



Glossary of Terms and Concepts

- A -

Ablation -- process of removal by erosion, melting, evaporation, or vaporization.

Abrasion -- a wearing, grinding or rubbing away by friction, usually (but not always) involving the action of particles against or between surfaces.

Absolute (Dynamic) Viscosity -- the ratio of shear stress to shear rate, representing a fluid's internal resistance to flow. Although the fundamental unit of absolute or dynamic viscosity is the *poise*, results are often expressed in *centipoise* (cP). 1 centipoise equals .01 poise.

Accumulator – an in-line vessel that stores fluid under pressure for later release; used in some larger hydraulic systems.

Accuracy – the closeness of a measured result to the actual (true) value.

Acid – any one of various hydrogen-containing molecules or ions capable of giving up a proton to a base, or of accepting an unshared pair of electrons from a base, or of reacting with a base to form a salt. A more limited definition restricts the acid to a hydrogen-containing substance that contains a non-metallic radical and produces hydrogen ions when placed in solution.

Acid digestion – process of dissolving a sample in an acid matrix, usually accompanied by heating.

Acid treating -- A refining process where unfinished petroleum products (gasoline, kerosene, lube oil stocks, etc.) are brought into contact with sulfuric acid to improve their color, odor, and other properties.

Acidity – specific to oil analysis, acidity denotes the presence of weakly and strongly acidic materials whose total concentration is usually defined in terms of the TAN (Total Acid Number).

Active metal – a metal ready to corrode or being corroded. Contrast with *noble metal*.

Additives – An agent added to oils, fuels, and coolants to impart specific beneficial properties to the finished products. Additives create new fluid properties, enhance properties already present and reduce the rate at which undesirable changes take place in a fluid during service. Selected additives are:

| TYPE | PURPOSE | TYPICAL COMPOUNDS |
|------------------------------------------|----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| Dispersants, Detergents | keep sludge, carbon and other deposit precursors suspended | succinimides, neutral metallic sulfonates, phenates, polymeric detergents, amines |
| Basic Metal Compounds | neutralize acids, prevent corrosion | overbased metallic sulfonates, phenates, carbonates |
| Oxidation Inhibitors | prevent or control oxidation of oil by forming oxygen-inactive compounds and / or scavenging free oxygen | zinc dialkyldithiophosphates; aromatic amines, sulfurized products, hindered phenols |
| Extreme Pressure (EP) Antiwear Additives | reduce wear, prevent scuffing and seizing by forming protective surface films | zinc dialkyldithiophosphates; tricresylphosphates, organic phosphates, chlorine and sulfur compounds |
| Viscosity Index Improvers | reduce the rate of viscosity change with temperature | polyisobutylene, methacrylate polymers, olefin copolymers- may incorporate dispersants |

| | | |
|------------------------|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Rust Inhibitors | prevent the formation of rust on metal surfaces by formation of surface film or neutralization of acids | high base additives, sulfonates, phosphates, organic acids or esters, amines |
| Corrosion Inhibitors | prevent corrosive attack on alloy bearings or other metallic surfaces | organically active sulfur, phosphorus, nitrogen compounds such as phosphites, metal salts of thiophosphoric acid, sulfurized waxes, terpenes |
| Antifoamants | reduce foam with surface tension modifiers that break up large surface bubbles, or small entrained bubble reducers | silicones, organic polymers |
| Friction Modifiers | reduce or modify friction | long chain polar compounds, (amides, phosphates, phosphites, acids, etc.), molybdenum disulfides |
| Metal Deactivators | form surface films so metal surfaces do not catalyze oil oxidation | zinc dialkyldithiophosphates, metal phenates, organic nitrogen compounds |
| Pour Point Depressants | lower "freezing" point of oils assuring free flow at low temperatures | low molecular weight methacrylate polymers |
| Emulsifiers | permit water-in-oil or oil-in-water emulsions by changing interfacial tension | soaps of fatty acids, sulfonic or naphthenic acids |
| Demulsifiers | lower emulsion stability | heavy metal soaps, alkaline earth sulfonates |
| Tackiness Agents | increase adhesiveness of lubricant on metal surfaces; reduce runoff | high molecular weight polymers, aluminum soaps of unsaturated fatty acids |
| Oiliness Agents | lower friction under near-boundary conditions | high molecular weight polar compounds such as fatty oils, oxidized waxes or soaps |

Adhesion – the force of molecular attraction exerted between two surfaces in contact.

Absorption -- the process by which one substance draws itself into another substance. An example is a sponge picking up water, or an oil recovering gasoline from wet natural gas.

Adsorption – the adhesion of an extremely thin layer of molecules (gases, dissolved solids, or liquids) to the surfaces of solids or liquids with which the molecules are in contact. This process is utilized in a broad range of fluid and additive applications to concentrate one material on the surface of another.

Aeration – combining or charging a fluid with a gas, as in oil being aerated with air.

Aerosol – a highly dispersed suspension of fine solid or liquid particles in a gas.

Aftercooling – the process of cooling compressed gases under constant pressure after the final stage of compression.

Agglomeration – the action of combining a number of small particles into a larger single mass, often the operating principle for additives which promote particle attraction and clumping.

Air entrainment -- The incorporation of air (bubbles) as a dispersed phase in a liquid. Air entrainment may result from mechanical means or by sudden environmental changes. The presence of *entrained* air is usually obvious from the hazy, opaque, or bubbly physical appearance of the liquid while *dissolved* air can only be determined by specific testing.

Alkali -- any substance having basic (as opposed to acidic) properties. A more limited definition restricts the alkali to hydroxides of ammonium, lithium, potassium and sodium.

Alloy steel – steel containing specified quantities of alloying elements added to effect changes in mechanical or physical properties.

Ambient temperature -- temperature of the area or atmosphere around a process, (not the operating temperature of the process itself).

Anhydrous -- free of water, especially water of crystallization (water present as an internal part of the structure of a salt crystal).

Aniline point -- the minimum temperature for complete miscibility of equal volumes of aniline and the sample. A product of high aniline point will be low in aromatics and naphthenes and, therefore, high in paraffins. Aniline point is often specified for spray oils, cleaning solvents, and thinners, where effectiveness depends upon aromatic content. In conjunction with API gravity, the aniline point may be used to calculate the net heat of combustion for aviation fuels.

Annealing – a generic term denoting a treatment consisting of heating a metal to a suitable temperature and holding it there, followed by cooling at a suitable rate. This process is used primarily to soften metallic materials, but also to simultaneously produce desired changes in the metal's microstructure or other properties. When the term is used by itself, *full annealing* is implied. When the treatment is applied only for the relief of stress, it is properly called *stress-relieving* or *stress-relief annealing*.

Anodizing – forming a conversion coating on a metal surface by anodic (electron-removing) oxidation; most frequently applied to aluminum.

Apparent viscosity -- The ratio of shear stress to rate of shear of a non-Newtonian fluid such as lubricating grease calculated from Poiseuille's equation and measured in poises. The apparent viscosity changes with changing rates of shear and temperature and must, therefore, be reported as the value at a given shear rate and temperature.

API engine service categories -- gasoline and diesel engine oil quality levels established jointly by API, SAE, and ASTM, and sometimes called SAE or API/SAE categories; formerly called API Engine Service Classifications.

API gravity -- a gravity scale established by the American Petroleum Institute and in general use in the petroleum industry, the unit being called "the API degree", which is represented by the equation:

$$API\ gravity, deg = (141.5 / \text{specific gravity at } 60/60^{\circ}F) - 131.5$$

API base stock -- base fluid for automotive engine oils. The API (American Petroleum Institute) currently designates five classes of base stocks. These stock types are independent of crude source or processing. Instead, they are based on physical characteristics of the base stock, which are then related to formulate engine oil performance:

| GROUP | CHARACTERISTICS |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Group I | Contain <90% saturates and/or >0.03% sulfur, with viscosity index ³ 80 and <120. Commonly referred to as conventional, solvent refined base stocks. |
| Group II | Contain ³ 90% saturates and £ 0.03% sulfur, with viscosity index ³ 80 and <120. Commonly referred to as severely hydrotreated and/or hydrocracked base stocks. |
| Group III | Contain ³ 90% saturates, with £ 0.03% sulfur, with viscosity index ³ 120. Commonly referred to as VHVI or XHVI base stocks. |
| Group IV | PAO's (polyalphaolefins) |
| Group V | All other base stocks not included in Groups I, II, III, or IV. |
| | (where < stands for less than, £ stands for less than or equal to, ³ stands for greater than or equal to, and > stands for greater than) |

Aromatic -- derived from, or characterized by, the presence of the benzene ring.

Ash -- a measure of the amount of inorganic material in lubricating oil. Determined by burning the oil and weighing the residue.

Asperities -- microscopic projections on metal surfaces. Asperities result from normal finishing processes or from any other process or condition which changes the surface profile. Interference between opposing asperities in sliding or rolling wear is a source of friction, and can lead to metal welding and scoring. Ideally, the lubricating film between two moving surfaces should be thicker than the combined height of the opposing asperities.

Auto-ignition point -- The temperature at which a substance ignites without other sources of energy. Also, associated with the spontaneous ignition and sustained combustion of part or all of the fuel-air mixture in an engine. The flame speed is many times greater than that associated with normal spark ignition, producing a characteristic "knocking" sound.

- B -

Babbitt -- a soft, white, non-ferrous alloy of copper, antimony, tin and lead. Found in sleeve/journal bearing overlays.

Bactericide -- chemical agent that inhibits the growth of bacteria promoted by the presence of water.

