LIST OF KEY DEFINITIONS

Definitions

Absolute viscosity: term used interchangeably with viscosity to distinguish it from kinematic viscosity and/or commercial viscosity; occasionally, "dynamic viscosity" (see viscosity).

Absolute pressure: the sum of hydraulic system pressure and gauge pressure (see pressure).

Absorbent (wash oil): oil that selectively strips heavier hydrocarbons from a gas, as in coke oven gas; by-product plants subsequently remove the hydrocarbons.

Acidity: in lubricants, acidity denotes the presence of acid-type constituents. The concentration of acid is expressed as an acid number or neutralization number.

Acid number: (see acidity, strong acid/strong base numbers).

Accumulator (hydraulics): a device in which hydraulic fluid is stored under pressure in a system to be used as a source of fluid power.

Actuator: a mechanical device, like a cylinder or hydraulic motor, used to convert hydraulic energy into mechanical energy.

Adaptor bolt (lube systems): a part used to connect an injector to a manifold block.

Addendum (gears): distance between the pitch circle and the tooth crest.

Additive: a chemical compound or compounds added to a lubricant or hydraulic fluid to impart new properties or enhance inherent properties.

Adjusting assembly (lube systems): a device used to control the length of the piston stroke.

Adhesion: the property of a lubricant that causes it to cling or adhere to a solid surface.

Age hardening: an undesirable process during which a solid (a grease, an elastomeric seal or rubber hose) hardens with prolonged storage.

AGMA: American Gear Manufacturers Association

Air entrainment: the presence of air bubbles throughout an oil as a result of agitation and/or the release of dissolved air because of a sudden change in environment. Air entrainment is visible, as the oil becomes opaque and bubbly (see foam, dissolved gases).

Air line lubricator: an oil reservoir attached to an air line that provides automatic air-borne lubrication to air operated power consuming equipment by means of venturi action.

Air-oil lubrication: a system of lubrication in which small quantities of oil are injected into an air line that terminates at a bearing or other lubrication point. The velocity of the air moves the oil, which remains in droplet form, along the periphery of the fluid conductor to the point of need; the clean, dry air, being unheated, helps cool the lubrication point. Since the lubricant does not return to a reservoir, these systems are classified as all-loss systems.

Air oil separator: a mechanical device that defoams oil, using a centrifugal oil trap (a defoamer), or any oil condensing device in an air line.

AISE: Association of Iron and Steel Engineers

Aliphatic: one of three types of hydrocarbons found in fuels or lubricants. Typically, aliphatics are visualized as linear molecules with no reactive chemical sites (see hydrocarbon).

Aluminum-base, aluminum complex grease: a grease prepared from lubricating oil and an aluminum soap. Such greases are made with more than one acid, often benzoic and stearic acids, and liquefy at higher temperatures than simple soaps.

Amine: a specific type of organic compound containing nitrogen, used to absorb acids or as an antioxidant. Common amines include aromatic amines, MEA (monoethanol amine) and DEA (diethanol amine).

Angular speed (gears): rotational speed at the pitch line, measured in rad/s.

Aniline point: for a petroleum fluid, the lowest temperature at which the product is completely miscible with an equal volume of freshly distilled aniline. It serves as a measure of the solvent or "grease-cutting" power of a hydrocarbon; generally, the lower the aniline point, the more effective the solvent.

ANSI: American National Standards Institute (a member of the ISO). Among other things, ANSI standards are used to evaluate load ratings for ball and roller bearings.

Anti-friction bearings: (see roller bearings).

Antioxidant: an additive to retard oxygen-related deterioration, especially oxidation of lubricants (see inhibitors).

Anti-seize compounds (pipe dope): grease-like substances with graphite, molybdenum disulfide and metallic particles dispersed throughout, primarily to prevent seizure on threaded joints.

API: American Petroleum Institute, the trade association of the oil industry.

API Gravity: measures the density of petroleum fluids. It is derived from specific gravity and was developed to express density in whole numbers with one or two decimal places. For example, an API gravity of 25.5 is the same as a specific gravity of 0.9013. This does not compare to an H2O constant.
This unit is defined in terms of specific gravity at 60°F (SPG 60°F) as follows:

$$\text{Degrees API} = \frac{141.5}{\text{SPG } 60^\circ \text{ F}} - 131.5$$

API separator (lube systems): a tank with baffles, used to separate oil from water: the water is removed by the underflow and the oil by the baffle overflow.

