MOLYDUVAL® Tables

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1 MOLYDUVAL Product Range

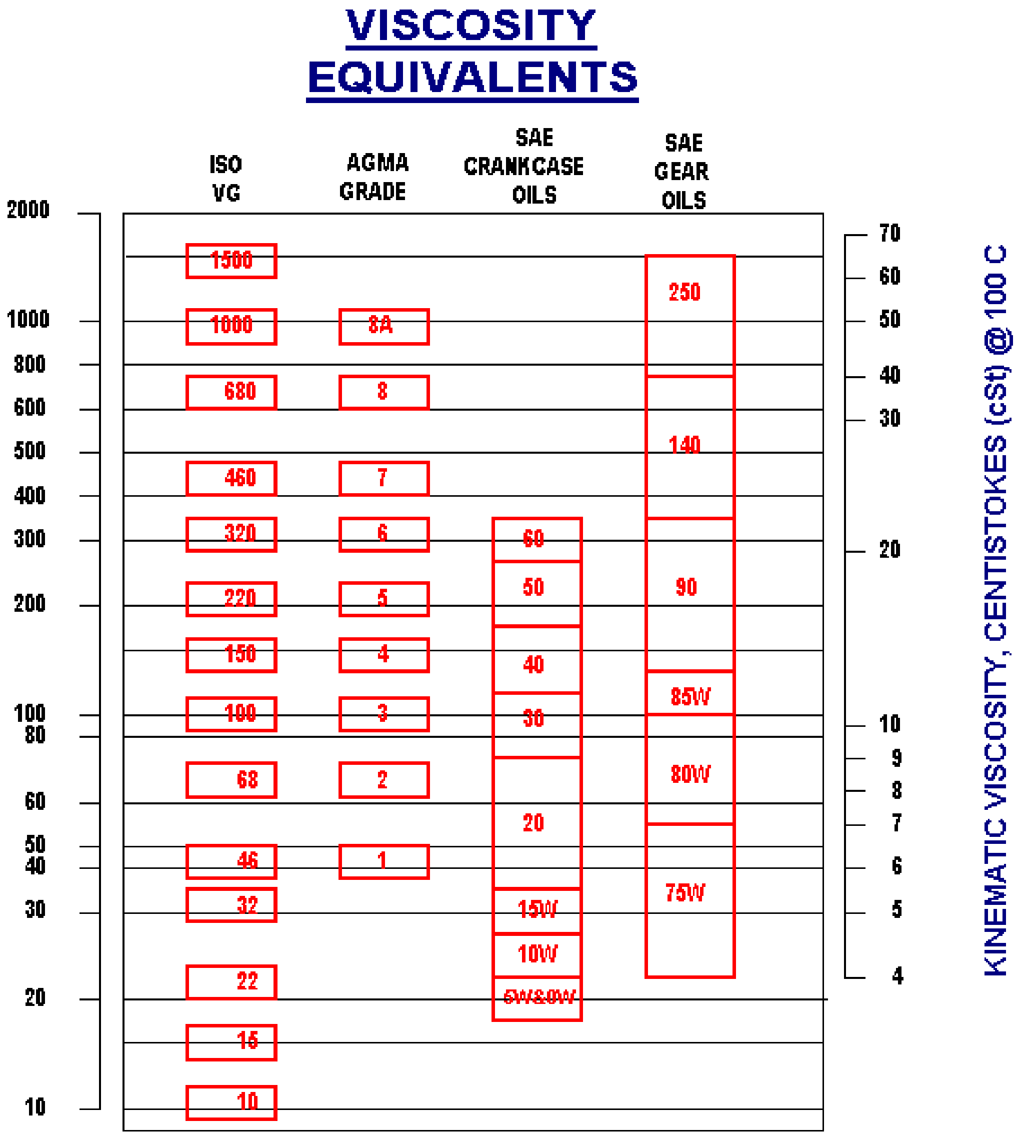
Oils	Greases	Pastes = Greases with high solid content
Precision Engineering Oils	**Long-Term Greases**	**Screw Pastes (Mainly)**
Sintered Bearing Oils	**Heavy Duty Greases (with solids)**	**White Color Paste**
Chain Fluids	**Gear Greases**	**Ceramic Paste**
Engine Oils	**Chain Greases**	**Copper Pastes (Anti-Seize)**
Gear (Bearing) Oils	**High Temp Greases**	**Aluminium Pastes**
Biodegradable Oils	**Food Grade Greases**	**Food Grade Pastes**
Food Grade Oils	**Silicone Greases**	
Corrosion Protection Oils	**Contact Greases**	
Rust Loosers	**Precision Mechanics Greases**	
Silicone Oils	**Low Temp Greases**	
Compressor Oils	**High Speed Greases**	
Textiel Machinery Oils	**Biodegradable Grease**	
Metal Working Fluids	**Plastic Greases**	
	Chemical Resistant Greases	