Base -- a material that neutralizes acids. Also, term referring to an oil additive containing colloiddally dispersed metal carbonate, used to reduce corrosive wear.

Base stock -- a primary refined petroleum fraction or a selected synthetic material, into which additives are blended to produce finished lubricants.

Batch -- quantity of product resulting from a single blending or other processing operation.

Bearing -- a machine part which positions and supports load and movement through the action of fitted or formed surfaces that move with respect to each other by sliding, rolling, reciprocating, or by combinations of these motions. Selected bearing types are:

| TYPE | DESCRIPTION |
|--------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Rolling element bearings Deep groove ball Cylindrical roller Tapered roller Spherical roller Needle roller | Generally consist of two races (rings or raceways) with a set of rolling elements running in their tracks. The rolling elements are in the form of balls or various types of rollers. The outer race is located in a housing and the inner race on the shaft. In 'self-aligning' types, often one of the races is not fixed axially but is free to move to allow for limited shaft movement. In 'thrust' types, the races are configured to support additional angular contact for axial loading. In <i>needle roller</i> bearings, there is no inner race, no element separator, and the rolling elements turn very close together directly against the shaft. |
| Plain (sliding) bearings Journal Guide Thrust | Generally consist of a unmoving solid surface conforming to, and operating directly against, an opposing shaft or plate. <i>Journals</i> may be single-piece or in connected sections, and wrap around all or part of the shaft surface. <i>Guide</i> bearings align rotating or reciprocating parts, while <i>thrust</i> bearings prevent a shaft from moving endwise and support heavy directional loads. |
| Tilting pad thrust bearing | Characterized by a journal-like enclosure of several separately mounted pivoting pads mounted at right angles to the shaft. |
| Sector pad thrust bearing (also known as <i>Kingsbury</i> bearing) | Characterized by a series of pivoted wedge-shaped segments mounted parallel to the shaft, against a circular thrust collar extending outward at right angles from the shaft. |
| Flat bearings | Various types of slides, guides and ways. |

Beta Rating -- efficiency-based filter performance rating. This is done using the Multi-Pass Test which counts the number of particles of a given size before and after fluid passes through a filter, over multiple passes of the fluid through the filter being tested.

Beta ratio (β -ratio) -- the ratio of the number of particles greater than a given size entering a filter to the number of particles greater than the same size leaving the filter, under specified test conditions.

Black oils -- lubricants containing asphaltic materials, which impart extra adhesiveness, that are used for open gears and steel cables.

Blend(ing) -- composite of two or more components or lubricants for the purpose of obtaining the desired physical and/or chemical properties. In petroleum product manufacture, a blend may consist of two or more base stocks or a base stock combined with chemical additives.

Bloom -- rapid growth and spread of a bacterial or algal colony. Also, fluorescence; the color of an oil by reflected light that could differ from its color by transmitted light.

Blow-by -- passage of unburned fuel and combustion gases past the piston rings of internal combustion engines, resulting in fuel dilution and contamination of the crankcase oil.

Boundary lubrication -- the state of lubrication when conditions exist that do not permit the formation of a lubricant film capable of completely separating the moving parts. Under these conditions, additives are used to increase oil film strength or coat metal surfaces with a sacrificial 'anti-wear' film. Anti-wear 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 managed with lubricants containing EP additives that prevent sliding surfaces from fusing together at high local temperatures and pressures.

Boiling point -- the temperature at which a substance boils, or is converted into vapor by bubbles forming within the liquid; it varies with pressure.

Bottoms -- in refining, the high-boiling point residual liquid that collects at the bottom of a distillation column, such as a pipe still. Examples of bottoms include such components as heavy fuels and asphalts.

Brinelling -- permanent deformation of the bearing surfaces where the rollers (or balls) contact the races. Brinelling results from excessive load or impact on stationary bearings. It is a form of mechanical damage in which metal is displaced or upset without being permanently removed from the surface.

Brookfield viscosity -- apparent viscosity in cP (centipoise) determined by Brookfield viscometer, which measures the torque required to rotate a spindle at constant speed in oil of a given temperature. Basis for measuring low temperature viscosity of lubricants.

BTU -- British thermal unit. The amount of heat required to raise the temperature of 1 pound of water 1 degree Fahrenheit.

BS&W (bottom sediment and water) -- the material that collects in the bottom of storage tanks, usually composed of oil, water, and foreign matter. Also called bottoms, or bottom settling and water.

Bubble point -- the differential (inner vs. outer) gas pressure at which the first steady stream of gas bubbles is emitted from a wetted filter element under specified test conditions.

Burst pressure rating -- maximum specified differential pressure that can be applied to a filter element without outward structural or filter-medium failure.

Bushing -- a usually removable cylindrical lining for an opening used to limit the size of the opening, resist abrasion, or serve as a guide.

Bypass filtration -- filtration approach in which only part of the total flow of a circulating fluid system passes through a filter at any given time, or approach in which a separate pump and filter combination operates in parallel to the main flow.

Bypass valve -- differential pressure valve or fitting on a filter which opens when the filter reaches a preset maximum capacity, assuring continued flow by allowing part or all of the fluid to bypass the filter element.

Calibration/ standardization – These two terms have a broad or narrow definition, depending on circumstances, and some sources use them interchangeably. *Calibration* connotes extensive or exacting measurements, under specified conditions, to determine how closely the output values of a measuring process or system compare to nationally or internationally traceable standards of verified known value. Once this measurement has been performed, any deviation from required performance specifications may be corrected by adjustment, repair or replacement.

Standardization connotes a procedure for making limited routine measurements and adjustments to the process or system in order to correct minor known variations, such as those associated with changes in operating environment or working materials. Calibrations are normally performed at longer intervals (annual or semi-annual) set by instrument manufacturers, official standardizing agencies, or operating circumstances, while standardizations are typically done on a daily or weekly basis. Not all simple systems or processes are readily adjustable—for example, the contents of a liquid-in-glass thermometer. In such a case the calibration would only involve determining the thermometer's 'true' reading as opposed to its stated reading and applying a correction factor, without the corresponding physical adjustments normally associated with the calibration process. For complex instrument systems used in modern oil analysis laboratories, both manual and electronic calibrations and standardizations are essential in maintaining acceptable performance.

Cam -- a rotating or sliding eccentric part which passes motion to a roller or pin moving against its edge. Used to cyclically raise, lower, or otherwise move a part a specific distance, such as the action of a cam moving an engine's valves.

Capacity -- the measure of total content, production or output. For example, the amount of heat a burned fuel will release, or amount of contaminants a filter will hold before an excessive pressure drop is caused.

Capillarity -- a property of a solid-liquid system manifested by the tendency of the liquid in contact with the solid to rise above or fall below the level of the surrounding liquid; this phenomenon is seen in a small-bore (capillary) tube.

Capillary viscometer-- a viscometer in that the oil flows through a capillary tube.

Carbon -- a non-metallic element, number 6 in the periodic table, found in the native (uncombined) form as graphite or diamond. Carbon is a constituent of all organic compounds including coal, petroleum, asphalt, etc. It also occurs in combined form in many inorganic substances; i.e., carbon dioxide, limestone, etc.

Carbon residue -- coked material remaining after an oil has been exposed to high temperatures under controlled conditions.

Case drain filter -- a filter located in a line conducting fluid from a pump or motor housing to reservoir.

Catalyst -- a substance which speeds a chemical action without undergoing a chemical change itself during the process.

Catalytic converter -- an integral part of vehicle emission control systems since 1975. Oxidizing converters remove hydrocarbons and carbon monoxide (CO) from exhaust gases, while reducing converters control nitrogen oxide (NOx) emissions. Both use noble metal (platinum, palladium or rhodium) catalysts that can be "poisoned" by lead compounds in the fuel or lubricant.

Catastrophic failure -- sudden, unexpected failure of a system.

Cavitation – the formation and instantaneous collapse of innumerable air or vapor pockets (or bubbles) in flowing liquids due to the hydrodynamic generation of rapid and intense pressure changes. This may result from the movement of a solid body, such as a propeller blade or piston. Cavitation can also occur in a hydraulic system as a result of low fluid levels that draw air into the system, producing tiny bubbles that undergo explosive decompression at the pump outlet.

Cavitation damage – the degradation of a solid body resulting from its exposure to cavitation. This may include loss of material, surface deformation or changes in properties or appearance.

Cellulose media -- a filter material made from plant fibers. Because cellulose is a natural material, its fibers are rough in texture and vary in size and shape. Compared to synthetic media, these characteristics create a higher restriction to the flow of fluids.

Centipoise (cP) -- a standard reporting unit of absolute viscosity. 1 centipoise = 0.01 poise.

Centistoke (cSt) -- a standard reporting unit of kinematic viscosity. 1 centistoke = 0.01 stoke.

Centralized lubrication -- a system of lubrication in which a metered amount of lubricant or lubricants for the bearing surfaces of a machine or group of machines are supplied from a central location.

Centrifugal separator-- a separator that removes immiscible fluid and solid contaminants that have a different specific gravity than the fluid being purified by accelerating the fluid mechanically in a circular path and using the radial acceleration component to isolate these contaminants.

Cetane number (calculated) -- the cetane number of distillate fuels as estimated from the API gravity and mid-boiling point by using a formula. This estimate is used if a standard test engine is not available, or if the sample is too small for an engine test.

Cetane improver-- a substance which, when added to a diesel fuel, has the effect of increasing its cetane number. In this class are nitro alkanes, nitrates, nitro carbonates, and peroxides.

Cetane index -- an approximation of cetane number based on API gravity and mid-boiling point of a fuel.

Certificate of analysis – list of laboratory test results that the supplier affirms to be representative of the quality of a product shipped to a particular customer.

