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Glossary

A

absolute viscosity - the ratio of shear stress to shear rate. It is a fluid's internal resistance to flow. The common unit of absolute viscosity is the poise (see viscosity). Absolute viscosity divided by the fluid's density equals kinematic viscosity.

acid number - The number of milligrams of potassium hydroxide required to neutralize one gram of an oil sample. ASTM D664 uses a potentiometric titration; D 974 uses a color-indicator titration - Also known as neutralization number

additive - a chemical substance added to a petroleum product to impart or improve certain properties. Common petroleum product additives are: antifoam agent, anti-wear additive, corrosion inhibitor, demulsifier, detergent, dispersant, emulsifier, EP additive, oiliness agent, oxidation inhibitor, pour point depressant, rust inhibitor, tackiness agent, viscosity index (VI.) improver.

AGMA (American Gear Manufacturers Association) - which, as one of its activities, establishes and promotes standards for gears and gear lubricants.

AGMA lubricant numbers - AGMA specification covering gear lubricants. The viscosity ranges of the AGMA numbers (or grades) conform to the International Standards Organization (ISO) viscosity classification system (see ISO viscosity classification system).

aniline point - lowest temperature at which equal volumes of aniline is soluble in a specified quantity of a petroleum product. as determined by test method ASTM D 611; hence, an empirical measure of the solvent power of a hydrocarbon-- the lower the aniline point, the greater the solvency. Paraffinic hydrocarbons have higher aniline points than aromatic types.

ANSI (American National Standards Institute) - an organization of industrial firms, trade associations, technical societies, consumer organizations, and government agencies, intended to establish definitions, terminologies, and symbols improve methods of rating, testing, and analysis; coordinate national safety, engineering and industrial standards; and represent U.S. interests in international standards work.

antifoam agent - one of two types of additives used to reduce foaming in petroleum products: silicone oil to break up large surface bubbles, and various kinds of polymers that decrease the amount of small bubbles entrained in the oils.

antioxidant - a chemical additive which increases a lubricant's oxidation resistance, which lengthens its service and storage life.



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antiwear additive - additive in a lubricant that reduces friction and excessive wear.

API (American Petroleum Institute) - a trade association of petroleum producers, refiners, marketers, and transporters, organized for the advancement of the petroleum industry by conducting research, gathering and disseminating information, and maintaining cooperation between government and the industry on all matters of mutual interest.

asperities - microscopic projections on metal surfaces resulting from normal surface finishing processes. Ideally the lubricating film should be thicker than the combined height of the opposing asperities.

aromatic - cyclic unsaturated hydrocarbons identified by one or more benzene rings or by chemical behavior similar to benzene. Aromatics are usually more reactive and have higher solvency than paraffins and naphthenes. Aromatics readily undergo electrophilic substitution: that is, they react to add other active molecular groups, such as nitrates, sulfonates, etc. Aromatics are used extensively as petrochemical building blocks.

ASTM (American Society for Testing and Materials) - an 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.

automatic transmission fluid (ATF) - a functional fluid for automatic transmissions in motor vehicles. Automatic transmission fluids must have a suitable coefficient of friction, good low-temperature viscosity, and antiwear properties. Other necessary properties are: high oxidation stability, anti-corrosion, anti-foaming, and compatibility with synthetic rubber seals.

B

base number - The number of milligrams of acid required to neutralize one gram of an oil sample. ASTM D974 uses hydrochloric acid and a color-indicator titration; D 2896 uses perchloric acid in a potentiometric titration

base stock - a primary refined petroleum fraction, usually lubricating oil, into which additives and other products are blended to produce finished products.

bearing — basic machine component designed to reduce friction between moving parts and to support a moving load.



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biodegradation - the chemical breakdown of materials by living organisms in the environment. The process depends on certain microorganisms, such as bacteria, yeast, and fungi, which break down molecules for sustenance. Certain chemical structures are more susceptible to microbial breakdown than others; vegetable oils, for example, will biodegrade more rapidly than petroleum oils. Most petroleum products typically will completely biodegrade in the environment within two months to two years.

bleeding – separation of a liquid (oil) from lubricating grease.

boundary lubrication - a form of lubrication between two rubbing surfaces without development of a full-fluid lubricating film. Boundary lubrication can be made more effective by including additives in the lubricating oil that provide a stronger oil film, thus preventing excessive friction and possible scoring. There are varying degrees of boundary lubrication, depending on the severity of service. For mild conditions, oiliness agents may be used; these are polar compounds that have an exceptionally high affinity for metal surfaces. By plating out on these surfaces in a thin but durable film, oiliness agents prevent scoring under some conditions that are too severe for a straight mineral oil. Compounded oils, formulated with polar fatty oils, are sometimes used for this purpose. Antiwear additives are commonly used in more severe boundary lubrication applications. The more severe cases of boundary lubrication are defined as extreme pressure conditions; they are met with lubricants containing EP additives that prevent sliding surfaces from fusing together at high local temperatures and pressures.

Brookfield viscosity —a measure of the viscosity characteristics of a lubricant under low shear conditions. The apparent viscosity of oil, usually determined by test method ASTM D 2983. The apparent viscosity of a non-Newtonian fluid is valid only for the shear rates and temperature at which it is determined. The Brookfield viscometer provides a known rate of shear by means of a spindle of specified configuration that rotates at a known constant speed in the fluid. The torque imposed by fluid friction can be converted to absolute viscosity units (centipoise) by a conversion factor or equation.

C

carbon residue — the measure of the coke forming tendency of oils at high temperatures.

carcinogen- a cancer-causing substance. Certain petroleum products are classified as potential carcinogens under OSHA criteria. Suppliers are required to identify such products as potential carcinogens on package labels and Material Safety Data Sheets.

catalyst — a substance that contributes to a chemical reaction without, itself, undergoing any change.



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cavitation - the formation of an air or vapor pocket (or bubble) due to lowering of pressure in a liquid, often as a result of a solid body, such as a piston, moving through the liquid; also, the pitting or wearing away of a solid surface as a result of the collapse of a vapor bubble. Cavitation can occur in a hydraulic system as a result of low fluid levels that draw air into the system, producing tiny bubbles that expand explosively at the pump outlet, causing metal erosion and eventual pump destruction. Cavitation can also result when reduced pressure in lubricating grease dispensing systems forms a void, or cavity, which impedes suction and prevents the flow of greases.

channel point – a measure of the lowest temperature at which a gear lubricant may be used safely.

chlorinated wax - certain solid hydrocarbons treated with chlorine gas to form straight-chain hydrocarbons with a relatively high chlorine component. Chlorinated waxes are used primarily as polyvinyl chloride plasticizers, extreme-pressure additives for lubricants, and formulation components for many cutting fluids.

circulating lubrication system - a system in which oil is recirculated from a sump or tank to the lubricated parts, in most cases requiring a pump to maintain circulation. Circulating lubrication makes possible extended lubricant use, and usually requires a high-quality rust and oxidation inhibited (R&O) oil.

clay filtration - a refining process using fuller's earth (activated clay), bauxite or other mineral to adsorb minute solids from lubricating oil, as well as remove traces of water, acids, and polar compounds.

cloud point — the temperature at which a lubricant appears hazy due to wax formation when a sample is cooled under standard conditions.