Apparent viscosity: Terms characterizing the resistance to flow of liquids whose viscosities vary with the rate of shear. It can be evaluated in a capillary-type instrument where it is defined as the shear stress at the capillary wall divided by the mean rate of shear as computed from the Poiseuille equation: it is expressed in fundamental viscosity units at a given rate of shear.

Arc of approach (gears): short distance of sliding contact between the dedendum of the driving tooth and the addendum of the driven tooth.

Aromatics: ring-structured hydrocarbons found in petroleum that contain unsaturated double bonds. Benzene is the simplest aromatic (see benzene, hydrocarbon).

ASA: American Standards Association

Ash content: percentage of non-combustible residue of a lubricating oil or fuel, as determined by ASTM-D-482 or D-874. Ash reveals the presence of metals, including the calcium, magnesium and zinc introduced by additives. The heavy metals formerly used also appeared in ash.

ASM: American Society for Metals, now ASM International.

ASME: American Society of Mechanical Engineers

Asperities: microscopic projections on metal surfaces, invisible to the naked eye, that creates peaks and valleys, even after grinding or machining. When two surfaces are in sliding contact, these imperfections cause interference that results in friction; without proper lubrication, wear, scoring or welding will follow.

Asphalt/bitumen: a soft black or dark brown tacky residual material containing asphaltenes, compounds of sulfur, nitrogen and tar. Asphalt, derived from petroleum, is solid at normal temperatures; as an adjective, "asphalt" is often used to describe viscous open gear compounds or black, tacky greases.

Asphaltenes: asphaltic materials soluble in aromatic solvents but insoluble in naphtha.

Asphaltic: similar in color and tackiness to asphalt.

ASTM: American Society for Testing and Materials

Auto ignition temperature: the minimum combustion temperature for a vapor-air mixture without an open flame. It permits evaluation of the fire hazards of vapors.

Axial load bearing: a bearing that supports an axial thrust (a load exerted in line with the length or the axis of a shaft).

Babbitt: a soft alloy of tin, copper and antimony used for plain bearings.

Backlash (gears): loose motion or play between the nondriving surfaces of adjacent gear teeth, arising from necessary clearance, wear or incorrect adjustment.

Backup roll bearings (Morgan or Mesta design): special sleeve bearings of the Morgoil design, with very large projected areas to reduce unit pressure. These

large-diameter oil-film bearings support backup rolls in rolling mills by means of a hydrodynamic film.

Bactericide: additive used with water-soluble cutting fluids to inhibit bacterial growth and unpleasant odors.

Ball bearing: a roller bearing whose rolling elements are balls (see roller bearings).

Bang-bang valve: conventional hydraulic or pneumatic valves operated by solenoids with either two or three distinct positions.

Barium/barium complex grease: a grease thickened with either barium soap or complex barium soap.

Barrel (drum): a standard container size, depending on context, e.g.: a 400-lb open top container (gear lubes and greases are sold by the pound), a 55-gal liquid container (most liquid lubricants) or a 42-gal charge (standard for crude oils).

Base circle (gears): the circle from which the involute tooth profile is derived.

Basic bearing number: for purposes of identification, anti-friction bearings are assigned numbers, referred to as basic bearing numbers. In most cases, they have four digits: the first indicates the TYPE of bearing, the second the bearing SERIES and the third and fourth the BORE SIZE of the bearing. Some manufacturers replace the first digit with letters of the alphabet to identify their bearings, others use numbers and letters.

Basic dynamic capacity: the radial load that 90% of identical bearings will bear for 1,000,000 revolutions before the first evidence of fatigue; also known as basic load rating.

Basic static capacity: the static load endured by a bearing before the most heavily loaded ball or roller experiences sufficient stress to cause a permanent deformation of the element or race equal to 0.0001 in. of the ball or roller diameter.

Beam strength (gears): capability of a gear tooth to withstand repeated bending that occurs whenever it is under load.

Bearing: machine element designed to support or position loads and, properly lubricated, to reduce friction between them. There are two basic designs, rolling element bearings and plain (sliding) types.

Bearing crush: the height by which half of the bearing exceeds the half diameter of the bore into which it is assembled.

Bench test: a modified service test in which the service conditions are approximate in the laboratory.

Bentonite thickener: clay, composed mainly of silicon dioxide and aluminum oxide, used to thicken greases. Such greases have no dropping points because the bentonite does not melt.

Benzene: the simplest aromatic hydrocarbon (C_6H_6) used in petrochemical processes and as a solvent. It must be used with caution because of its toxicity. For safety considerations, laboratories have substituted other solvents like toluene in its place.