Channelling -- the phenomenon observed among gear lubricants and greases when they thicken, due to cold weather or other causes, to such an extent that a groove is formed through which the part to be lubricated moves without actually coming in full contact with the lubricant.

Chip detector – a magnetic plug fitted with open electrical contacts. When one or more ferromagnetic particles are attracted to the detector end and bridge the contacts, this completes an electrical circuit and activates an indicator, thus notifying the operator that this particle buildup has occurred. Often used in high-speed, close-tolerance systems such as aviation turbine engines where any release of larger iron alloy flakes or fragments is considered a serious condition.

Chromatography -- a method of separation based on selective adsorption. A solution of the substance is allowed to diffuse slowly through a column of adsorbent, moved by a gas or solvent flow. Different substances will pass with different speeds down the column and will eventually be separated into zones whose content may be monitored by various types of detectors. If the method

is used for separation, the column core can then be pushed out and the zones of material cut apart, or the zones can be eluted by passing more solvent down the column and collecting it in small fractions.

Gas chromatography is an analytical technique for separating mixtures of volatile substances. The procedure consists of introducing the mixture to be examined into the chromatographic column and washing it down (eluting it) with an inert gas. The column is packed with adsorbent materials that selectively retard the components of the sample. A detector profiles the sample's components, using the time each component took to reach the detector and the intensity of the detector's response to each component.

Paper chromatography is a micromethod. A drop of the liquid to be investigated is placed near one end of a strip of paper. This end is immersed in solvent that travels down the paper and distributes the materials present in the original drop selectively. Comparison with known substances makes identification possible. The commonly used and extremely simple "blotter test" is a long-established example of the principle of paper chromatography, although it omits the solvent and standard comparison steps.

Partition chromatography involves the selective solution of the desired material between two solvents. The final solvent, usually water, is used to wet the solid material packed in the column, and the first solvent containing the desired material is poured into the column as described.

Circulating lubrication -- lubricating system that recirculates fluid through a system after it has passed through the system and returned to a central collection point.

Cleanable filter -- a filter element whose media allows cleaning for reuse, using a suitable process to restore an acceptable percentage of the filter's original contaminant capacity.

Clean room -- an enclosed area in which air quality factors (such as particulate level, temperature, humidity, and pressure) are controlled and maintained at specific levels by special facilities and operating processes.

Cloud point -- the temperature at which paraffin waxes or other solid substances begin to crystallize or separate from the solution, imparting a cloudy appearance to the oil when chilled.

Coalescer -- a separator that divides a mixture or emulsion of two immiscible liquids using the interfacial tension between the two liquids and the difference in wetting of the two liquids on a particular porous medium.

Coefficient of friction -- the number obtained by dividing the friction force resisting motion between two bodies by the normal force pressing the bodies together.

Cohesion -- molecular attraction that causes substances to resist mechanical separation.

Cold cranking simulator (CCS) -- an intermediate shear rate viscometer that predicts the ability of an oil to permit a satisfactory engine cranking speed under cold conditions.

Collapse -- an inward structural failure. For example, filter element failure due to abnormally high differential pressure.

Collapse pressure -- the minimum differential pressure that an element is designed to withstand without permanent deformation.

Colloid -- a suspension of finely divided particles in a gas or liquid which do not settle and are not easily filtered. A lubricating grease is a *colloidal system*, in which metallic soaps or other thickening agents are dispersed in, and give structure to, the liquid lubricant.

Complex grease -- a lubricating grease thickened by a complex soap consisting of a normal soap and a complexing agent.

Compound -- a distinct substance formed by the combination of two or more elements in definite proportions by weight and possessing physical and chemical properties different from those of the combining elements.

Compounding -- the addition of fatty oils and similar materials to lubricants to impart special properties. Lubricating oils to which such materials have been added are known as compounded oils.

Compression -- the use of mechanical force and motion to pressurize (apply force to) a gas or liquid. Examples of pressure-creating devices are *compressors*, where the pressure of a gas is raised, and *pumps*, which are more commonly associated with liquids.

Compressibility -- the change in volume of a unit volume of a fluid when subjected to a unit change of pressure.

Compression ratio -- in an internal combustion engine, the ratio of the volume of combustion space at bottom dead center to that at top dead center.

Consistency -- the degree to that a semisolid material such as grease resists deformation. Sometimes used qualitatively to denote viscosity of liquids.

Contaminant -- any foreign or unwanted substance that can have a negative effect on system operation, life or reliability.

Contaminant capacity -- the weight of a specified artificial contaminant entering a filter to produce a given differential pressure across a filter at specified conditions. Used as an indication of relative service life.

Contaminant failure -- any loss of performance due to the presence of contamination. This process may occur gradually or rapidly, depending on conditions.

Contaminant lock -- the binding or jam of a moving part caused by solid contaminant accumulation between critical surfaces.

Contamination control -- a broad subject that applies to all types of material systems (including both biological and engineering). It is concerned with planning, organizing, managing, and implementing all activities required to determine, achieve and maintain a specified contamination level.

Coolant -- a fluid used to remove heat. This term has broad application in any process which generates heat as a result of frictional or combustion processes.

Copper strip corrosion -- a test that assesses a petroleum product's tendency to corrode pure copper.

Correlation -- two or more things so related that the presence or amount of one corresponds to the presence or amount of another. For example, the percentage of peaks in a used oil infrared spectrum which match those in a new reference oil. A high correlation would imply the oils match, a low correlation would imply mixing or degradation. Another example would be the amount of dirt contamination within a system correlated to the amount of abrasive wear on the internal parts.

Corrosion -- the decay and loss of a metal due to a chemical reaction between the metal and its environment. It is a transformation process in which the metal passes from its elemental form to a combined (or compound) form.

Coupling -- a connecting assembly, as in a joining connector for hoses or pipes.

Cracking -- the process whereby large molecules are broken down by the application of heat and pressure to form smaller molecules.

Crown -- the top of the piston in an internal combustion engine above the fire ring, exposed to direct flame impingement.

Cryogenics -- the branch of physics relating to the production and effects of very low temperatures.

Cutting fluid -- any fluid that assists the cutting operation by cooling or lubricating the cutting tool or the material being cut.

Cycle -- a single complete operation consisting of progressive phases starting and ending at the neutral position.

Cyclic stress -- a stress whose magnitude fluctuates in a regular pattern.

Cylinder -- a device that converts fluid power into linear mechanical force and motion. It usually consists of a moveable element such as a piston and piston rod, plunger rod, plunger or ram, operating within a cylindrical bore.

-D-

Deaerator-- a separator that removes air from the system fluid.

Defect -- an imperfection in a material that contributes significantly to failure or limited serviceability.

Degas -- removing air from a liquid, usually by ultrasonic and/or vacuum methods.

Degradation -- the progressive reduction of performance, usually ending in failure of a machine or lubricant.

Dehydrator -- a separator that removes water from the system fluid.

Delamination -- a complex wear process where a machine surface is peeled away or otherwise removed by forces of another surface acting on it in a sliding motion.

Demulsibility -- the ability of a fluid that is insoluble in water to separate from water with which it may be mixed in the form of an emulsion.

Density -- the mass of a unit volume of a substance. Its numerical value varies with the units used.

Deposit -- process of a solid residue accumulating on a surface. For example, oil-insoluble materials that result from oxidation and decomposition of lube oil and contamination from external sources and engine blow-by are deposited on machine or engine parts. Other examples are sludge, varnish, lacquer and carbon.

Depth filter -- a filter medium that retains contaminants primarily within the winding deep structure of the filter.

Desorption -- opposite of absorption or adsorption. In filtration, it relates to the downstream release of particles previously retained by the filter.

Detection limit -- practically defined as the point where the signal level decreases to less than two to three times the noise level.

Detergent -- in lubrication, either an additive or a compounded lubricant having the property of keeping insoluble matter in suspension thus preventing its deposition where it would be harmful. A detergent may also redisperse deposits already formed.

Dielectric Strength -- a measure of the ability of an insulating material to withstand electric stress (voltage) without failure. Fluids with high dielectric strength (usually expressed in volts or kilovolts) are good electrical insulators.

Dieseling -- the continued running of a spark-ignited engine after the ignition is turned off. There are two basic causes of dieseling:

surface ignition, where combustion chamber surfaces remain hot enough to ignite fuel after the spark is terminated;

compression ignition, where the conditions of temperature, pressure, fuel composition and engine idle speed allow ignition to continue.

Differential pressure indicator -- an indicator that signals the difference in pressure between any two points of a system or a component.

Disposable -- a filter element intended to be discarded and replaced after one service cycle.

Dissolved gases -- those gases that enter into chemical solution with a fluid, as distinguished from free or entrained gases (mechanically mixed but not chemically bound).

Distillation -- process of driving gas or vapor from liquids or solids by heating, then condensing the vapor for the purposes of separation, purification, or measurement.

Drum-- a container with a capacity of 55 U.S. gallons.

Dry-film lubricant -- solid material deliberately deposited between two moving surfaces to prevent metal-to-metal contact, thus reducing friction and wear. Such materials are especially useful in the region of boundary lubrication, and for lubrication under special conditions of extremely high or low temperature where usual lubricants are inadequate. Some examples are graphite or molybdenum disulfide.

Duplex filter -- an assembly of two filters with valving for selection of either or both filters.

- E -

Effluent -- material exiting a system.

Elastohydrodynamic lubrication -- Lubrication modified to take into consideration the elastic properties of the bearing material and the viscosity increase of the lubricant under concentrated load. In rolling element bearings, the bearing undergoes elastic deformation (flattening) as it rolls under load in the bearing race. This momentary flattening improves the hydrodynamic lubrication properties by converting point or line contact to surface-to-surface contact.