Cold Cranking Simulator — a viscometer used to predict the ability of an engine lubricant to allow cranking during cold starts.

compounded oil - a mixture of petroleum oil with animal or vegetable fat or oil. Compounded oils have a strong affinity for metal surfaces; they are particularly suitable for wet-steam conditions and for applications where lubricity and extra load-carrying ability are needed. They are not generally recommended where long-term oxidation stability is required.



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consistency (grease) - a basic property describing the softness or hardness of a grease, i.e., the degree to which a grease resists deformation under the application of force. Consistency is usually measured by means of a cone penetration test. The consistency of grease depends on the viscosity of the base oil and the type and proportion of the thickener. It can also be affected by recent agitation; to take this phenomenon into consideration, grease is usually subjected to working (a standard churning process) prior to measuring its penetration value.

corrosion - a chemical attack on a metal or other solid by contaminants in a lubricant. Common corrosive contaminants are: (1) water, which causes rust of ferrous materials, and (2) acids, which may form as oxidation products in a deteriorating oil, or may be introduced into the oil as combustion by-products in piston engines.

corrosion inhibitor - an additive for protecting lubricated metal surfaces against chemical attack by water or other contaminants. There are several types of corrosion inhibitors. Polar compounds wet the metal surface preferentially, protecting it with a film of oil. Other compounds may absorb water by incorporating it in a water-in-oil emulsion so that only the oil touches the metal surface. Another type of corrosion inhibitor combines chemically with the metal to present a non-reactive surface.

cylinder oil - a lubricant for independently lubricated cylinders, such as those of steam engines and air compressors; also for lubrication of valves and other elements in the cylinder area. Steam cylinder oils are available in a range of grades with high viscosity's to compensate for the thinning effect of high temperatures; of these, the heavier grades are formulated for super-heated and high-pressure steam, and the lighter grades for wet, saturated, or low-pressure steam. Some grades are compounded for service in excessive moisture; see compounded oil. Cylinder oils lubricate on a once-through basis.

D

demulsifier - an additive that promotes oil water separation in lubricants that are exposed to water or steam.

density - mass per unit volume of a material.

detergent - an important component of engine oils and some industrial lubricants, such as paper machine oils and hydraulic fluids: helps control deposits by preventing contaminants of combustion from directly contacting metal surfaces and, in some cases, by neutralizing acids. A detergent is usually a metallic (commonly barium, calcium or magnesium) compound, such as a sulfonate, phosphonate, thiophosphonate, phenate, or salicylate. Because of its metallic composition, a detergent leaves a slight ash when the oil is burned. A detergent is normally used in conjunction with a dispersant.

dispersant - an additive that helps prevent deposits by holding the insoluble products of oil oxidation and fuel combustion in suspension in the oil.



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dropping point – the temperature at which grease passes from a semi-solid to a liquid state as specified under ASTM D556.

E

Elasto-hydrodynamic(EHD) lubrication - a lubrication phenomenon occurring during elastic deformation of two non-conforming surfaces under high load. A high load carried by a small area (as between the ball and race of a rolling contact bearing) causes a temporary increase in lubricant viscosity as the lubricant is momentarily trapped between slightly deformed opposing surfaces.

elastomer - a rubber or rubber-like material, both natural and synthetic, used in making a wide variety of products, such as seals and hoses. In oil seals, an elastomer's chemical composition is a factor in determining its compatibility with a lubricant
electrical insulating oil - a high-quality oxidation-resistant oil refined to give long service as a dielectric and coolant for electrical equipment, most commonly transformers-
Insulating oil must resist the effects of elevated temperatures, electrical stress, and contact with air, which can lead to sludge formation and loss of insulation properties. It must be kept dry, as water is detrimental to dielectric strength - the minimum voltage required to produce an electric arc through an oil sample, as measured by test method ASTM D 877.

elastomer (seal) compatibility – the quality of a lubricant to remain in contact with an elastomer without significantly affecting the chemical and physical properties of either. Immersion tests at elevated temperatures are commonly used to evaluate compatibility. Changes in volume (see seal swell) and hardness (Durometer) are most often determined in lubricant laboratories: rubber laboratories usually run additional tests, such as tensile strength and elongation.

emulsifier - an additive that promotes the formation of a stable mixture, or emulsion, of oil and water. Common emulsifiers are: metallic soaps, certain animal and vegetable oils, and various polar compounds (having molecules that are water-soluble at one extremity of their structures and oil-soluble at the other).

emulsion - a two-phase liquid system in which small droplets of one liquid are immiscible in, but uniformly dispersed throughout, a second, continuous phase. Generally of a milky or cloudy appearance, emulsions may be of two types: oil-in-water (where water is the continuous phase) and water-in-oil (where water is the discontinuous phase). Oil-in-water emulsions are used as cutting fluids because of the need for the cooling effect of the water. Water-in-oil, or invert, emulsions are used where the oil, not the water, must contact a surface - as in rust preventives, non-flammable hydraulic fluids, and compounded steam cylinder oils (see compounded oil): such emulsions are sometimes referred to as invert emulsions. Emulsions are produced by adding an emulsifier. Emulsibility is not a desirable characteristic in certain lubricating oils, such as crankcase or turbine oils, that must separate from water readily. Unwanted emulsification can occur as a result of oxidation products - which are usually polar compounds - or other contaminants in the oil.



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EP additive - a lubricant additive that prevents sliding metal surfaces from seizing under conditions of extreme pressure (EP). At the high local temperatures associated with metal-to-metal contact, an EP additive combines chemically with the metal to form a surface film that prevents the welding of opposing asperities, and the consequent scoring that is destructive to sliding surfaces under high loads. Reactive compounds of sulfur, chlorine, or phosphorus are used to form these inorganic films.

EP oil - a lubricating oil formulated to withstand extreme pressure (EP) operating conditions.

ester - a chemical compound usually derived from the reaction of an organic or inorganic acid with an alcohol.