Bernoulli's Theorem: theory developed by Daniel Bernoulli, 18th century Swiss scientist, one implication of which is that any rise in hydraulic fluid velocity is accompanied by a drop in static pressure and vice versa.

Bevel gears: gears, conical in form, that operates on intersecting axes, usually at right angles.

Biodegradable: capable of decaying through the action of living organisms.

Biodegradability – can be defined as the ability of a substance to degrade over time to carbon dioxide and water in the presence of water, nutrients and microorganisms

Biotoxic: toxic to the environment.

Black oils: dark-colored lubricants containing asphaltic materials, with medium flash points and medium to high viscosity, used in heavy-duty applications requiring adhesiveness under exposed conditions.

Bleeding (grease): the tendency of a liquid component to separate from a liquid-solid or liquid-semisolid mixture, as oil may separate from a grease.

Blending: the process of combining fluid and/or solid components into a finished mixture, particularly with liquid lubricants. Though compounding is similar, the purpose of compounding is to obtain properties not usually attainable with blending.

Block/brick grease: a grease of moderate dropping point, NLGL grade 5 or 6, firm to the touch at normal temperatures, that can be handled in block or stick form. The penetrating powers of such greases are measured at 77°F; grade 6 grease has a penetration range of 85-115.

Blown oils: natural fatty oils, of animal or vegetable origin, are artificially oxidized and thickened by blowing air through them. They are used primarily for compounding petroleum oils, to give them a strong affinity for metal surfaces.

Bomb: in lubrication terminology, a closed container used for conducting tests under elevated pressures.

Bomb oxidation stability: resistance of oils and greases to oxidation when subjected to accelerated oxidation in a sealed unit filled with pure oxygen under pressure and at elevated temperatures. As the lubricant absorbs oxygen, the pressure drops to indicate oxidation resistance. ASTM test D-2272, the Rotary Bomb Oxidation Test, rotates the container during the test.

Bonnet (lube systems): upper portion of packing gland assembly that serves as a viewer for movement of indicator.

Bottoms (residuum): the liquid that collects at the bottom of the distillation column, consisting of high-boiling residual liquids like heavy fuels and asphaltic materials.

Boundary Lubrication: lubrication between two rubbing surfaces in the absence of a full fluid lubricating film. Boundary lubrication is often accomplished with the use of extreme pressure additives. Example – high pressure gears.

Brake valve: a device that permits a machine component driven by a hydraulic rotary motor to revolve unimpeded during operation but restrains the motor return line fluid to slow the machine when it is desired to stop.

Brass: a non-ferrous alloy consisting of varying proportions of tin, zinc and copper; lead is added to attain higher machining speed. Brasses may or may not be lined with babbitt metal (see bronze).

Breather: an air filtering device placed on top of a reservoir to allow it to "breathe" as the oil level rises and falls. All incoming air is thereby filtered to keep out airborne contaminants.

Bright stock: describes high-viscosity lubricating oils that are refined to make them clear products of good color. Bright stocks are made from residuals or bottoms, solvent dewaxed and deasphalted; they may be used for blending.

Brinell hardness: a system to measure the hardness of metals by indentation. A hardened steel ball is pressed into a smooth surface of the metal under a fixed load and the resulting indentation is microscopically measured. With a conversion chart, this number can also be used to determine the approximate tensile strength of the same metal.

BHN: Brinell hardness number

Bromine number: see iodine number.

Bronze: a non-ferrous alloy of copper and a metal other than zinc or nickel. The family of bronzes includes: copper-tin, aluminum (for high tensile strength), phosphor (for corrosion resistance and low friction), leaded phosphor (for machinability) and silicon. ASTM distinguishes five grades of bronze casting alloys.

BS&W: an acronym for the material that settles to the bottom of a storage tank, namely bottoms, sediment and water. Laboratories sometimes quantify and report this information when examining oil in service.

BTU: British thermal unit: the amount of heat required to raise the temperature of a pound of water one degree Fahrenheit.

Buffer solution: a solution that prevents drastic changes in pH values when moderate amounts of acid or alkali are added.

Builder: any substance that increases the effectiveness of a cleaner, e.g., water-softening agents, buffer agents, alkalies.

Bulk appearance (grease): visual appearance when the undisturbed surface is viewed in an opaque container. Bulk appearance should be characterized in the following terms: bleeding (free oil shows on surface or in cracks of a cracked grease), cracked (showing surface cracks of appreciable magnitude), grainy (a surface with small granules or lumps of constituent thickener particles), rough (many small irregularities on the surface), smooth (surface relatively free of irregularities).