Electrostatic separator -- a separator that removes contaminant from dielectric fluids by applying an electrical charge to the. Once charged, the contaminant is then attracted to a collection device of different electrical charge.

Emulsibility -- the ability of a non-water-soluble fluid to form an emulsion with water.

Emulsion -- intimate mixture of oil and water, 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).

Environmental contaminant -- material entering a system from an operating system's external surroundings, such as dust, air, moisture or chemicals.

Erosion -- the progressive removal of a machine surface by cavitation or by particle impingement at high velocities.

Failure – a general term used to imply that a part or system has:

Become completely inoperable; Is still operable but is incapable of satisfactorily performing its intended function;

Has deteriorated seriously to the point that it has become unreliable or unsafe for continued use.

Fatigue -- a structural failure due to flexing caused by cyclic motions or cyclic differential pressures which do not exceed the tensile strength of the material.

Fault -- failure to reach or maintain a measured standard of reliability or performance. With respect to condition monitoring, additional terms relating to *fault* are:

| TERM | DESCRIPTION |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Occurrence | Any detected or diagnosed fault requiring remedial action whether the action was reactive, preventive or proactive |
| Apparent Fault Condition | A diagnostic system reading indicates an abnormal condition, pending confirmation and evaluation of severity |
| True Fault Condition | An apparent fault condition has been confirmed as a valid abnormal condition (by inspection, multi-technique cross checking, loss or variance in performance, etc.) |
| False Alarm | An apparent fault condition has not been confirmed or has been traced to an external cause (sampling or instrument error, misidentification, judgement error, etc.) |

Ferrography – a method of debris analysis that uses a high gradient magnetic field to attract, hold and deposit particles contained in a fluid. The resulting slide traps both magnetic and non-magnetic particles, which are then microscopically examined for characteristics that reveal size, composition, mode of wear, and possible source.

Film strength -- the property of an oil which enables it to maintain an unbroken film on lubricated surfaces under operating conditions, where otherwise there would be scuffing or scoring of the surfaces.

Filter -- any device or porous substance used as a strainer for cleaning fluids by removing suspended matter.

Filter efficiency -- method of expressing a filter's ability to trap and retain contaminants of a given size.

Filter element -- the porous device that performs the actual process of filtration.

Filter head -- an end closure for the filter case or bowl that contains one or more ports.

Filter housing -- a ported enclosure that directs the flow of fluid through the filter element.

Filter life test -- a type of filter capacity test in which a clogging contaminant is added to the influent of a filter, under specified test conditions, to produce a given rise in pressure drop across the filter or until a specified reduction of flow is reached. Filter life may be expressed as test time required to reach terminal conditions at a specified contaminant addition rate.

Filter media, depth -- porous materials that primarily retain contaminants within a tortuous path, performing the actual process of filtration.

Filter media, surface -- porous materials which primarily retain contaminants on the influent face, performing the actual process of filtration.

Filtration -- the physical or mechanical process of separating insoluble particulate matter from a fluid by passing the fluid through a filter medium that traps the insoluble particles.

Fire point -- the temperature at which vapor released from a combustible liquid will burn continuously when ignited under specified conditions.

Fire-resistant fluid -- a fluid difficult to ignite and/or which shows little tendency to propagate flame, used especially in high-temperature or hazardous hydraulic applications. These fluids are less flammable than mineral (petroleum) oil and are approved for fire resistance by Factory Mutual Research. They will burn at the ignition source but will not propagate a flame back through a spray mist to the leak. They will self-extinguish when the ignition source is removed. Three common types of fire-resistant fluids are:

water-petroleum oil emulsions, in which the water prevents burning of the petroleum constituent;

water-glycol fluids, which are essentially non-flammable by nature;

non-aqueous fluids of low volatility, such as phosphate esters, silicones, and halogenated hydrocarbons.

Flash point -- the lowest temperature at which vapors arising from the oil will ignite momentarily when exposed to a flame.

Flaw – an imperfection in a material that does not affect its serviceability. A component may have imperfections and still retain its usefulness. This fact is recognized by most material codes that permit, but limit, the size and extent of imperfections.

Flow, laminar -- fluid flow in parallel layers.

Flow, turbulent – fluid flow in random directions.

Flow fatigue rating -- the ability of a filter element to resist structural failure of the filter medium due to flexing caused by cyclic differential pressure.

Flow rate -- the volume, mass, or weight of a fluid passing through any conductor per unit of time.

Flowmeter -- a device which indicates either flow rate, total flow, or a combination of both.

Fluid -- a general classification of physical state, including liquids and gases.

Fluid compatibility – assessment of a fluid mixture or one or more of its components to avoid or control undue effects on fluid properties, filters, seals or the system serviced with the mixture.

Fluid power -- energy transmitted and controlled through use of a pressurized fluid.

Flushing -- a fluid circulation process designed to remove contamination from the wetted surfaces of a fluid system.

Foam -- an agglomeration of gas bubbles separated from each other by a thin liquid film, which is observed as a persistent phenomenon on the surface of a liquid.

Force feed lubrication -- pressurized lubrication system delivering oil directly to the lubricated parts.

Fretting corrosion -- surface oxidation resulting when two metals are held in contact and subjected to repeat small sliding, relative motions. Also termed brinelling or chafing.

Friction -- the resisting force encountered at the common boundary between two bodies when, under the action of an external force, one body, moves or tends to move relative to the surface of the other.

Fourier Transform-- A mathematical technique for analyzing a complex waveform into its component frequencies and thus expressing it as a sum of a continuous series of sine and cosine (fixed frequency and amplitude) waves. The Fourier transform is central to many kinds of signal processing, including the analysis and compression of all types of frequency-based information. In oil analysis, the "FT" portion of "FTIR".

Full-flow filtration -- a system of filtration in which the total flow of a circulating fluid system passes through a filter.

Full fluid-film lubrication -- a continuous lubricating film thick enough to completely separate two surfaces. Normally in full fluid-film lubrication oil adheres to the moving part and is drawn into the area between the sliding surfaces, where hydrodynamic processes form a pressure wedge.

- G -

Gauge -- an instrument or device for measuring, indicating or comparing a physical characteristic.

Galling -- a form of wear in which seizing or tearing of the surface occurs.

Gasohol -- a blend of 10% anhydrous ethanol (ethyl alcohol) and 90% gasoline, by volume. Used as a motor fuel.

Gear -- a cylindrical or conical part using a tooth or screw-based surface configuration to mechanically transmit power from one portion of a machine to another. Gear designs are based in part on the shaft alignment: parallel, angled, over-and-under, etc. Selected gear types are:

| TYPE | DESCRIPTION |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Spur gear | Has teeth on the outside of a cylindrical body that are straight and parallel to the axis of rotation. |
| Helical gear | Has teeth that spiral around the outside of a cylindrical body at an angle. |
| Internal gear | Has teeth on the inside of a hollow cylindrical shape. |
| Bevel or miter gear | Has teeth on the outside of a conical body. They may be straight cut (as in the <i>plain bevel</i> gear), or spiral cut (as in the <i>spiral bevel</i> gear). Both transmit motion between intersecting shafts at various angles. |
| Hypoid gear | Has teeth cut in spiral bevel pattern, but set on non-intersecting shafts crossing at a right angle (over-and-under). |
| Worm gear | Has threads that wrap around a cylindrical body. |
| Herringbone gear | Has two separate rows of adjoining teeth on the same gear, cut in the configuration of two connected helical gears with teeth angled in a V-shaped alignment. |
| Crown gear | Has teeth set in the rim perpendicular to the rotation plane of the gear. |
| Straight gear (rack and pinion) | Has a toothed bar into which a worm or spur type 'pinion' meshes, normally used to translate rotating motion into reciprocating motion. |
| Ratchet and pawl | Has a toothed wheel or bar which catches a 'pawl' (a mechanical device that allows rotation only in one direction). |
| Sprocket | Has a gearlike wheel which drives or is driven by a chain as opposed to direct mesh. |

Gear train -- group or sequence of gears which perform a desired mechanical transfer of power. Selected gear train types are:

| TYPE | DESCRIPTION |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Transmission | Gear train characterized by multiple selectable gear speed ratios and the ability to uncouple the gear train from the power source to permit starting and stopping the gear train without stopping the power source. Used in applications where varying speed/torque/output direction requirements must be satisfied by a single geared system. |
| Differential | Gear train characterized by the connection of two output shafts or axles in the same line, with an <i>epicyclic</i> (one or more parts travel around the circumference of another fixed or moving part) gear arrangement permitting one output shaft to revolve faster than the other. |
| Planetary | Gear train characterized by a predominantly epicyclic arrangement, consisting of a series of <i>planet</i> gears rotating in a <i>carrier</i> between a central <i>sun</i> gear and an outer <i>ring</i> gear (of internal gear type). A planetary gearset may be configured in a variety of ways, depending on which part of the gearset is used for power input, which part is held stationary or braked, which part is used for power output, and the actual number and arrangement of sun and planet gears. Generally, the more planet gears the greater the torque capacity of the system. |
| Speed increaser or reducer | Gear train characterized by high to extremely high ratios of input to output speed, for the purposes of large-scale RPM increases or large-scale torque increases. Usually a single-speed gear ratio; if multispeed, they differ from transmissions in that they are shifted as often or as easily. |

Generated contaminant -- created by internal processes such as wear or progressive degradation of system fluids, rather than external sources or inherent from assembly or maintenance.