F

ferrography - a method of particle analysis using precision magnets to strip iron-laden and other susceptible particles from a used lubricating oil for study; results indicate extent of equipment wear and likelihood of imminent failure. Direct-reading ferrography uses optical sensors to measure the density of particles collected and the ratio of large particles to small (fatigue-related catastrophic failure generally is characterized by generation of particles larger than 10-15 microns). Analytical ferrography employs microscopic and photographic evaluation of wear particles. The test provides in-depth analysis of particle composition (e.g., steel, copper, bronze) and type of wear (e.g., corrosion, metal-to-metal contact).

fire point - the temperature rating at which a lubricant will catch fire.

fire-resistant fluid - a lubricant used especially in high-temperature or hazardous hydraulic applications, such as steel mills and underground mining. Three common types of fire-resistant fluids are: (1) water-petroleum oil emulsions, in which the water prevents burning of the petroleum constituent; (2) water-glycol fluids; and (3) non-aqueous fluids of low volatility, such as phosphate esters, silicones, and halogenated hydrocarbon-type fluids.

flash point - the minimum temperature at which a fluid will support instantaneous combustion (flash) but before it will burn continuously (fire).

flow improver - an additive designed to modify wax crystal growth, thereby lowering the pour point and improving low temperature fluidity.



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foaming - a frothy mixture of air and a petroleum product (e.g., lubricant, fuel oil) that can reduce the effectiveness of the product, and cause sluggish hydraulic operation, air binding of oil pumps, and overflow of tanks or sumps. Foaming can result from excessive agitation, improper fluid levels, air leaks, cavitation, or contamination with water or other foreign materials. Foaming can be inhibited with an antifoam agent. The foaming characteristics of a lubricating oil can be determined by blowing air through a sample at a specified temperature and measuring the volume of foam, as described in test method ASTM D 892.

fretting - a form of attritive wear resulting from small-amplitude oscillations or vibrations that cause the removal of very finely divided particles from rubbing surfaces (e.g., the vibrations imposed on the wheel bearing of an automobile when transported by rail car). With ferrous metals the wear particles oxidize to a reddish, abrasive iron oxide, which has the appearance of rust or corrosion, and is therefore sometimes called fretting corrosion; other terms applied to this phenomenon are false brinelling (localized fretting involving the rolling elements of a bearing) and friction oxidation. Generally, lubricants will not prevent fretting, but they can alleviate the problem to varying degrees. ASTM D 4170 is used to determine the fretting wear protection quality of greases, but it cannot distinguish between fretting wear and false brinelling.

friction - the resistance to the motion of one surface over another. The amount of friction is dependent on the smoothness of the contacting surfaces, as well as the force with which they are pressed together. Friction between unlubricated solid bodies is independent of speed and area. The coefficient of friction is obtained by dividing the force required to move one body over a horizontal surface at constant speed by the weight of the body. Coefficients of rolling friction (e.g., the motion of a tire or ball bearing) are much less than coefficients of sliding friction. Sliding friction is thus more wasteful of energy and can cause more wear. Fluid friction occurs between the molecules of a gas or liquid in motion, and is expressed as shear stress. Unlike solid friction, fluid friction varies with speed and area. In general, lubrication is the substitution of low fluid friction in place of high solid-to-solid friction.

friction modifier — an additive designed to affect the frictional properties of rubbing surfaces.

full-fluid-film lubrication - the presence of a continuous lubricating film sufficient to completely separate two surfaces, as distinct from boundary lubrication. Full-fluid-film lubrication is normally hydrodynamic lubrication, whereby the oil adheres to the moving part and is drawn into the area between the sliding surfaces, where it forms a pressure, or hydrodynamic, wedge. A less common form of full-fluid lubrication is hydrostatic lubrication, wherein the oil is supplied to the bearing area under sufficient external pressure to separate the sliding surfaces.



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G

gear - a machine part that transmits motion and force by means of successively engaging projections, called teeth. The smaller gear of a pair is called the pinion: the larger, the gear. When the pinion is on the driving shaft, the gear set acts as a speed reducer: when the gear drives, the set acts as a speed multiplier. The basic gear type is the spur gear, or straight-tooth gear, with teeth cut parallel to the gear axis. Spur gears transmit power in applications utilizing parallel shafts. In this type of gear, the teeth mesh along their full length, creating a sudden shift in load from one tooth to the next, with consequent noise and vibration. This problem is overcome by the helical gear, which has teeth cut at an angle to the center of rotation, so that the load is transferred progressively along the length of the tooth from one edge of the gear to the other. When the shafts are not parallel, the most common gear type used is the bevel gear, with teeth cut on a sloping gear face, rather than parallel to the shaft. The spiral bevel gear has teeth cut at an angle to the plane of rotation, which, like the helical gear, reduces vibration and noise- A hypoid gear resembles a spiral bevel gear, except that the pinion is offset so that its axis does not intersect the gear axis; it is widely used in automobiles between the engine driveshaft and the rear axle. Offset of the axes of hypoid gears introduces additional sliding between the teeth, which, when combined with high loads, requires a high-quality EP oil. A worm gear consists of a spirally grooved screw moving against a tooth wheel; in this type of gear, where the load is transmitted across sliding, rather than rolling, surfaces, compounded oils or EP oils are usually necessary to maintain effective lubrication.

gearbox (gear housing) - a casing for gear sets that transmit power from one rotating shaft to another. A gear box has a number of functions: it is precisely bored to control gear and shaft alignment, it contains the gear oil, and it protects the gears and lubricant from water, dust, and other environmental contaminants. Gearboxes are used in a wide range of industrial, automotive and home machinery, Not all gears are enclosed in gearboxes; some are open to the environment and are commonly lubricated by highly adhesive greases.

gear oil - a high-quality oil with good oxidation stability, load-carrying capacity, rust protection, and resistance to foaming, for service in gear housings and enclosed chain drives. Specially formulated industrial EP gear oils are used where highly loaded gear sets or excessive sliding action (as in worm gears) is encountered.