Additives	Dry Lubricants
Additives for engine oils	**Bonded Coatings**
Additives for gear oils	**PTFE Coatings**
Additives for plastics	**Lubricant Sticks**
Additives for Oil or Grease Manufacturer	**Powder Lubriocants**

2 Why Special Lubricants ?

	Sintered Bearings	*Rolling Bearings*	*Gears*	*Open Gears*	*Precision Mechanics*	*Sliding Surfaces*	*Engines*	*Automotive Gears*	*Hydraulics*
Protection in Case of Non-Hydrodynamic Friction	+	++	+++	++	++	+	++	+++	++
Cooling Properties	++	++	++	-	-	-	+	++	++
Low Friction	+	++	++	-	++	+	+++	+++	-
Tackiness	+	++	-	++	+++	+	++	-	-
Sealing Properties	-	++	-	+	-	+	-	-	-
Temperature	+	++	++	+	-	+	+++	+++	++
Corrosion Protection	+	++	-	++	-	+	++	++	++
Volality	+	+	-	++	+++	+	+++	-	-
Foam	-	-	++	-	-	-	++	++	+++
Flammability	-	-	-	-	-	-	-	-	++

3 Viscosity Table

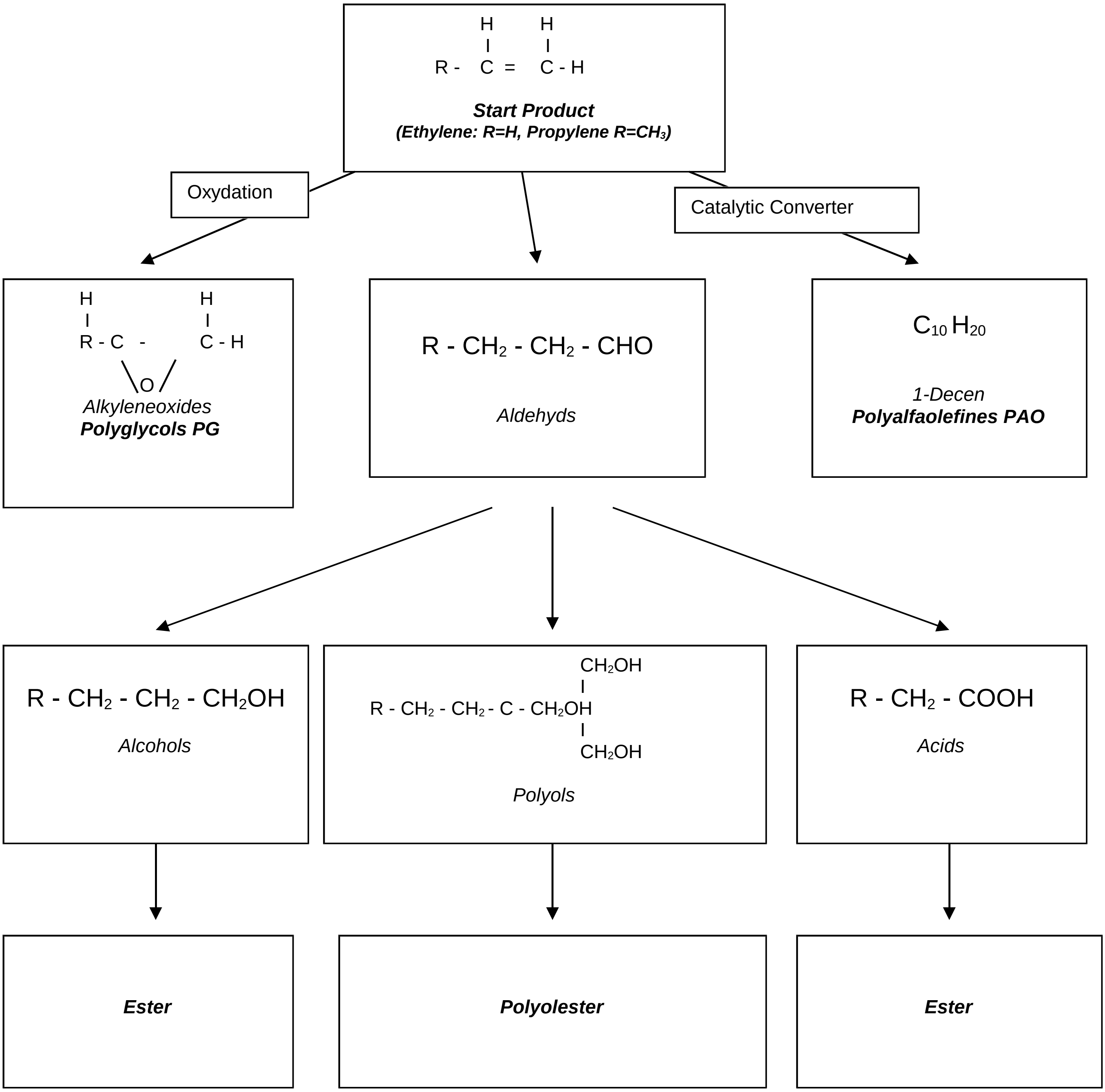


NOTES:

*Assumes 100 VI single grade oils. Read across horizontally.
*SAE grades based upon viscosity at 100 C. ISO and AGMA grades based upon viscosity at 40 C
*Equivalence is in terms only of viscosity. Quality requirements are a separate consideration.
*Viscosity limits are approximate: For precise data, consult ISO, AGMA and SAE specifications.
*W grades define only in terms of 100 C viscosity. For low temperature limits, consult SAE specifications.

*ISO = International Standardization Organization
*AGMA = American Gear Manufacturers Association
*SAE = Society of Automotive Engineers

4 Manufacturing of Synthetic Fluids



5 Producing a Lubricant

Base Fluid	Additives	Thickener	Solids
MIN Mineral Oil	EP Extreme Pressu-re	Ca Calcium	MoS2 Molybdenum Disulphide
HC Hydrocrack Oils	AW Anti-Wear	CaK Calcium Com-plex	C Graphite
PAO Polyalfaolefine	Anti-Foam	Li Lithium	Metals Copper, Alu, Zinc