Graphite -- a crystalline form of carbon having a laminar structure, which is used as a lubricant. It may be of natural or synthetic origin.

Gravimetric analysis -- a method of analysis whereby the dry weight of contaminant per unit volume of fluid can be measured showing the degree of contamination in terms of milligrams of contaminant per liter of fluid.

Grease -- a lubricant composed of an oil or oils thickened with a soap, soaps or other thickener to a semisolid or solid consistency.

- H -

Hardness -- the resistance of a substance to surface abrasion.

Heat exchanger -- a device which transfers heat through a conducting wall from one fluid to another.

Housing -- a ported enclosure which directs the flow of fluid through the filter element.

Hydraulic Fluid -- fluid serving as the power transmission medium in a hydraulic system, with specific properties tailored to the fluid's use in this application.

Hydraulics -- engineering science pertaining to liquid pressure and flow.

Hydrocarbon -- a compound containing only hydrogen and carbon. The simplest hydrocarbons are gases at ordinary temperatures; but with increasing molecular weight, they change to the liquid form and, finally, to the solid state. They form the principal constituents of petroleum.

Hydrodynamic lubrication -- a system of lubrication in which the shape and relative motion of the moving surfaces causes the formation of a fluid film having sufficient pressure to separate the surfaces.

Hydrofinishing -- a process for treating raw extracted base stocks with hydrogen to saturate them for improved stability.

Hydrolysis -- breakdown process that occurs in anhydrous hydraulic fluids as a result of heat, water, and metal catalysts (iron, steel, copper, etc.)

Hydrolytic stability -- ability of additives and certain synthetic lubricants to resist chemical decomposition (hydrolysis) in the presence of water.

Hydrometer -- an instrument for determining either the specific gravity of a liquid or the API gravity.

Hydrostatic lubrication -- a system of lubrication in which the lubricant is supplied under sufficient external pressure to separate the opposing surfaces by a fluid film.

Hypoid gear lubricant -- a gear lubricant especially designed for hypoid gear types, as in the differential of an automobile. Hypoid gear tooth contact involves a combination of radial and sideways sliding which is intermediate between the worm type and the spiral bevel type gear, requiring additional EP (extreme pressure) additization for proper function.

- I -

Idler -- a wheel, gear or roller inserted into a drive train primarily for the function of guiding, supporting or tensioning a portion of the drive train.

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.

In-line filter -- a filter assembly in which the filter element is mounted along the same orientation as the filter inlet and outlet.

Indicator -- a device which provides external evidence of sensed phenomena.

Indicator, differential pressure -- an indicator that signals the difference in pressure between two points, typically between the upstream and downstream sides of a filter element.

Influent -- the material entering a system.

Infrared spectra -- a graph of infrared energy absorbed at various frequencies in the additive region of the infrared spectrum. The current sample, the reference oil and the previous samples are usually compared.

Ingested contaminants -- environmental contaminant that enters a system due to the action of the system or machine.

Inhibitor -- any substance that slows or prevents such chemical reactions as corrosion or oxidation.

Insoluble's -- residues of carbon or agglomerates of carbon and other material such as spent additives or oxidation by-products.

Interfacial tension (IFT) -- the energy per unit area present at the boundary of two immiscible liquids, usually expressed in dynes/cm.

ISO Solid Contaminant Code -- a index number code assigned on the basis of the number of particles per unit volume, allowing quick assessment of contamination.

ISO viscosity grade -- a number indicating the nominal viscosity of an industrial fluid lubricant at 40°C (104°F) as defined by ISO Standard 3448. For example, an unused ISO 68 grade product would be expected to show a viscosity at 40°C of 68 cSt, plus or minus 10% (6.8 cSt). This pattern is maintained throughout the ISO viscosity grading system.

-K-

Kinematic viscosity -- the ratio of the absolute viscosity to the density at the temperature of the viscosity measurement. The metric units of kinematic viscosity are the stoke and centistoke, which correspond to the poise and centipoise of absolute viscosity.

- L -

Lacquer -- a deposit resulting from the oxidation and polymerization of fuels and lubricants when exposed to high temperatures. Similar to, but harder than, varnish.

Laminar particle -- wear analysis-specific term for very thin free metal flakes which are generated during the life of a rolling element bearing, but whose increased presence is generally accepted as preceding deep spalling.

Liquid -- any substance that flows readily or changes in response to the smallest influence. More generally, any substance in which the force required to produce a deformation depends on the rate of deformation rather than on the magnitude of the deformation.

Load-carrying capacity -- property of a lubricant to form a film on the lubricated surface, which resists rupture under given load conditions. Expressed as maximum load the lubricated system can support without failure or excessive wear.

Lubricant -- any usually oily liquid or solid of vegetable, animal, mineral or synthetic origin that reduces friction, heat and wear when applied to the surfaces of moving parts.

Lubricity -- ability of an oil or grease to lubricate; also called film strength.

-M -

Magnetic filter -- a filter element which removes additional ferromagnetic particles from the filtered fluid by the action of one or more magnets built into the filter body.

Magnetic plug -- solid plug with a magnetic tip protruding into a dynamically circulating part of the oil system. This plug attracts and removes ferromagnetic particles, thus providing a visual condition indicator of the presence of larger iron alloy and similar debris in the oil system. Although it does remove particles, it does not significantly impact oil cleanliness.

Maintenance -- the act of holding or keeping in a preserved state. Specifically, the recurring day-to-day work required to preserve systems and / or their parts in such a condition that they are reliably and consistently available for their intended purpose throughout their normal design life, and beyond. Selected terms and concepts for modern maintenance are:

| TERM/CONCEPT | DESCRIPTION |
|----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Scheduled maintenance | Performed to reduce the possibility of or prevent the occurrence of a life-limited failure. See <i>preventive maintenance</i> . |
| Unscheduled maintenance | Performed to reduce the possibility of or prevent the occurrence of a condition failure, or to return a system to serviceability following a condition failure. See <i>corrective maintenance</i> . |
| Repair | Work required to restore a system or part to a condition substantially equivalent to its originally intended design capacity, efficiency, or capability. It includes the replacement of systems and parts made necessary by incipient or actual failure. |
| Reliability | Measure of the ability of a component or system to function successfully when required for the period required in the specific environment, without unscheduled outages, expressed as a probability. Reliability is a continuous, multivariate function; unless all variables are known and/or have fixed end points (such as material strength vs load/speed, etc.) then reliability cannot be determined based on the range of a single variable. |
| Operability | Application-specific critical system term with same general meaning as reliability, generally expressed in 'go / no-go' terms. |
| Availability | Machine is either operating or in ready-to-operate standby mode. Affected by scheduled and unscheduled maintenance. |
| Utilization | Actual time that machine is operating. Affected by standby downtime, scheduled and unscheduled maintenance |
| Maintainability | The probability of preserving a part or system in, or repairing it to, a reliable operable status in a specified period of time under stated conditions using prescribed procedures and / or resources. A system is maintainable if repair time is less than or equal to allowed downtime. |
| Corrective maintenance | Maintenance initiated only when a failure occurs or performance becomes unsatisfactory in service (also termed <i>reactive maint</i> , see <i>repair</i>). |
| Preventive maintenance | The planned, scheduled, periodic maintenance initiated to forestall or prevent failures or loss of performance in service. This type of maintenance includes user and vendor requirements and recommendations for inspection, adjustment, cleaning, parts replacement, lubrication, and minor repair and is usually time interval-based. |
| Predictive maintenance | Testing / inspection procedures performed to identify needs for component lubrication, adjustment, repair or replacement. This technology generates information that is applied to preventive or proactive maintenance goals by assessing performance as it relates to the above factors. Also termed <i>condition monitoring</i> , predictive maintenance is a primary maintenance process which analyzes data on individual items in service and whole populations of systems in order to indicate whether some allocation of technical resources is required. |
| Proactive maintenance | Changes in design / servicing / operations / maintenance initiated to reduce the total amount of maintenance required and permanently improve reliability and performance through systematically determining and eliminating the root causes of failures. |
| Reliability-centered maintenance (RCM) | Utilizes data gathered from operational performance (including failures) and predictive, preventive, and proactive maintenance technologies in an integrated manner to increase the confidence that a system or component will operate reliably over an extended life cycle. RCM supports ISO 9000 goals by aiding in the reduction of process variations and the number of shutdown and startup process interruptions. |

Manifold – an assembly containing multiple inlet and/or outlet ports and integral relating components servicing more than one area. For example, an intake manifold which delivers air to multiple cylinders, or a filter manifold which directs and collects oil from multiple filter sets.

Manifold filter -- a filter in which the inlet and outlet port axes are at right angles, and the filter element axis is parallel to either port axis.

Matrix – the components of the sample other than the elements of interest. In spectroscopy, the matrix can cause result changes through spectral interference or viscosity change.

Matrix matching – an approach to instrument operation in which the calibrations and standardizations of the instrument attempt to match the major chemical compositions of the standards, blanks, and samples in order to reduce the effect of the sample matrix on the analysis results.

Media migration – portions of the filter medium itself are passing into the effluent (downstream) from the filter.

Medium-- the porous material that performs the actual process of filtration.

Media – with respect to filtration, the plural of 'medium'.

Micron, micrometer (µm) -- a unit of length. One micron = 39 millionths of an inch (.000039"). Contaminant size is usually described in microns. Relatively speaking, a grain of salt is about 60 microns and the eye can see particles to about 40 microns.

Many hydraulic filters are required to be efficient in capturing a substantial percentage of contaminant particles as small as 5 microns.

MIL-Spec -- military specification; a guide in determining the quality requirements of products used by the military services, published by the United States Department of Defense.