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grease (lubricating) - a mixture of a fluid lubricant (usually petroleum oil) and a thickener (usually soap) dispersed in the oil. Because greases do not flow readily, they are used where extended lubrication is required and where oil would not be retained. The thickener plays as important a role as the oil in the lubrication mechanism. Soap thickeners are formed by reacting (saponifying) a metallic hydroxide, or alkali, with a fat, fatty acid, or ester. The type of soap used depends on the grease properties desired. Calcium (lime) soap greases are highly resistant to water, but unstable at high temperatures, so are seldom used any more, Sodium soap greases are stable at high temperatures, but wash out in moist conditions. Lithium soap greases resist both heat and moisture. A mixed base soap is a combination of soaps, offering some of the advantages of each type. A complex soap is formed by the reaction of an alkali with a high-molecular-weight fat or fatty acid to form a soap, and the simultaneous reaction of the alkali with a short-chain organic or inorganic acid to form a metallic salt (the complexing agent). Complexing agents usually increase the dropping point of grease. Lithium, calcium, and aluminum greases are common alkalis in complex-soap greases. Non-soap thickeners, such as clays, silica gels, carbon black, and various synthetic organic materials (especially polyureas) are also used in grease manufacture. Multi-purpose greases are designed for different applications. They provide resistance to heat, as well as water, and may contain additives to increase load-carrying ability and inhibit rust.

H

hydraulic fluid - a fluid serving as the power transmission medium in a hydraulic system. The most commonly used fluids are petroleum oils, synthetic lubricants, oil-water emulsions, and water/glycol mixtures. The principal requirements of a premium hydraulic fluid are proper viscosity, high viscosity index, anti-wear protection (if needed), good oxidation stability, adequate pour point, good demulsibility, rust inhibition, resistance to foaming, and compatibility with seal materials. Antiwear oils are frequently used in compact, high-pressure- and high-capacity pumps that require superior lubrication protection. Certain synthetic lubricants and water-containing fluids are used where fire resistance is needed. Synthetic lubricants also are used in extreme-temperature conditions.



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hydraulic system - a system designed to transmit power through a liquid medium, permitting multiplication of force in accordance with Pascal's law, which states that "a pressure exerted on a confined liquid is transmitted undiminished in all directions and acts with equal force on all equal areas." Hydraulic systems have six basic components: (1) a reservoir to hold the fluid supply; (2) a fluid to transmit the power; (3) a pump to move the fluid; (4) a valve to regulate pressure; (5) a directional valve to control the flow, and (6) a working component -- such as a cylinder and piston or a shaft rotated by pressurized fluid -- to turn hydraulic power into mechanical motion. Hydraulic systems offer several advantages over mechanical systems: they eliminate complicated mechanisms such as cams, gears, and levers; are less subject to wear; are usually more easily adjusted for control of speed and force; are easily adaptable to both rotary and linear transmission of power; and can transmit power over long distances and in any direction with small losses.

hydrogenation - in refining, the chemical addition of hydrogen to a hydrocarbon in the presence of a catalyst; a severe form of hydrogen treating. Hydrogenation may be either destructive or non-destructive. In the former case, hydrocarbon chains are ruptured (cracked) and hydrogen is added where the breaks have occurred. In the latter, hydrogen is added to a molecule that is unsaturated with respect to hydrogen. In either case, the resulting products are highly stable. Temperatures and pressures in the hydrogenation process are usually greater than in hydrofining.

hydrolytic stability - the ability of a lubricant to resist chemical decomposition (hydrolysis) in the presence of water.

I

immiscible - incapable of being mixed without separation of phases. Water and petroleum oil are immiscible under most conditions, although they can be made miscible with the addition of an emulsifier.

industrial lubricant - any petroleum or synthetic-base fluid or grease commonly used in lubricating industrial equipment, such as gears, turbines, and compressors.

infrared (IR) analysis - a form of absorption spectroscopy that identifies organic functional groups present in a used oil sample by measuring their light absorption at specific infrared wavelengths; absorbance is proportional to concentration. The test can indicate additive depletion, the presence of water, hydrocarbon contamination of a synthetic lubricant, oxidation, nitration, and glycol contamination from coolant. Fourier Transform Infrared (FTIR) permits the generation of complex curves from digitally represented data



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inhibitor - an additive that improves the performance of a petroleum product through the control of undesirable chemical reactions.

insolubles - a test for contaminants in used lubricating oils, such as test method ASTM D 893. In this method, the oil is first diluted with pentane, causing the oil to lose its solvency for certain oxidation resins, and also causing the precipitation of such extraneous materials as dirt, soot, and wear metals. These contaminants are called pentane insolubles. The pentane insolubles may then be treated with toluene, which dissolves the oxidation resins (benzene was formerly used). The remaining solids are called toluene insolubles. The difference in weight between the pentane insolubles and the toluene insolubles is called insoluble resins. Testing for grease insolubles is described in ASTM D 128.

ISO viscosity classification system - an international system, approved by the international Standards Organization (ISO), for classifying industrial lubricants according to viscosity. Each ISO viscosity grade number designation corresponds to the mid-point of a viscosity range expressed in centistokes (cSt) at 40°C. For example, a lubricant with an ISO grade of 32 has a viscosity within the range of 28.8 – 35.2 cSt, the mid-point of which is 32.

K

kinematic viscosity – a measure of viscosity derived from the time taken for a fixed volume of oil to flow through a capillary tube. Common units are mm²/s or centistokes (cSt).

L

load-wear index (LWI) - measure of the relative ability of a lubricant to prevent wear under applied loads: it is calculated from data obtained from the Four Ball EP Method. Formerly called mean Hertz load.

lubricant - any usually oily liquid or solid that reduces friction, heat, or wear when applied to the surfaces of moving parts.

lubrication - the control of friction and wear by the introduction of a friction-reducing film between moving surfaces in contact. The lubricant used can be a fluid, solid, or plastic substance.

lubricity - the ability of an oil or grease to lubricate: also, called film strength. Lubricity can be enhanced by additive treatment.



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M

metalworking lubricant - any lubricant, usually petroleum-based, that facilitates the cutting or shaping of metal. Basic types of metalworking lubricants are: cutting and tapping fluids, drawing compounds, etc.

mineral oil - any petroleum oil, as contrasted to animal or vegetable oils or synthetic fluids.

mineral seal oil - a distillation fraction between kerosene and gas oil, widely used as a solvent oil in gas adsorption processes, as a lubricant for the rolling of metal foil, and as a base oil in many specialty formulations. Mineral seal oil takes its name - not from any sealing function - but from the fact that it originally replaced oil derived from seal blubber for use as an illuminant for signal lamps and lighthouses.

miscible - capable of being mixed in any concentration without separation of phases: e.g., water and ethyl alcohol are miscible.

mold (release) lubricant - a compound, often of petroleum origin, for coating the interiors of molds for glass and ceramic products. The mold lubricant facilitates removal of the molded object from the mold, protects the surface of the mold, and reduces or eliminates the need for cleaning it.

molybdenum disulfide - a black, lustrous powder (MoS_2) that serves as a dry-film lubricant in certain high-temperature and high-vacuum applications. It is also used in the form of pastes to prevent scoring when assembling press-fit parts, and as an additive to impart residual lubrication properties to oils and greases. Molybdenum disulfide is often called moly or moly sulfide.