PG Polyglycol	C Corrosion	LiK Lithium Com-plex	Ceramics Boron Nitride
E (Di) Esters	L Oxidation	Na Natrium	Zinc Oxides, Zinc Phospha-tes
E (Polyol) Esters	Tackiness	NaK Natrium Com-plex	PTFE Polytetra-fluoro- ethyle-ne
PFPE (HFC) Perfluorinated Po-lyethers	Color	AlK Aluminium Complex	
SI Silicone Fludis	FM Friction Modify-ing	Bentone	
	PP Pour-Point De-pressant	Gels	
	VI Viscosity Index Improver	Polyurea	
	EM Emulsifier		

6 Greases

6.1 Properties of Base Fluids for Greases

	Chemical Formula	Temperature Range	Lubrication Properties, Anti Wear Properties, Frictional Behaviour	Corrosion Protection (fortified)	Seal, Plastics and Lacquer Compatibility	Price Relation against Mineral Oil	Applications Advantages Disadvantages
Mineral Oil	Hydrocarbons	-30°C -> +120°C	good	very good	very good	--	Multi Purpose Bearing Greases
Alkyle Benzole	Synthetic Hydrocarbons	-40°C -> +100°C	good	very good	very good	< 1 very good	Multi Purpose Bearing Greases, Low Temperature Greases, Lubrication of Aluminium
PAO Polyalfaolefine	Synthetic Hydrocarbons	-60°C -> +180°C	good	very good	very good	2-4	Low Temp Greases, High Temp Greases, High Speed Greases, Plastics Compatible Greases
PG Polyglycole		-10°C -> +160°C	very good	good	bad	2-4	High Temp Greases
Rapsöl	Native Esters	-15°C -> +90°C	very good	good	bad	ca. 2	Biodegradable Bearing Greases
Synthtetic Esters	Synthetic Esters	-60°C -> +240°C	very good	good	bad	ca. 2-4	Low Temp Greases, Biodegradable Greases, High Performance Greases, Precision Engineering Greases
Silicone Oils	Phenyl-Methyl- Silicone Oils	-70°C -> +250°C	moderate	moderate	very good	ca. 40	High Temp Greases, Low Temp Greases, only low loads, Precision Engineering
Polyether	Polyether	-10°C -> +300°C	good	good	very good	ca. 200	High Temp Greases, Acid and Solvent Resistant Greases, Vaccum Applications