Mineral oil -- any petroleum oil, as opposed to animal or vegetable-based oils.

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

Middle distillate -- one of the distillates obtained between kerosene and lubricating oil fractions in the refining processes. These include light fuel oils and diesel fuel.

Motor -- a device which converts fluid power into mechanical force and motion.

Multigrade oil -- an oil meeting the requirements of more than one SAE viscosity grade classification, and may therefore be suitable for use over a wider temperature range than a single-grade oil.

Multigrade oil -- one of the multiviscosity number oils in which one oil combines three SAE viscosity number grades. For example, multigrade SAE 10W-40 grade may be used where SAE 10W, SAE 20W, SAE 20, SAE 30, or SAE 40 grades are specified. These oils are made possible by improved refining processes and the use of polymer additives.

Multipass or recirculation test -- filter performance tests in which the contaminated fluid is allowed to recirculate through the filter for the duration of the test. Contaminant is usually added to the test fluid during the test. The test is used to determine the *beta ratio* (relation of pre- to post-filter fluid cleanliness).

-N-

Naphthene-- hydrocarbon characterized by saturated carbon atoms in a ring structure, having the general formula C_nH_{2n} ; also called *cycloparaffin* or *cycloalkane*.

Naphthenic -- a type of petroleum fluid derived from naphthenic crude oil. Characterized by low pour point (due to low wax content), and good solvency properties.

Neutralization number -- a measure of the total acidity or basicity of an oil; this includes organic or inorganic acids or bases or a combination thereof.

Newtonian fluid -- a fluid whose viscosity does not change with the rate of flow / shear. So-called multigrade oils are non-Newtonian because viscosity varies with shear rate.

Nitration -- specific to internal combustion engines, the formation of nitrogen oxides (NO_x) during fuel combustion. NO_x escapes the combustion area via ring blow by and reacts with water in the crankcase to form nitrous acid (HNO₂), which can degrade the oil and increase oil viscosity. Nitration is a particular problem in gas engines due to relatively high combustion chamber temperatures.

NLGI number -- one of a series of numbers classifying the consistency range of lubricating greases, based on the ASTM cone penetration number. The National Lubricating Grease Institute (NLGI) grades are in order of increasing consistency (hardness).

Noble metal -- a metal with marked resistance to chemical reaction, particularly to oxidation and to solution by inorganic acids. Contrast with *active metal*.

Nominal filtration rating -- filter rating indicating the approximate particle size for which the majority will not pass through a given filter. It is generally interpreted as meaning that 85% of the particles of size equal to the nominal filter rating will be retained by the filter. Due to irreproducibility and lack of precision with respect to true upstream vs. downstream contamination loads, this rating is discouraged as a means of assessing a filter's performance.

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.

-O-

Oil analysis -- generic term for scientific examination of fluid properties, entrained wear and contamination for a variety of purposes. Selected goals and capabilities of oil analysis include:

| GOAL / CAPABILITY | DESCRIPTION |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Assay | Tests are performed to examine and determine a sample's characteristics, specifically related to the presence, absence or quantity of one or more substances. No conclusions are drawn past the quantitative results of the testing. |
| Specification | Selected performance-evaluating and assay tests are performed in order to compare a sample's properties to known standards. Requires specification reference data (acceptable minimum / maximum values, and 'typical' values) for each parameter measured. Conclusions are drawn based on the comparisons / rankings of the unknown sample to predetermined target ranges in order to assess quality and performance in service. |
| Identification | A combination of assay and specification tests are performed in order to determine a sample's manufacturing trade name and / or product designation, or to match an unknown sample to a known product. Requires advance knowledge of the specifications involved. Known references or chemical characteristics for each product may also be required if a complex mixture is to be separated by content, or if no specifications are available. Conclusions are drawn in terms of 'match, no-match, sample appears to be...', with respect to the product in question. |
| Diagnosis | Assay, specification and identification tests are applied in conjunction with experience and statistics-based interpretation strategies, in order to assess the relationship between the result values and the fluid / mechanical condition of the system from which the sample was taken. Normally requires a time series of repeated measurements as well as individual requirements for the types of tests performed. Conclusions are drawn based on various maintenance and root cause analysis goals (see <i>maintenance</i> definition reference table). |
| | |
| | |

Octane number -- term numerically indicating the relative antiknock value of a gasoline. For octane numbers 100 or below, it is based upon a comparison with the reference fuels isoctane (100 octane number) and n-heptane (0 octane number). The octane number of an unknown fuel is the percent by volume of isoctane with n-heptane which matches the unknown fuel in knocking tendencies under a specified set of conditions. Above 100, the octane number of a fuel is based on the engine rating, in terms of milliliters of tetraethyl lead in isoctane which matches that of the unknown fuel.

Oil drain interval -- time between complete oil drains from a sump or crankcase.

Oiliness -- that property of a lubricant that produces low friction under conditions of boundary lubrication. The lower the friction, the greater the oiliness.

Oil ring -- a loose ring, the inner surface of which rides a shaft or journal and dips into a reservoir of lubricant from which it carries the lubricant to the top of a bearing by its rotation with the shaft.

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 organic acids formed by oxidation are corrosive to metals. The process is accelerated by heat, light, metal catalysts and the presence of water, acids, or solid contaminants. The basic oxidation process for hydrocarbons is summarized as:

Organic *peroxides* form as the first reaction products;

Peroxides catalyze continued formation of *alcohols*, *aldehydes*, *ketones*, and *organic acids*;

Alcohols, etc. further oxidize to form high molecular-weight, oil insoluble *polymers*;

Polymers settle out as *sludges*, *varnishes* and *gums*.

Oxidation stability -- ability of a substance to resist natural degradation upon contact with oxygen.

- P -

Pale oil -- base or process oil refined until its color, by transmitted light, is straw to pale yellow.

Paraffinic -- a type of petroleum fluid derived from Paraffinic crude oil and containing a high proportion of straight chain saturated hydrocarbons. Often susceptible to cold flow problems.

Particle -- a minute quantity or solid fragment, not necessarily of uniform composition. Particle size, quantity and characteristics (composition, shape, surface features, color, etc.) are all important factors considered in a total fluid analysis. A particle's visual characteristics may be described generically. They may also have specific terms associated with them, especially when certain wear modes are under examination. With respect to characteristics, selected particle types and/or surface features are:

| Generic TYPE | DESCRIPTION |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fine | An extremely small fragment, very thin in gauge or texture. |
| Sliver | A long slender piece cut or torn off. |
| Flake | A thin flattened piece or layer. <i>Chip</i> is also used for this type particle, with the connotation of features associated with sudden sharp impact or a regular process such as machining. |
| Granule | A small grain-like form, usually but not always crystalline. |
| Clump | A compact mass of smaller forms grouped together. |
| Chunk | A short thick piece. |
| Sphere | A rounded globular body. |
| Fiber | A slender and greatly elongated threadlike natural or synthetic filament. |
| Generic FEATURES | DESCRIPTION |
| Smooth | A continuous even surface, free of irregularities. |
| Rough | Having definite inequalities, ridges, or projections. |
| Pitted | Marked with small regular hollows or indentations. |
| Jagged | A sharply uneven edge or surface. |
| Striated | Marked with a series of shallow parallel grooves, lines or channels. |
| Furrowed | Marked with deep wrinkles or rough-edged 'plowed' grooves. |
| Ridged | Marked with raised strips or elongated crests. |
| Oxidized | A surface dulled or damaged by the chemical combination of oxygen with the material composing the particle. |
| Corroded | Agressively eaten away and/or weakened by direct chemical action. |
| Reflective | Bouncing or returning light from a surface. |
| Refractive | Permitting the passage of light but bending or changing its direction. |
| Opaque | Absorbing light; obstructing or preventing its passage. |
| Translucent | Permitting the passage of light, but diffusing it so interior features and opposite-side surface features of the particle cannot clearly be seen. |
| Transparent | Transmitting light without significant scattering or redirection, so that all surface and interior features of the particle and objects beyond it are clearly visible. |

Particle count -- the number of particles present greater than a particular micron size per unit volume of fluid. Selected methods of particle counting are:

automated optical, where particles are directly sized and counted using the dispersion or blockage of light created by a solid particle passing between a light source and a sensor;

Image analysis, where stationary particles are directly sized and counted under the microscope by manual or automated systems;

Electrical resistance, which measures the volume of a particle as it passes through an orifice in an electrically conductive liquid;

Flow decay, where count and size data is extrapolated from a standard equation applied to the rate at which flow decreases through a screen as particles block it.

Patch test -- a method by which a specified volume of fluid is filtered through a membrane filter of known pore structure. All particulate matter in excess of an "average size," determined by the membrane characteristics, is retained on its surface. Thus, the membrane is discolored by an amount proportional to the particulate level of the fluid sample. Visually comparing the test filter with standard patches of known contamination levels determines acceptability for a given fluid.

Penetration -- consistency, expressed as the distance in millimeters that a standard needle or cone penetrates vertically into a sample of the material (for example, grease) under known conditions of loading, time, and temperature.

Permeability -- the relationship of flow per unit area to differential pressure across a filter medium.

pH -- measure of alkalinity or acidity in water and water-containing fluids. pH can be used to determine the corrosion-inhibiting characteristic in water-based fluids. Typically, pH > 8.0 is required to inhibit corrosion of iron and ferrous alloys in water-based fluids.

Pinion -- the smaller of two mating or meshing gears; may apply to either the driving or the driven gear.

Platelet -- wear analysis-specific term for a smooth-surfaced, irregular or round-edged flake whose appearance is "plate-like", associated with rolling element bearing fatigue; also known as *spall flakes*.

