960	1760
107.8	226	438.8	287.8	550	1022	521.1	970	1778
108.9	228	442.4	293.3	560	1040	526.7	980	1796
110.0	230	446.0	298.9	570	1058	532.2	990	1814
111.1	232	449.6	304.4	580	1076	537.7	1000	1832
112.2	234	453.2	310.0	590	1094			
113.3	236	456.8	315.6	600	1112			
114.4	238	460.0	321.1	610	1130			
115.6	240	464.0	326.7	620	1148			
116.7	242	467.6	332.2	630	1166			
117.8	244	471.2	337.8	640	1184			
118.9	246	474.8	343.3	650	1202			
120.0	248	478.4	348.9	660	1220			
121.1	250	482.0	354.4	670	1238			
126.7	260	500	360.0	680	1256			
132.2	270	518	365.6	690	1274			
137.8	280	536	371.1	700	1292			
143.3	290	554	376.7	710	1310			
148.9	300	572	382.2	720	1328			
154.4	310	590	387.8	730	1346			
160.0	320	608	393.3	740	1364			
165.6	330	626	398.9	750	1382			
171.1	340	644	404.4	760	1400			
176.7	350	662	410.0	770	1418			
182.2	360	680	415.6	780	1436			
187.8	370	698	421.1	790	1454			
193.3	380	716	426.8	800	1472			
198.9	390	734	432.2	810	1490			
204.4	400	752	437.8	820	1508			
210.0	410	770	443.3	830	1526			
215.6	420	788	448.9	840	1544			
221.1	430	806	454.4	850	1562			
226.7	440	824	460.0	860	1580			
232.2	450	842	465.6	870	1598			
237.8	460	860	471.1	880	1616			
243.3	470	878	476.7	890	1634			

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
Cubic feet	cubic yards	0.0370
Cubic feet	gallons (British)	6.2288
Cubic feet	gallons (US)	7.4805
Cubic feet	litres	28.3162

COMMONLY USED CONVERSION FACTORS *(continued)*

To Convert From	To	Multiply by
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 = (t, + 459.67)/1.8
Degrees (C)	degree kelvin	tk = (tc + 273.15)
Dynes	newton	1.000 x 10-fi
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 x 10-3
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

COMMONLY USED CONVERSION FACTORS *(continued)*

To Convert From	To	Multiply by
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
Kilograms	ounces (avoirdupois)	35.274
Kilograms	pounds (avoirdupois)	2.2046
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

COMMONLY USED CONVERSION FACTORS *(continued)*

To Convert From	To	Multiply by
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
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

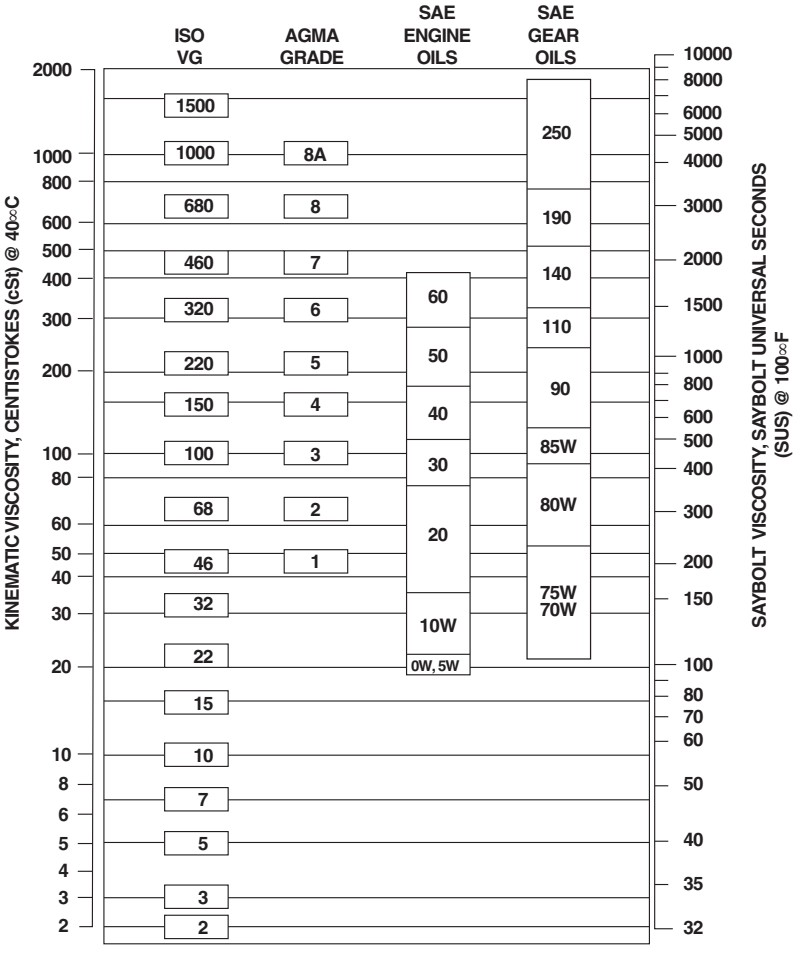
COMMONLY USED CONVERSION FACTORS *(continued)*

To Convert From	To	Multiply by
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
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
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	% Depth Filled	% of Capacity	% Depth Filled	% of Capacity
1	0.20	26	20.73	51	51.27	76	82.50
2	0.50	27	21.86	52	52.55	77	82.60
3	0.90	28	23.00	53	53.81	78	83.68
4	1.34	29	24.07	54	55.08	79	84.74
5	1.87	30	25.31	55	56.34	80	85.77
6	2.45	31	26.48	56	57.60	81	86.77
7	3.07	32	27.66	57	58.86	82	87.76
8	3.74	33	28.84	58	60.11	83	88.73
9	4.45	34	30.03	59	61.36	84	89.68
10	5.20	35	31.19	60	62.61	85	90.60
11	5.98	36	32.44	61	63.86	86	91.50
12	6.80	37	33.66	62	65.10	87	92.36
13	7.64	38	34.90	63	66.34	88	93.20
14	8.50	39	36.14	64	67.56	89	94.02
15	9.40	40	37.39	65	68.81	90	94.80
16	10.32	41	38.64	66	69.97	91	96.55
17	11.27	42	39.89	67	71.16	92	96.26
18	12.24	43	41.14	68	72.34	93	96.93
19	13.23	44	42.40	69	73.52	94	97.55
20	14.23	45	43.66	70	74.69	95	98.13
21	15.26	46	44.92	71	75.93	96	98.66
22	16.32	47	46.19	72	77.00	97	99.10
23	17.40	48	47.45	73	78.14	98	99.50
24	18.50	49	48.73	74	79.27	99	99.80
25	19.61	50	50.00	75	80.39	100	100.00

VISCOSITY EQUIVALENTS



NOTE:

- Read across horizontally.
- Assumes 96 VI single grade oils.
- Equivalence is in terms of viscosity at 40°C only.
- Viscosity limits are approximate: For precise data, consult ISO, AGMA and SAE specifications.
- W grades are represented only in terms of approximate 40°C viscosity. For low temperature limits, consult SAE specifications.

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