6.2 Properties of Thickeners for Greases

	Dropping Point	Temperature Range	Water Resistance	Corrosion Protection	Walk Stability	Load-Carrying Properties	Advantages Disadvantages	Applications
Ca Calcium	~ 90°C	-25°C bis +60°C	very good	good	good	mittel	Formate gel at temperatures of more than 150°C	Not suited for antifriction bearings. (Water pump greases, chassis greases)
CaK Calcium Complex	~ 240°C	-30°C -> +130°C	very good	good	good	good	Formate gel at temperatures of more than 150°C	Water endangered lubrication points. Long-Life greases.
Li Lithium	~ 170-220°C	-35°C -> +140°C	good	good	very good	mittel	Very good tackiness	Multi-Purpose Antifrictional Bearing Greases.
LiK Lithium Complex	> 220°C	-30°C -> +170°C	good	good	very good	good	Very good oxidation and temperature resistance	Long-Life Greases. High Temperature Greases. High Speed Greases.
Na Natrium	~ 130-200°C	-30°C -> +100°C	bad	good	bad	bad	Very good tackiness. Good Sealing properties, because water will be emulsified into structure. Not water resistant.	Mostly used for gears.
NaK Natrium Complex	> 220°C	-30°C -> +130°C	bad	good	moderate	good	Good Tackiness	Multi-Purpose Greases.
BaK Barium Complex	> 220°C	-30°C -> +150°C	very good	good	good	very good	Classified to be harmful	Antifriction Bearings.
AlK Aluminium Complex	> 230°C	-30°C -> +180°C	very good	good	good	very good	No residues in case of overheating	High Temperature Greases. High Speed Greases. Heavy Duty Greases.
Gele Bentonit	without	-35°C -> +250°C	good	bad	good	good	Formate gel at high temperatures	High Temperature Greases for Bearings at low turnarounds.

6.3 Compatibility of Base Fluids

	Mineral Oil	PAO	PG	Ester (Native)	Ester (Synth.)	Silicones Methyl Based	Silicone Phenyl Based	Polyether
Mineral Oil	•	YES	NO	YES	YES	NO	YES	NO
PAO	YES	•	NO	YES	YES	NO	YES	NO
PG	NO	NO	•	YES	YES	NO	NO	NO
Natural Esters	YES	YES	NO	•	YES	NO	YES	NO
Synthet. Ester	YES	YES	NO	YES	•	NO	YES	NO
Silicones Methyl Based	NO	NO	NO	NO	NO	•	YES	NO
Silicones Phenyl Based	YES	YES	NO	YES	YES	YES	•	NO
Polyether	NO	NO	NO	NO	NO	NO	NO	•

6.4 Compatibility Grease Thickeners

	Ca	Ca Complex	Li	Li Complex	Na	Na Complex	Ba Complex	Al Complex	Gele Bentone	Polyurea
Ca	YES	YES	YES	YES	NO	indef	indefinitely	NO	NO	YES
Ca Complex	YES	YES	indefinitely	indefinitely	NO	indefinitely	indefinitely	NO	NO	YES
Li	YES	indefinitely	YES	YES	NO	indefinitely	indefinitely	YES	NO	YES
Li Complex	YES	indefinitely	YES	YES	NO	indefinitely	YES	YES	indefinitely	YES
Na	NO	NO	NO	NO	YES	indefinitely	indefinitely	NO	NO	YES
Na Complex	indefinitely	indefinitely	indefinitely	indefinitely	indefinitely	YES	indefinitely	indefinitely	indefinitely	YES
Ba Complex	indefinitely	indefinitely	indefinitely	YES	indefinitely	indefinitely	YES	indefinitely	indefinitely	YES
Al Complex	NO	NO	YES	YES	NO	indefinitely	indefinitely	YES	NO	YES
Gel Bentone	NO	NO	NO	Indefinitely	NO	indefinitely	indefinitely	NO	YES	NO
Polyurea	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES

7 Gears

7.1 Properties of Base Fluids for Gear Oils

	Chemical	Temperature Range	Lubrication Friction Properties	Corrosion Protection	Seal Compatibility	Price (in Comparison to Mineral Oil)	Applications Advantages Disadvantages
Mineral Oil	Mixture of Hydrocarbons (C,H)	+120ºC -30ºC	Good	Very good	Very good	1	Standard Gear Oils
PAO Polyalfaolefines	Mixture of Synthetic Hydrocarbons (C,H)	+180ºC -60ºC	Good	Very good	Very good	ca. 2-4	Low Temperature Oils, High Temp Oils, High Speed Gear Oils, Plastic Compatible Oils, Sintered Bearing Oils
PG Polyglycols	Copolymers from Ethylen- or Propylenoxides (C,H,O)	+160ºC	Very good	Good	Bad	ca. 2-4	High Temperature Oil, Worm Gear Oils
Natural Esters (Rapseed Oil)	(C,H,O)	+90ºC -15ºC	Very good	Good	Bad	ca. 2	Biodegradable Oils
Synthetic Esters	(C,H,O)	+240ºC -60ºC	Very good	Good	Bad	ca. 2-4	Low Temp Oils, Biodegradable Oils, Oils for Precision Engineering, High Temperature Gear Oils
Silicode Oils (Only Polyphenyl Fluids)	(C,H,O,Si)	+250ºC -70ºC	Moderate	Moderate	Very good	ca. 40	High Temperature Oils, Low Temp Oils, Oils for low Loads, Precision Engineering
Polyphenyl - ether	(C,H,O)	+300ºC -10ºC	Good	Good	Very good	ca. 200	High Temperature Oils, Acid Resistance, Solvent Resistance
Perfluoroalkylether	(C,F,O)	+300ºC -10ºC	Good	Good	Very good	ca. 200	High Temperature Oils, Acid Resistance, Solvent Resistance

8 Temperature Range for Screw Pastes

Temperature	*MOLYDUVAL Product*	*Lubrication Properties* *Wear Protection*	*Why ?* *Advantages Disadvantages*
-0°C - 200°C	**Quick Paste**	**Very good**	**Low Friction**
200°C - 400°C	**Quick PG** **Quick PAO**	**Very Good**	**Synthetic Base Fluids: Lower Residues, Plastic Compatibility** **MoS_2 decomposes at 400°C**
400°C - 600°C	**Quick GM** **Quick GS** **Quick GN**	**Good**	**Graphite based** **very good in wet conditions** **higher friction than MoS_2 !**
600°C - 700°C	**Ciric A**	**low**	**Aluminium, soft** **Graphite would decompose in this temp range**
700°C - 1200°C	**Ciric B**	**Low**	**Copper, soft** **because Aluminium melts at this temperatures**
1200°C - 1400°C	**Titus ZKG**	**Bad**	**Ceramics do have only separating properties, no lubrication effect** **expensive** **(former nickel pastes)**

9 Friction Coefficients of Screws

Werkstoff		Paste M	Paste Quick	Paste B 27	Ciric B 272	Ciric B 271	Ciric SO
C45	Kopf	0,075	0,060	0,110	0,110	0,100	0,150
	Gewinde	0,100	0,080	0,110	0,110	0,115	0,150
C45 verzinkt	Kopf	0,098	0,065	0,100	0,100	0,094	0,130
	Gewinde	0,078	0,080	0,110	0,110	0,097	0,155
Edelstahl V2A (X5CrNi18 9)	Kopf	0,099	0,077	0,120	0,120	0,119	0,160
	Gewinde	0,089	0,069	0,125	0,125	0,140	0,211
Warmfester Stahl (X19CrMoVNb11 1)	Kopf	0,079	0,059	0,092	0,092	0,104	0,179
	Gewinde	0,105	0,080	0,121	0,121	0,130	0,188

10 Advantages & Disadvantages of Solids

Defintion: Lubricant Powders, offering low friction due to their chemical Structure

Advantages	*Disadvantages*
• ***further Temperature Range Compared with Oil***	• abrasion with the Time
• ***steadily in relation to aggresiven Media***	• with Oil additives complex is neceseeary suspedierung, set off otherwise
• ***simpler Constructions, no Oil or Fat Supply Necessirly***	• bad Corrosion Protection
• ***Emergency running properties***	• problematic Relubrication

Important, if no closed oil film (hydrodynamics) is present, e.g:	
• ***with extremely high Pressure Loads***	• Heavy mechanical Engineering • Mining Industry • Railway • Steel Plants
• ***with reciprocating Movements***	• Vibrations • Bridge • Mining Industry • Steel Plants
• ***at very high or very low temperatures***	• Furnaces • Power Stations
• ***in the Vacuum***	• Space Travel (PTFE) • Pump
• ***during aggressive Enviroment***	• Chemistry • Refineries

11 Glossary

ACID NUMBER
(see NEUT NUMBER)

AGMA
American Gear Manufacturers Association. One activity is the establishment 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. 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 formed to further the interests of the petroleum industry, in which 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 Classification for crankcase oils.