Pleated filter -- a filter element whose medium consists of a series of uniform folds and has the geometric form of a cylinder, cone, disc, plate, etc. Synonymous with "convoluted" and "corrugated".

Pneumatics -- engineering science pertaining to gaseous pressure and flow.

Poise (absolute viscosity) -- a unit of viscosity equal to the viscosity of a fluid that would require a shearing force of one dyne to move a square centimeter area of either of two parallel layers of fluid one centimeter apart, with a velocity of one centimeter per second relative to the other layer, with the space between the layers being filled with the fluid in question. It is the ratio of the shear stress to the shear rate of a fluid, expressed in dyne seconds per square centimeter. 1 centipoise equals .01 poise.

Polar compound -- a chemical compound whose molecules exhibit electrically positive characteristics at one extremity and negative characteristics at the other. Polar compounds are used as additives in many petroleum products. Polarity gives certain molecules a strong affinity for solid surfaces; as lubricant additives (oiliness agents), 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 in engine oils by keeping contaminants finely dispersed.

Polishing (bore) -- excessive smoothing of the surface finish of the cylinder bore or cylinder liner in an engine to a mirror-like appearance, resulting in decreased ring seal and increased oil consumption.

Polymerization -- the chemical combination of similar-type molecules to form larger molecules, often in chain-like structures.

Pore -- a small channel or opening in a filter medium which allows passage of fluid.

Pore size distribution -- the ratio of the number of effective holes of a given size to the total number of effective holes per unit area expressed as a percent and as a function of hole size.

Porosity -- the ratio of pore volume to total volume of a filter medium expressed as a percent.

Positive crankcase ventilation (PCV) -- system for removing blow-by gases from the crankcase and returning them through the carburetor intake manifold to the combustion chamber where the recirculated hydrocarbons are burned. A PC valve controls the flow of gases from the crankcase to reduce hydrocarbon emissions.

Power unit -- a combination of pump, pump drive, reservoir, controls and conditioning components which may be required for its application.

Pressure -- force per unit area, usually expressed in pounds per square inch.

Pressure, absolute -- the sum of atmospheric and gage pressures.

Pressure, atmospheric -- pressure exerted by the atmosphere at any specific location. (Sea level pressure is approximately 14.7 pounds per square inch absolute.)

Pressure, back -- the pressure encountered on the return side of a system.

Pressure, cracking -- the pressure at which a pressure operated valve begins to pass fluid.

Pressure, rated -- the qualified operating pressure which is recommended for a component or a system by the manufacturer.

Pressure, system -- the pressure which overcomes the total resistances in a system. It includes all losses as well as useful work.

Pressure drop -- Resistance to flow created by the element (media) in a filter. Defined as the difference between upstream pressure (filter inlet) and downstream pressure (filter outlet).

Pressure line filter -- a filter located in a line conducting working fluid to a working device or devices.

Process contamination -- unwanted solids or liquids entering one part of a process from another part of the same process, but generally not referring to operating environment sources.

Process oil -- an oil not used for lubrication but as a component of another material, or as a carrier of other products.

Pump -- a device which applies mechanical force and motion to a liquid, creating hydraulic fluid power. Pumps are divided into two categories:

Positive displacement and centrifugal:

Positive displacement pumps force liquid to flow in volume proportion to increasing and decreasing pump volume, as in *Reciprocating* and *rotary* pumps. Reciprocating pumps use pistons, plungers or diaphragms to increase and decrease fluid volume.

Rotary pumps use a rotating gear, vane or screw to force liquid from the pump.

Centrifugal pumps, also called kinetic pumps, provide smooth non-pulsed flow and adjustable flow velocity. Liquid flow is established through centrifugal force created by a rotating impeller, as in *radial flow* and *axial flow* centrifugal pumps. In a radial flow pump, fluid enters the pump at the impeller rotational axis and is forced outward by vanes. In an axial flow pump, a propeller or screw moves fluid down the axis of the pump, parallel to the shaft.

Pumpability -- the low temperature, low shear stress-shear rate viscosity characteristics of an oil that permit satisfactory flow to and from the engine oil pump and subsequent lubrication of moving components.

Pump, fixed displacement -- a pump in which the displacement per cycle cannot be varied.

Pump, variable displacement -- a pump in which the displacement per cycle can be varied.

-R-

Rate of shear -- the difference between the velocities along the parallel faces of a fluid element divided by the distance between the faces.

Reducer -- a connector having a smaller line size at one end than the other.

Refraction -- the change of direction or speed of light as it passes from one medium to another.

Rerefining -- a process of reclaiming used lubricant oils and restoring them to a condition similar to that of virgin stocks by filtration, clay adsorption or more elaborate methods.

Reservoir -- a container for storage of liquid in a fluid power system.

Reservoir (sump) filter - a filter installed in a reservoir in series with a suction or return line.

Residual dirt capacity -- the dirt capacity remaining in a service loaded filter element after use, but before cleaning, measured under the same conditions as the dirt capacity of a new filter element.

Return line -- a location in a line conducting fluid from working device to reservoir.

Return Line Filtration -- filters located upstream of the reservoir but after fluid has passed through the system's output components (cylinders, motors, etc.).

Ring lubrication -- a system of lubrication in which the lubricant is supplied to the bearing by an oil ring.

Rings -- circular metallic elements that ride in the grooves of a piston and provide compression sealing during combustion. Also used to spread oil for lubrication.

Ring sticking -- freezing of a piston ring in its groove in a piston engine or reciprocating compressor due to heavy deposits in the piston ring zone.

Roll-off cleanliness -- the fluid system contamination level at the time of release from an assembly or overhaul line. Fluid system life can be shortened significantly by full-load operation under a high fluid contamination condition for just a few hours.

Contaminant implanted and generated during the break-in period can devastate critical components unless removed under controlled operating and high performance filtering conditions.

Roller bearing -- an antifriction bearing comprising rolling elements in the form of rollers.

Rust -- a corrosion product consisting of hydrated oxides of iron.

Rust prevention test -- a test for determining the ability of an oil to aid in preventing the rusting of ferrous parts in the presence of water.

- S -

SAE viscosity number -- system for classifying crankcase, transmission, and differential lubricants, according to their viscosities, established by the Society of Automotive Engineers. SAE numbers are used in connection with recommendations for crankcase oils to meet various design, service, and temperature requirements affecting viscosity only; they do not denote quality.

Saturation level -- the amount of water that can dissolve in a fluid.

Saybolt Universal Viscosity (SUV) or Saybolt Universal Seconds, (SUS) -- the time in seconds required for 60 cubic centimeters of a fluid to flow through the orifice of the Standard Saybolt Universal Viscometer at a given temperature under specified conditions. (ASTM Designation D 88.)

Scuffing -- abnormal engine wear due to localized welding and fracture. It can be prevented through the use of anti-wear, extreme-pressure and friction modifier additives.

Semisolid -- any substance having the attributes of both a solid and a liquid. Similar to semiliquid but being more closely related to a solid than a liquid. More generally, any substance in which the force required to produce a deformation depends both on the magnitude and on the rate of the deformation.

Shear rate -- rate at which adjacent layers of fluid move with respect to each other, usually expressed as reciprocal seconds.

Shear stress -- frictional force overcome in sliding one "layer" of fluid along another, as in any fluid flow. The shear stress of a 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 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.

Silt -- contaminant particles 5 µm and less in size.

Silting -- a failure generally associated with a valve which movements are restricted due to small particles that have wedged in between critical clearances (e.g., the spool and bore.)

Single-pass test -- filter performance tests in which contaminant which passes through a test filter is not allowed to recirculate back to the test filter.

Sintered medium-- a metallic or nonmetallic filter medium processed to cause diffusion bonds at all contacting points.

Sleeve bearing -- a journal bearing, usually a full journal bearing.

Sludge -- insoluble material formed as a result either of deterioration reactions in oil or of contamination of oil, or both.

Soap -- general term denoting the salt of a fatty acid. The ordinary soaps are those of sodium and potassium. The soaps of lithium, calcium, sodium, and aluminum are the principal thickeners used in grease making.

Solid -- any substance having a definite shape which it does not readily relinquish. More generally, any substance in which the force required to produce a deformation depends upon the magnitude of the deformation rather than upon the rate of deformation.

Solvency -- ability of a fluid to dissolve inorganic materials and polymers, which is a function of aromaticity.

Spall -- to break up or damage a surface by moderate to deep cracking or flaking.

Specific gravity -- the ratio of the weight of a given volume of material to the weight of an equal volume of water.

Spectrometry – using the analysis of electromagnetic radiation (light) to determine trace elements and their concentrations in a sample. In the atomic spectrometry techniques most commonly used for trace element analysis, the sample is decomposed by intense heat into a cloud of hot gases containing free atoms and ions of the element of interest. In general, there are four types of thermal sources normally used in analytical atomic spectrometry to perform this decomposition process: *flames*, *furnaces*, *direct electrical discharges*, and *plasmas*. Instruments which separate, isolate and measure light by wavelength in this way are called *spectrographs* or *spectrometers*. *Atomic absorption spectrometry* shines a light of a wavelength characteristic of the element of interest through the hot vapor (usually created by a flame or furnace). Some of this light is then absorbed by the atoms of that element. The amount of light that is absorbed is measured and used to determine the concentration of that element in the sample. *Optical emission spectrometry* uses electrical discharges or radio-frequency stimulated plasmas to bring the sample to temperatures high enough to disassociate the sample into atoms and introduce significant amounts of excitation and ionization through atom-to-atom collisions. Once the atoms or ions are in this excited state, then they decay to lower states by radiating light. The intensity of the light is measured at specific wavelengths and used to determine the elemental concentrations. For example, two popular types of spectrometers use the emission principle:

Rotating disc emission (RDE) spectroscopy, where the electric arc struck between a rod and a rotating disc or between two rotating discs provide the energy source;

Inductively coupled plasma (ICP) spectroscopy, where a high-temperature discharge is generated by flowing a conductive gas (for example, argon) through the magnetic field generated by a radio-frequency load coil that surrounds the tubes carrying the gas. This highly energetic source stimulates the necessary light emission from the elements being analyzed.