MRV viscosity - the measure of viscosity at low temperature and shear rate using a mini rotary viscometer and designed to determine the ability of an engine oil to pump to critical locations immediately following a cold start.

MSDS (Material Safety Data Sheet) - a publication containing health and safety information on a product (including petroleum). The OSHA Hazard Communication Standard requires that an MSDS be provided by manufacturers to distributors or purchasers prior to or at the time of product shipment. An MSDS must include the chemical and common names of all ingredients that have been determined to be health hazards if they constitute 1% or greater of the product's composition (0.1% for carcinogens). An MSDS also includes precautionary guidelines and emergency procedures.

mutagenicity - the tendency of a substance to cause genetic mutations under long term exposure. Defined by modified Ames test or long-term dermal bioassay.



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N

naphthenic - petroleum fluid derived from naphthenic crude oil, characterised by a high proportion of cyclo-paraffinic structures or by an absence of wax molecules.

neutralization number – a number used as a measure of the acidic or basic constituents. This term is ambiguous and now obsolete. (See acid/base number, TANITBN)

Newtonian fluid - any fluid, such as a straight mineral oil, whose viscosity does not change with rate of flow.

NLGI Automotive Grease Classifications - automotive lubricating grease quality levels established jointly by SAE, ASTM, and NLGI. There are several categories in two classifications'. Chassis Lubricants and Wheel Bearing Lubricants Quality or performance levels within each category are defined by ASTM tests.

NLGI (National Lubricating Grease Institute) - trade association whose main interest is grease and grease technology. NLGI is best known for its system of rating greases by penetration.

NLGI consistency grades - simplified system established by the National Lubricating Grease Institute (NLGI) for rating the consistency of grease.

non-Newtonian fluid - fluid, such as a grease or a polymer-containing oil (e.g., multi-grade oil), in which shear stress is not proportional to shear rate.

normal paraffin - a hydrocarbon consisting of molecules in which any carbon atom is attached to no more than two other carbon atoms: also called straight chain paraffin and linear paraffin.

O

oiler - a device for once-through lubrication. Three common *types* of oilers are: drop-feed, wick-feed, and bottle-feed: all depend on gravity to induce a metered flow of oil to the bearing. The drop-feed oiler delivers oil from the bottom of a reservoir to a bearing one drop at a time', flow rate is controlled by a needle valve at the top of the reservoir. In a wick-feed oiler, the oil flows through a wick and drips from the end of the wick into the bearing: feed is regulated by changing the number of strands, by raising or lowering the oil level, or by applying pressure to the wick. In a bottle-feed oiler, a vacuum at the top of the jar keeps the fluid from running out; as tiny bubbles of air enter, the vacuum is reduced and a small amount of oil enters the bearing or is added to a reservoir from which the bearing is lubricated.



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Glossary

open gear - a gear that is exposed to the environment, rather than being housed in a protective gearbox. Open gears are generally large, heavily loaded, and slow moving. They are found in such applications as mining and construction machinery, punch presses, plastic and rubber mills, tube mills, and rotary kilns. Open gears require viscous, adhesive lubricants that bond to the metal surfaces and resist run-off. Such lubricants are often called gear shields. Top-quality lubricants for such applications are specially formulated to protect the gears against the effects of water and other contaminants.

organic compound – a chemical substance containing carbon and hydrogen. Other elements, such as nitrogen or oxygen, may also be present

OSHA - Occupational Safety and Health Administration

oxidation - the chemical combination of a substance with oxygen. All petroleum products are subject to oxidation, with resultant degradation of their composition and performance. The process is accelerated by heat, light metal catalysts (eg - copper), and the presence of water, acids, or solid contaminants. The first reaction products of oxidation are organic peroxides. Continued oxidation catalyzed by peroxides, forms alcohols, aldehydes, ketones, and organic acids, which can be further oxidized to form high-molecular weight, oil-insoluble polymers. These settle out as sludges, varnishes, and gums that can impair equipment operation. The organic acids formed from oxidation are corrosive to (ie., cause oxidation of) metals. Oxidation resistance of a product can be improved by careful selection of base stocks (paraffins have greater oxidation resistance than eaphthenes), special refining methods, and addition of oxidation inhibitors. Also, oxidation can be minimized by good maintenance of oil and equipment to prevent contamination and excessive heat

oxidation inhibitor - a substance added in small quantities to a petroleum or other product to increase its oxidation resistance, thereby lengthening its service or storage life: also called antioxidant. An oxidation inhibitor may work in one of three ways: (1) by combining with an modifying peroxides (initial oxidation products) to render them harmless, (2) by decomposing The peroxides, or (3) by rendering an oxidation catalyst (metal or metal ions) inert.

oxidation stability - the resistance of a petroleum product to oxidation: hence, a measure of its potential service or storage life. There are a number of ASTM tests to determine the oxidation stability of a lubricant or fuel, all of which are intended to simulate service conditions on an accelerated basis. In general, the test sample is exposed to oxygen or air at an elevated temperature, and sometimes to water or catalysts (usually iron or copper). Depending on the test, results are expressed in terms of the time required to produce a specified effect (such as a pressure drop), the amount of sludge or gum produced, or the amount of oxygen consumed during a specified period.



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P

paraffin - any hydrocarbon identified by saturated straight (normal) or branched (iso) carbon chains; also called an alkane. The generalized paraffinic molecule can be symbolized by the formula C_nH_{2n+2} . Paraffins are relatively non-reactive and have excellent oxidation stability. In contrast to naphthenic oils, paraffinic lubricating oils have relatively high wax content and pour point, and generally have a high viscosity index (VI). Paraffinic solvents are generally lower in solvency than naphthenic or aromatic solvents.

particulates - particles made up of a wide range of natural materials (e.g., pollen, dust, resins). combined with man-made pollutant (e.g., smoke particles, metallic ash); in sufficient concentrations, particulates can be a respiratory irritant.

PCB - polychlorinated biphenyl, a class of synthetic chemicals consisting of an homologous series of compounds beginning with monochlorobiphenyl and ending with decachlorobiphenyl. PCBs do not occur naturally in petroleum. but have been found as contaminants in used oil. PCBs have been legally designated as a health hazard, and any oil so contaminated must be handled in strict accordance with state and federal regulations.

pH - a measure of the acidity or alkalinity of an aqueous solution. The pH scale ranges from 0 (very acidic) to 14 (very alkaline), with a pH of 7 indicating a neutral solution equivalent to the pH of distilled water.

phenol - a white, crystalline compound (C_6H_5OH) derived from benzene, used in the manufacture of phenolic resins, weed killers, plastics, disinfectants; also used in solvent extraction, a petroleum refining process. Phenol is a toxic material; skin contact must be avoided.

phosphate ester - any of a group of synthetic lubricants having superior fire resistance. A phosphate ester generally has poor hydrolytic stability, poor compatibility with mineral oil, and a relatively low viscosity index (VI). It is used as a fire-resistant hydraulic fluid in high-temperature applications.