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 bay 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." 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. Planting 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 , COMPOUND OILS which are formulated with polar fatty oils, are sometimes used for this purpose. Another class of boundary lubricants are those 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 oils 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 lubricants.

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 greater significance than the quality.

CENTISTOKE (cSt)
(see VISCOSITY)

CENTIPOISE (cP)
(see VISCOSITY)

CHANNELING
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 CHANNELING can be controlled to a large extent by the consistency or viscosity of the lubricant. While some degree of CHANNELING 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 lubrication fro the metal surfaces. The fatty materials enable the oil to combine physically with the water instead of being displaced. Cylinder oils for wet steam applications and for some air compressors are compounded. Because the fatty materials impart a strong affinity for metal surfaces, compounded oils are frequently used for applications in which lubricity or extra load-carrying ability are needed. They are not generally recommended for service that requires high oxidation stability. (See BOUNDARY LUBRICATION)

COPPER STRIP CORROSION
This is an 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 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
The test time required for a specified oil-water emulsion to break, using ASTM D1401 test method. Highly refined straight 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 oil 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. This is a 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 a sludge. Neutral or basic compounds are created which can remain in suspension in the oil. Dispersants operate to break insoluble 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 a 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 a 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.

FIRE POINT
See FLASH POINT

FLASH POINT
The minimum temperature of a petroleum product or other combustible fluid at which vapor is produced at a rate sufficient to yield a combustible mixture. Specifically, it is the lowest sample temperature at which the air vapor mixture will "flash" in the presence of a small flame. Flash point may be determined by following ASTM Methods.

Fire Point is the minimum sample temperature at which vapor is produced at a sufficient rate to maintain combustion. Specifically, it is the lowest sample temperature at which the ignited vapor persists in burning for at least 5 seconds. Since the fire point of commercial petroleum oils ordinarily run about 30 ° C above the corresponding flash point, they are 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 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 a 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 TEST
Two test procedures based on the same principle:

Four-Ball EP Test (ASTM D2596)
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 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 the specified period, the average diameter of wear scar on the three 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 and Weld Point.

HYDROTREATING
A generic name for a general refinery process for treating fuels or lubricant base stocks at elevated temperatures in the presence of hydrogen and a catalyst. Mild hydrotreating, sometimes called hydrofinishing, is used to improve the colour an odour of fuels and lubricating base stocks. Hydrotreating is a patented process which is used by a few manufacturers of superior lubricant base stock. In the process, the lubricant feedstock is reacted with hydrogen in the presence of a catalyst at a very high temperature (425° C) and high pressure (3200 psig). Under these severe conditions, virtually all olefin and aromatic hydrocarbons are cracked and saturated to yield a base stock which is 95-99+% saturated. Other impurities which contain sulphur, nitrogen, or oxygen are also destroyed by the severe hrdrocracking process. This Hydrotreating process produces very high quality ("semi-synthetic") lubricant base stock.

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 causes 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. Examples of inhibitors include oxidation inhibitors, rust inhibitors, and foam inhibitors.

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.

NEUT NUMBER OR NEUTRALIZTION NUMBER
The specific quanity of reagent required to "neutralize" the acidity or alkalinity of a lube 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 show increasing acidity as the result of oxidation, and additive depletion. Though acidity is not, by itself, necessarily harmful, an increase in acidity may be indicative of oil deterioration, and the neut number is widely used to evaluate the condition of the oil in service. The most common measurement is ACID NUMBER, the specific quanity 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. Only broad experimentation with the individual situation can determine the value. Neut number is determined in accordance with the ASTM method D664 or D974. The former is a potentiometric method, the latter, colormetric. Values for Total Acid, Strong Acid, Total Base, and Strong Base can be obtained. Strong acid numbers are considered to be related to inorganic acids, such as those derived from sulfur, while the difference between the total and strong acid numbers is attributed to weak (organic) acids. A total acid number (TAN) and a total base number (TBN) can exist simultaneously, both representing 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 organic materials - are subjected. the resistance of