Spin-on filter -- a throw-away type bowl and element assembly that mates with a permanently installed head.

Spindle oil -- a light-bodied oil used principally for lubricating textile spindles and for light, high-speed machinery.

Splash lubrication -- a system of lubrication in which parts of a mechanism dip into and splash the lubricant onto themselves and/or other parts of the mechanism.

Stainless steel – any of several steels containing 12% to 30% chromium as the principal alloying element; the steels usually are passive in aqueous environments.

Starting fluid (diesel) -- a fluid, such as diethyl ether, that has a wide flammability range; used to start diesel engines at extremely low temperatures.

Static friction -- the force just sufficient to initiate relative motion between two bodies under load. The value of the static friction at the instant relative motion begins is termed break-away friction.

Statistical process control – use of control charts and appropriate procedures to track and eliminate unacceptable physical variables in repetitive manufacturing processes.

Statistical quality control -- use of control charts and appropriate procedures to demonstrate consistency in the final quality of a product.

Stoke (St) -- standard metric kinematic unit of measurement of a fluid's resistance to flow, defined by the ratio of the fluid's dynamic viscosity to its density, equal to 1 cm² s⁻¹. The standard *reporting* unit of measurement for kinematic viscosity is the *centistoke*, equal to 1/100 of a stoke.

Strainer -- a coarse filter element (pore size over approximately 40 μm).

Stringer – wear analysis-specific term for a string like or strip like formation of small joined flakes, usually associated with groups of small platelets which have not separated into individual particles.

Suction filter -- a pump intake-line filter in which the fluid is below atmospheric pressure.

Sulfurized oil -- oil to which sulfur or sulfur compounds have been added.

Surface filtration -- filtration which primarily retains contaminant on the influent surface.

Surface tension -- the contractile surface force of a liquid by which it tends to assume a spherical form and to present the least possible surface. It is expressed in dynes/cm or ergs/cm².

Surfactant -- surface-active agent that reduces interfacial tension of a liquid. A surfactant used in a petroleum oil may increase the oil's affinity for metals and other materials.

Surge -- a momentary rise of pressure in a circuit.

Swarf -- the cuttings, and grinding fines that result from metal working operations.

Switch, pressure -- an electric switch operated by fluid pressure.

Synthetic lubricant -- a lubricant produced by chemical synthesis rather than by extraction or refinement of petroleum to produce a compound with planned and predictable properties.

Sulfated ash -- the ash content of fresh, compounded lubricating oil as determined by ASTM Method D 874. Indicates level of metallic additives in the oil.

Synthetic oil -- lubricant produced by synthesis rather than by extraction or refinement.

- T -

Tensile strength – the ratio of maximum load to original cross-sectional area. Also called *ultimate strength*.

Thermography -- the use of infrared thermography whereby temperatures of a wide variety of targets can be measured remotely and without contact. This is accomplished by measuring the infrared energy radiating from the surface of the target and converting this measurement to an equivalent surface temperature.

Thermal conductivity -- measure of the ability of a solid or liquid to transfer heat.

Thermal stability -- ability of a fuel or lubricant to resist oxidation under high temperature operating conditions.

Thin film lubrication -- a condition of lubrication in which the film thickness of the lubricant is such that the friction between the surfaces is determined by the properties of the surfaces as well as by the viscosity of the lubricant.

Thixotropy -- tendency of grease or other material to soften or flow when subjected to a shearing stress, followed by a return to original consistency when the stress is removed.

Traceability – the ability to trace a reported measurement through an unbroken chain of comparisons to a national or international standard.

Tribology -- the science and technology of interacting surfaces in relative motion, including the study of lubrication, friction and wear. Tribological wear is wear that occurs as a result of relative motion at the surface.

Turbidity -- the degree of opacity of a fluid.

Turbulent flow sampler -- a sampler that contains a flow path in which turbulence is induced in the main stream by abruptly changing the direction of the fluid.

-U-

Unloading -- release of stored pressure from a circuit or accumulator; release of trapped contaminant initially captured by a filter medium.

-V-

Vacuum separator -- a separator that utilizes sub atmospheric pressure to remove certain gases and liquids from another liquid because of their difference in vapor pressure.

Valve -- a device which controls fluid flow direction, pressure, or flow rate.

Valve, by-pass -- a valve whose primary function is to provide an alternate flow path.

Valve, directional control -- a valve whose primary function is to direct or prevent flow through selected passages.

Valve, directional control, servo -- a directional control valve which modulates flow or pressure as a function of its input signal.

Valve, flow control -- a valve whose primary function is to control flow rate.

Valve lifter -- sometimes called a "cam follower," a component in engine designs that use a linkage system between a cam and the valve it operates. The lifter typically translates the rotational motion of the cam to a reciprocating linear motion in the linkage system. 1

Valve, pressure control, relief -- a pressure control valve whose primary function is to limit system pressure.

Valve, relief, differential pressure -- a valve whose primary function is to limit differential pressure.

Vapor pressure -- pressure of a confined vapor in equilibrium with its liquid at specified temperature thus, a measure of a liquid's volatility.

Vapor Pressure (Reid method or RVP) -- measure of the pressure of vapor accumulated above a sample of gasoline or other volatile fuel in a standard bomb at 100°F (37.8°C). Used to predict the vapor locking tendencies of the fuel in a vehicle's fuel system. Controlled by law in some areas to limit air pollution from hydrocarbon evaporation while dispensing.

Varnish -- a thin film deposit resulting from the oxidation and polymerization of fuels and lubricants. Similar to but softer than lacquer, and not removable by mechanical wiping.

Viscometer or Viscosimeter -- an apparatus for determining the viscosity of a fluid.

Viscosity -- measurement of 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. In addition to kinematic viscosity, there are other methods for determining viscosity, including Saybolt Universal Viscosity (SUV), Saybolt Furol viscosity, Engier viscosity, and Redwood viscosity. Since viscosity varies in inversely with temperature, its value is meaningless until the temperature at which it is determined is reported.

Viscosity, absolute -- the ration of the shearing stress to the shear rate of a fluid. It is usually expressed in centipoise.

Viscosity, kinematic -- the absolute viscosity divided by the density of the fluid. It is usually expressed in centistokes.

Viscosity, SUS -- Saybolt Universal Seconds (SUS), which is the time in seconds for 60 milliliters of oil to flow through a standard orifice at a given temperature. This viscosity system is still in limited use, although it has been generally replaced by the ISO grading system.

Viscosity grade -- any of a number of systems which characterize lubricants according to viscosity for particular applications, such as industrial oils, gear oils, automotive engine oils, automotive gear oils, and aircraft piston engine oils. ISO and SAE are the two systems most often encountered in oil analysis applications.

Viscosity index (VI) -- empirical unit less number indicating the effect of temperature change on the kinematic viscosity of oil. The higher the viscosity index, the smaller the relative change in viscosity with temperature.

Viscous -- possessing viscosity. Frequently used to imply high viscosity.

Volatility -- expression of evaporation tendency; the degree and rate at which a liquid vaporizes under set parameters of temperature and pressure. The more volatile a petroleum liquid, the lower its boiling point and the greater its flammability. Changes in liquid stability may result in reduced volatility.

-W-

Wear-- the attrition or rubbing away of the surface of a material as a result of mechanical action. There is some difference of opinion on types of wear. Selected wear types are:

| TYPE | DESCRIPTION |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Abrasive wear | A cutting or scratching action caused when either hard particles or hard projections wear away or cut into softer surfaces. Wear involving two surfaces and a separate hard particle between them is termed <i>three-body abrasion</i> . Wear involving a hard surface projection, or a free particle, contacting an opposing surface is termed <i>two-body abrasion</i> . |
| Erosive wear | A form of two-body abrasive wear specifically referring to the impact damage and material removal associated with high-velocity particles striking part surfaces. Erosion often is worst in metering orifices or angled turns in high pressure systems. |
| Adhesive wear | Occurs when the oil film becomes so thin that the roughest parts of the opposing moving part surfaces begin to touch each other. Metal may be torn off the part surfaces or transferred from one surface to the other and eventual seizure of the affected parts is likely. |
| Corrosive (chemical) wear | Results when chemical reactions cause corrosion, oxidation and pitting of part surfaces and/or when part movement or fluid pressure dislodges material from this surface layer. |
| Cavitation wear | Occurs when metal is removed from part surfaces by the violent impact of collapsing cavitation bubbles. |
| Fatigue wear | Occurs when cyclic or repeated load stresses cause cracking, spalling and pitting of the component part surfaces. |
| Fretting wear | Wear between two tightly fitting surfaces having a cyclic relative oscillating motion of small amplitude. |
| | |

Wicking -- the active absorption of a liquid into a porous material by capillary forces.

Worked penetration -- the penetration of a sample of lubricating grease immediately after it has been brought to 770F and then subjected to 60 stokes in a standard grease worker.

- Z -

ZDDP -- common abbreviated term for an anti-wear additive found in many types of hydraulic and lubricating fluids specifically *zinc dialkyldithiophosphate*.