PNA (polynuclear aromatic) - any of numerous complex hydrocarbon compounds consisting of three or more benzene rings in a compact molecular arrangement. Some types of PNA's are formed in fossil fuel combustion and other heat processes, such as catalytic cracking.

poise - a unit of measurement of absolute (or dynamic) viscosity.



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polar compound - a chemical compound whose molecules exhibit electrically positive characteristics at one end and negative characteristics at the other end. Polar compounds are used as additives in many petroleum products. Polarity gives certain molecules a strong affinity for solid surfaces; as lubricant additives, such molecules plate out to form a tenacious friction-reducing film. Some polar molecules are oil-soluble at one end and water soluble at the other end: in lubricants, they act as emulsifiers, helping to form stable-oil water emulsions. Such lubricants are said to have good metal-wetting properties. Polar compounds with a strong attraction for solid contaminants act as detergents.

polyglycols - polymers of ethylene or propylene oxides used as a synthetic lubricant base. Properties include very good hydrolytic stability, high viscosity index (VI), and low volatility. Used particularly in water emulsion fluids.

polymer - a substance formed by the linkage (polymerization) of two or more simple, molecules, called monomers, to form a single larger molecule having the same elements in the same proportions as the original monomers; i.e. each monomer retains its structural identity. A polymer may be liquid or solid: solid polymers may consist of millions of repeated linked units. A polymer made from two or more dissimilar monomers is called a copolymer; a copolymer composed of three different types of monomers is a terpolymer. Natural rubber and synthetic rubbers are examples of polymers. Polymers are commonly used as viscosity index improvers in mu':5-grade oils and tackifiers in fabricating greases.

polyolefin - a polymer derived by polymerization of relatively simple olefins. Polyethylene and polyisoprene are important polyolefins.

polyol ester - a synthetic lubricant base, formed by reacting fatty acids with a polyol (such as a glycol) derived *from* petroleum. Properties include good oxidation stability at high temperatures and low volatility. Used in formulating lubricants for turbines, compressors, jet engines, and automotive engines.

pour point - the lowest temperature under which an oil will flow when cooled under prescribed conditions.

pour point depressant - an additive used to lower the pour point of a petroleum product.

ppb - parts per billion.

ppm - parts per million.



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process oil - an oil that serves as a temporary or permanent component of a manufactured product. Aromatic process oils have good solvency characteristics: their applications include proprietary chemical formulations, ink oils, and extenders in synthetic rubbers. Naphthenic process oils are characterized by low pour points and good solvency properties. Paraffinic process oils are characterized by low aromatic content and light color.

pump - a mechanism through which force is applied to a liquid. There are two basic categories of pumps: positive displacement and centrifugal. Positive displacement pumps force liquid to flow in volumetric proportion to decreasing pump volume. Hydraulic systems are a primary application, wherein the hydraulic fluid functions as the lubricant. Positive displacement pumps can be divided into reciprocating and rotary. Reciprocating pumps use pistons, plungers, or diaphragms to increase and decrease volume. Rotary pumps use a rotating device (gear, screw, or vane) to force liquid from the pump. Centrifugal pumps, also called kinetic pumps, differ from positive displacement pumps in that they provide uniform (non-pulsing) flow and adjustable flow velocity. Movement is imparted to the liquid through centrifugal force created by a rotating impeller. There are two basic types of centrifugal pumps: radial flow and axial flow. In the former type, liquid enters the pump at the impeller's axis of rotation and is forced outward by vanes. In the latter type, a propeller or screw on a rotating shaft moves liquid in the axial direction of the shaft.

Q

quenching oil - (also called heat treating oil) a high-quality, oxidation-resistant petroleum oil used to cool metal parts during their manufacture, and is often preferred to water because the oil's slower heat transfer lessens the possibility of cracking or warping of the metal. A quenching oil must have excellent oxidation and thermal stability, and should yield clean parts, essentially free of residue. In refining terms, a quenching oil is an oil introduced into high temperature vapors of cracked (see cracking) petroleum fractions to cool them.

R

R&O - rust-and-oxidation inhibited. A term applied to highly refined industrial lubricating oils formulated for long service in circulating lubrication systems, compressors, hydraulic systems, bearing housing, gear boxes, etc. The finest R&O oils are often referred to as turbine oils.



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refining - a series of processes for converting crude oil and its fractions to finished petroleum products. Following distillation, a petroleum fraction may undergo one or more additional steps to purify or modify it. These refining steps include: thermal cracking, catalytic cracking, polymerization, alkylation, reforming, hydrocracking, hydroforming, hydrogenation, hydrogen treating, hydrofining, solvent extraction, dewaxing, deoiling, acid treating, clay filtration, and deasphalting. Refined lubricating oils may be blended with other lube stocks, and additives may be incorporated, to impart special properties.

re-refining – a series of processes used to convert used oil into high-quality base-stock, rheology - the study of the deformation and flow of matter in terms of stress, strain, temperature, and time. The rheological properties of a grease are commonly measured by penetration and apparent viscosity.

rolling oil - an oil used in hot- or cold-rolling of ferrous and non-ferrous metals to facilitate feed of the metal between the work rolls, improve the plastic deformation of the metal, conduct heat from the metal, and extend the life of the work rolls. Because of the pressures involved, a rolling oil may be compounded or contain EP additives. In hot rolling, the oil may also be emulsifiable.

rust inhibitor - a type of corrosion inhibitor used in lubricants to protect surfaces against rusting.

rust preventive - a compound for coating metal surfaces with a film that protects against rust: commonly used for the preservation of equipment in storage. The base material of rust preventive may be petroleum oil, solvent, wax, or asphalt, to which a rust inhibitor is added. A formulation consisting largely of a solvent and additives is commonly called thin-film rust preventive because of the thin coating that remains after evaporation of the solvent. Rust preventives are formulated for a variety of conditions of exposure, e.g., short-time "in-process" protection, indoor storage, exposed outdoor storage. etc.

S

saponification – the alkaline hydrolysis of fats to form a soap; more generally, the hydrolysis of an ester by an alkali with the formation of an alcohol and a salt of the acid portion. *In situ* saponification is the traditional method of making soap-type grease thickeners.