many petroleum products to oxidation is very high. Oxidation usually involves the addition of oxygen atoms, and the result is always one of degradation. It is accelerated by higher temperatures, the reaction becoming significant above 70°C. For every 10& deg;C rise, the rate of oxidation doubles. Oxidation is also promoted by the presence of catalytic metals, copper being one of these metals. In addition, the peroxides that are the initial products of oxidation are themselves oxidizing agents. So the oxidation of petroleum products is a chain reaction; the further it progresses, the more rapid it becomes. With fuels and lube oils, oxidation produces sludge, varnishes, gums, and acids, all of which are undesirable. Nevertheless, many oils, such as turbine oils, give years of service without need of replacement. Petroleum products that require a long service or storage life can be formulated to meet requirements by:

Proper selection of crude type. Paraffinic oils are noted for natural resistance to oxidation.

Thorough refining which removes oxidation susceptible materials and allow greater response to the inhibitor.

Addition of oxidation inhibitors

Long service is also promoted by good maintenance practices including filtration, centrifuging, limiting duration or intensity of high temperatures, and eliminating the presence of air. For information on determining the degree of deterioration sustained by used oil, refer to NEUT NUMBER.

OXIDATION INHIBITOR
Chemical added in small quantities to a petroleum product to increase oxidation resistance, and lengthen its service or storage life. An oxidation inhibitor may combine with the peroxides and therefore modify the peroxides in such a way to arrest their oxidation influence. or the inhibitor (a passivator) may react with a catalyst either to "poison" it or coat it with an inert film.

POISE
CGS unit of absolute viscosity. This is the shear stress (in dynes per square) required to move one layer of fluid along another over a total layer thickness of one centimeter at a shear rate of one centimeter per second. Dimensions are dyne-sec/cm². The Centipose (cP) is 1/100 of a poise and is the unit of absolute viscosity most commonly used. Whereas ordinary viscosity measurements depend on the force of gravity on the fluid to supply the shear stress and are thus subject to distortion by differences in fluid density. Absolute Viscosity measurements are independent of density and are directly related to resistance to flow. (See also VISCOSITY)

POUR POINT
It is 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 is cold-weather start-up, but must be considered along with pumpability, the ease with 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 D97 is used to determine pour point. ASTM D97 also provides for the determination of Cloud Point, the lowest temperature at which the sample becomes clouded by the formation of wax crystals. Clouding is a characteristic only of paraffinic oils. It 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 formed by oil degradation. Some rust inhibitors operate similarity 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.

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 base stocks. The process relies on the solubility of impurities (especially aromatic components that may also contain sulfur and nitrogen) in an extractive solvent usually furfural or phenol. The by-products of this process is highly aromatic extract used to make Extender oils, and as feed for other refinery processes.

STYLE
(see ASH)

SYNTHETIC LUBRICANTS
Lube oils possessing a base oil that has been manufactured from chemical constituents or by the polymerization of hydrocarbons (olefins) rather than by conventional refining of petroleum. The three most common types of synthetic base oils are:

Polyalpolefins

Organic esters

Polyglycols

Synthetic lubricants have several advantages over conventional mineral oils:

excellent low temperature fluidity

low pour point

high natural viscosity index

excellent oxidation stability

high flash, fire, and auto-ignition points

low volatility

non-corrosive and non-toxic

Synthetic lubricants have been in use for some time in applications such as jet engine lubrication, Arctic lubrication, and fire-resistant hydraulic fluids. These applications tolerate the extremely high cost of synthetics because they are the only products that do the job. Synthetic lubricants are now beginning to replace conventional petroleum lubricants in some applications. Despite their higher purchase price, synthetics may offer operating advantages that can make them more economical in the long run. (For example, reduced oil consumption, longer oil life, improved fuel economy, and easier starting at low temperatures).

TIMKEN OK LOAD
This is a 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
This is a 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 orfice. 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 - SSF (ASTM Method D88). Other less common viscosity units are the Engler and Redwood scales, principally in Europe. (See also BROOKFIELD VISCOSITY, POISE).

VISCOSITY INDEX(V.I)
The measure of the rate of change of viscosity with temperature. This change is common to all 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. improper. 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.