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saponification number - the number of milligrams of potassium hydroxide (KOH) that combine with one gram of oil under conditions specified by test method ASTM D 94. Saponification number is an indication of the amount of fatty saponifiable material in compounded oil. Caution must be used in interpreting test results if certain substances, such as sulfur compounds or halogens, are present in the oil, since these also react with KOH, thereby increasing the apparent saponification number.

Saybolt Universal 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 carefully controlled temperature, as prescribed by test method ASTM D 88. In the petroleum industry, this method has largely been replaced by the kinematic viscosity method ASTM D 455.

scoring - distress marks on sliding metallic surfaces in the form of long, distinct scratches in the direction of motion. Scoring is an advanced stage of scuffing.

scuffing - localized distress marks on sliding metallic surfaces, appearing as a matte-finished area rather than as *individual* score marks.

seal swell (rubber swell) - the swelling of rubber (or other elastomer) gaskets, or seals, when exposed to petroleum, synthetic lubricants, or hydraulic fluids. Seal materials vary widely in their resistance to the effect of such fluids. Some seals are designed so that a moderate amount of swelling improves seating action.

semi-synthetic - a metal removal fluid typically composed of a translucent micro-emulsion of water, chemicals and a small percentage of oil. A lubricant consisting of a blend of conventional mineral oil and a synthetic hydrocarbons.

shear rate - the rate at which adjacent layers of a fluid move with respect to each other, usually expressed as reciprocal seconds (also see shear stress). When the fluid is placed between two parallel surfaces moving relative to each other:

shear rate (seconds)⁻¹ = relative velocity of surface (meters/second) / distance between surfaces (meters)

shear stress - the frictional force overcome in sliding one "layer" of fluid along another, as in any fluid flow. The shear stress of petroleum: oil or other Newtonian fluid at a given temperature varies directly with shear rate (velocity). The ratio between: shear stress and shear rate is constant: this ratio is termed viscosity. The higher the viscosity of a Newtonian fluid, the greater the shear stress as a function of rate of shear. In a non-Newtonian fluid – such as grease or polymer-containing oil (e.g., multi-grade oil) --shear stress is not proportional to the rate of shear. A non-Newtonian fluid may be said to have an apparent viscosity, a viscosity that holds only for the shear rate (and temperature) at which the viscosity is determined.



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SI – from the French name. *Système Inter-national d'Unites*, the international system of units developed and maintained by the General Conference on Weights and Measures. This is the modern metric system based on the fundamental units of meters, kilograms, and seconds (MKS). The fundamental units of the older (cgs) metric system are centimeters, grams and seconds. (See ASTM E 380.)

soluble oil – a metal remove: fluid typically composed of a stable milky emulsion of water, oil, emulsifiers and other functional additives. Commonly used where cooling is of primary importance.

solvent - a material with a strong capability to dissolve a given substance. The most common petroleum solvents are mineral spirits, xylene, toluene, hexane, heptane, and naphthas. Aromatic-type solvents have the highest solvency for organic chemical materials, followed by naphthenes and paraffins. In most applications, the solvent disappears, usually by evaporation, after it has served its purpose. The evaporation rate of a solvent is very important in manufacture,

solvent extraction - a refining process used to separate components (unsaturated hydrocarbons) from lube distillates in order to improve the oils oxidation stability, viscosity index, and response to additives- The oil and the solvent extraction media are mixed in an extraction tower, resulting in the formation of two phases: a heavy phase consisting of the undesirable unsaturates dissolved in the solvent. and a lighter phase consisting of a high quality oil with some solvent dissolved in it. The phases are separated and the solvent recovered from each by distillation.

spectrographic analysis (elemental analysis) - a technique for detecting and quantifying metallic elements resulting from wear, contamination, or additives. The oil sample is energized to make each element emit or absorb a quantifiable amount of energy, which indicates the element's concentration in the oil.

spindle oil - a low-viscosity oil of high quality for the lubrication of high-speed textile and metal-working (grinding) machine spindles. In addition to the rust and oxidation inhibitors needed for prolonged service in humid environments, spindle oils are often fortified with antiwear additives to reduce torque load and wear, especially at start-up.

statistical process control (SPC) - the use of control charts to track and eliminate variables in repetitive manufacturing processes, in order to ensure that the product is of consistent and predictable quality. If a chart reveals only chance variations that are inherent in the system, the process is said to be in a state of "statistical control". If the chart reveals variations traceable to changes in equipment, procedures or workers, the process is said to be "out of control". Statistical process control differs from statistical quality control in that the former monitors manufacturing process parameters and the latter monitors product quality parameters.



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stick-slip motion - erratic, noisy motion characteristic of some machine ways, due to the starting friction encountered by a machine part at each end of its back-and forth (reciprocating) movement. This undesirable effect can be overcome with a way lubricant, which reduces starting friction.

STLE (Society of Tribologists and Lubrication Engineers) - a technical organization intended to advance the knowledge and application of lubrication and related sciences. Formerly known as the American Society of Lubrication Engineers (ASLE).
straight mineral oil - petroleum oil containing no additives. Straight mineral oils include such diverse products as low-cost once-through lubricants and thoroughly refined white oils. Most high-quality lubricants, however, contain additives.

straight oil - a metal removal fluid typically composed of mineral or vegetable oil or esters and functional additives. Commonly used where lubricity is of primary importance.

sulfated ash - ash content determination by ASTM D874. In which the oil is burned and treated with sulfuric acid. Indicates level of metallic additives in the oil.

sulfonate - a hydrocarbon in which a hydrogen atom has been replaced with the highly polar (SO₂OX) group, where X is a metallic ion or alkyl radical. Petroleum sulfonates are refinery by-products of the sulfuric acid treatment white oils. Sulfonates have important applications as emulsifiers and chemical intermediates in petrochemical manufacture, and substituted sulfonates are widely used as corrosion inhibitors. Synthetic sulfonates can be manufactured from special feedstocks rather than from white oil base stocks.

sulfur - a common natural constituent of petroleum and petroleum products. While certain sulfur compounds are commonly used to improve the EP, or load-carrying, properties of an oil, high sulfur content in a petroleum product may be undesirable as it can be corrosive and create an environmental hazard when burned. For these reasons, sulfur limitations are specified in the quality control of fuels, solvents, etc.

synthetic fluid - a metal removal fluid composed of a transparent solution of chemical lubricants (typically glycols or esters) in water with functional additives.



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synthetic lubricant - a lubricating fluid made by chemically reacting materials of a specific chemical composition to produce a compound with planned and predictable properties; the resulting base stock may be supplemented with additives to improve specific properties. Many synthetic lubricants (also called synlubes) are derived wholly or primarily from petrochemicals, other synlube raw materials are derived from coal and oil shale, or are lipochemicals (from animal and vegetable oils). Synthetic lubricants may be superior to petroleum oils in specific performance areas. Many exhibit higher viscosity index (VI), better thermal stability and oxidation stability, and low volatility (which reduces oil consumption). Most synlubes offer longer service life and, in some cases, better biodegradability than conventional lubricants. Consequently, they are increasingly being used in industrial and automotive applications. Individual synthetic lubricants offer specific outstanding properties: phosphate esters, for example, are fire resistant, diesters have good oxidation stability and lubricity. and silicones offer exceptionally high VI. Polyalphaolefins are versatile lubricants with low pour points, and excellent thermal and oxidation stability, they have good compatibility with petroleum lubricants and most seals used with petroleum lubricants. Most synthetic lubricants can be converted to grease by adding thickeners. Because synthetic lubricants are higher in cost than petroleum oils, they are used selectively where performance or safety requirements may exceed the capabilities of a conventional oil.

T

tackifier (tackiness additive or agent) - a high molecular weight, fluid polymer added to greases to improve adhesiveness.

TAN - (total) acid number.

TBN - (total) base number.

thermal stability - the ability to resist chemical degradation at high temperatures.

thixotropy - the tendency of grease or other material to soften or flow when subjected to shearing action. Grease will usually return to its normal consistency when the action stops. Thixotropy is also an important characteristic of drilling fluids, which must thicken when not in motion so that the cuttings in the fluid will remain in suspension.

tribology - the science of the interactions between surfaces moving relative to each other. Such interactions usually involve the interplay of two primary factors, the load, or force, perpendicular to the surfaces, and the frictional force that impedes movement. Tribological research on friction reduction has important energy conservation applications, since friction increases energy consumption.



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turbine oil - a top-quality rust and oxidation inhibited (R&O) oil that meets the rigid requirements traditionally imposed on steam-turbine lubrication. Quality turbine oils are also distinguished by good demulsibility, a requisite of effective oil-water separation. Turbine oils are widely used in other exacting applications for which long service life and dependable lubrication are mandatory. Such applications include circulating systems, compressors, hydraulic systems, gear drives, and other equipment. Turbine oils can also be used as heat transfer fluids in open systems, where oxidation stability is of primary importance.

U

V

varnish - a hard coating formed from oil oxidation products, that bakes on to surfaces during high-temperature operation of auto-motive engines and industrial machinery. Varnish can accelerate cylinder wear. Varnish formation can be reduced with the use of a detergent-dispersant and an oxidation inhibitor in the oil.

viscosity - a fluid's resistance to flow. The common metric unit of absolute viscosity is the poise, which is defined as the force in dynes required to move a surface one square centimeter in area past a parallel surface at a speed of one centimeter per second with the surfaces separated by a fluid film one centimeter thick. For convenience, the centipoise (cP) (one one-hundredth of a poise) is the unit customarily used in the petroleum industry. Laboratory measurements of viscosity normally use the force of gravity to produce flow through a capillary tube (viscometer) at a controlled temperature. This measurement is called kinematic viscosity. The unit of kinematic viscosity is the stoke, expressed in square centimeters per second. The more customary unit is the centistoke (cSt) – one one-hundredth of a stoke. Kinematic viscosity can be related to absolute viscosity by the equation:

$$cSt = cP / \text{fluid density}$$

In addition to kinematic viscosity, there are other methods for determining viscosity, including Saybolt Universal viscosity, Saybolt Furol viscosity, Engler viscosity, and Redwood viscosity. Since viscosity varies inversely with temperature, its value is meaningless unless the temperature at which it is determined is reported.



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viscosity index (VI) - an empirical, unitless number indicating the effect of temperature on the kinematic viscosity of an oil. Liquids change viscosity with temperature, becoming less viscous when heated: the higher the VI of an oil, the lower its change in viscosity with temperature. The VI of an oil -- with known viscosity at 40°C -- is determined by comparing the oil with two standard oils having an arbitrary VI of 0 and 100, respectively, and both having the same viscosity at 100°C as the test oil. The following formula is used, in accordance with test method ASTM D 2270:

$$VI = (L - U / L - H) \times 100$$

where L is the viscosity at 40°C of the 0-VI oil, H is the viscosity at 40°C of the 100-VI oil, and U is the viscosity at 40°C of the test oil. There is an alternative calculation, also in ASTM D 2270, for oils with VI's above 100. The VI of paraffinic oils is inherently high, but is low in naphthenic oils, and even lower in aromatic oils (often below 0). The VI of any petroleum oil can be increased by adding a viscosity index improver. High-VI lubricants are needed wherever relatively constant viscosity is required at widely varying temperatures.

viscosity index improver – a polymeric additive designed to increase the viscosity index of an oil. Also known as a viscosity modifier.

viscosity-temperature relationship - the manner in which the viscosity of a given fluid varies inversely with temperature. Because of the mathematical relationship that exists between these two variables, it is possible to predict graphically the viscosity of a petroleum fluid at any temperature within a limited range if the viscosities at two other temperatures are known. The charts used for this purpose are the ASTM Standard Viscosity-Temperature Charts for Liquid Petroleum Products, available in 6 ranges. If two known viscosity-temperature points of a fluid are located on the chart and a straight line drawn through them, other viscosity-temperature values of the fluid will fall on this line, however, values near or below the cloud point of the oil may deviate from the straight-line relationship.

volatility - expression of evaporation tendency. The more volatile a petroleum liquid, the lower its boiling point and the greater its flammability.

W

way - longitudinal surface that guides the reciprocal movement of a machine part

way lubricant - lubricant for the sliding ways of machine tools such as planers, grinders, horizontal boring machines, shapers, jig borers, and milling machines. A good way lubricant is formulated with special frictional characteristics designed to overcome the stick-slip motion associated with slow-moving machine parts.



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weld point - the lowest applied load in kilograms at which the rotating ball in the Four Ball EP test either seizes and welds to the three stationary balls. or at which extreme scoring of the three balls results.

X

Y

Z

ZDTP or ZDP (zinc dialkyl or diaryl dithiophosphate) - widely used as an antiwear-additive in engine oils to protect heavily loaded parts, particularly the valve train mechanisms (such as the camshaft and cam followers) from excessive wear. It is also used as an anti-wear agent in hydraulic fluids and certain other products. ZDTP is also an effective oxidation inhibitor. Oils containing ZDTP Should not be used in machines that employ silver alloy bearings.