Bulk modulus: the resistance to compressibility of a fluid or elastomer; the reciprocal of its compressibility.

Buna-N/S: Buna-N and Buna-S are types of synthetic rubber. Buna-N is a copolymer of butadiene and acetonitrile; Buna-S is a copolymer of butadiene and styrene.

Butyl: copolymer of isobutylene and various amounts of isoprene and butadiene.

Calcium grease/cup grease: oils thickened with calcium soap.

Calcium complex grease: see complex greases.

Calcium sulfonate grease: a calcium neutralized grease thickened with sulfonic acid and fatty acids. Sulfonate greases have inherent rust inhibition (see complex greases).

Capillary action: the tendency of a liquid in contact with a small bore (capillary) tube to rise above the level of the surrounding liquid.

Carbon residue: the residue remaining after the evaporation and pyrolysis of a sample of oil under specified conditions. Tests that determine carbon residue are the Ramsbottom and Conradson methods, ASTM D-524 and D-189, respectively.

Case hardening: the process of hardening steel surfaces by changing the structure of a thin layer on its surface. Methods include carburizing, cyaniding, nitriding and induction or flame hardening.

Catalyst: a material or agent that promotes or produces a chemical action but does not itself participates in the chemical action.

Cavitation (hydraulics): when the absolute pressure in a pump intake line is reduced below the vapor pressure of the liquid, the fluid may vaporize, or "boil", or the dissolved air in the fluid may separate. In either case, as the bubbles go through the pump, they collapse or implode and damage the metal of the pump.

Centerline (gears): line that intersects the geometrical centers of the pinion and gear.

Centerline average – average height of peaks and valleys (asperities) on a surface.

Centipoise: a unit of absolute viscosity; one centipoise equals 0.01 poise. At the same temperature, centipoises equals centistokes multiplied by specific gravity (cp = cSt x sp. grav.).

Centistoke: a unit of kinematic viscosity, abbreviated as cSt: one centistoke equals 0.01 stoke. At the same temperature, centistokes equals centipoises divided by specific gravity (cSt = cp/sp.grav.).

Centralized lubrication: a system of non-recirculating lubrication that supplies a metered amount of lubricant from a central location to individual lubrication points.

Centrifuge: an instrument that employs centrifugal or rotating force to separate substances of different densities, useful for precipitating solids from a liquid or separating liquids of different densities.

Centrifugal pump: a pump with a rotating element, shaft and impeller and a stationary casing. In this pump, fluid is propelled at high velocity as centrifugal force at the periphery of the impeller blades discharges pressurized fluid into the system.

Cetane number: a number that expresses the ignition quality of a diesel fuel, equal to the percent by volume of cetane ($C_{16}H_{34}$) blended with methyl naphthalene that has the same ignition performance as the test fuel. A CFR test engine is used to determine this number.

Cetane index: the theoretical cetane number calculated according to ASTM D-976, using API gravity and mid-boiling point.

CFR engine: an ASTM test engine developed by the Cooperative Fuel Research Committee to measure the cetane numbers of diesel fuels and octane numbers of gasolines.

Chain lubrication: a dip or splash system that uses a chain to distribute lubricant to bearings, similar, in a way, to an oil ring; or any system designed to lubricate a conveyor chain.

Channeling (grease): a term describing the usually desirable tendency of grease to form a channel by working down in a bearing, leaving shoulders of unworked grease that serve as both reservoirs and seals.

Channeling (liquids): the undesired formation of troughs or channels in flow-type lubricants due to thickening during cold weather. Since such behavior

occurs near the pour point of the lubricant, lubrication may be marginal until the lubricant warms up from being worked (see channeling point).

Channeling point (gears): a federal test that measures the tendency of lubricants at low temperatures to form plastic structures of sufficient strength to resist flow under gravitational forces only. This test is specified and required for MIL 2105-type gear oils.

Check valve (hydraulics): in hydraulic and lubrication systems, a valve permitting flow in only one direction.

Chelation: the reaction of a metal with another substance called a "chelator" to form a very stable, soluble metal complex that may resist subsequent waste treatment processes designed to remove the metal ion from the solution. Chelators in cleaner formulations prevent soap scum formation by combining with hard-water metals like calcium and magnesium.

Chlorinated paraffin: an additive used for severe or difficult metal cutting or metal working operations.

Chromatography: a powerful method for analyzing fluids and determining their components by selective adsorption or size exclusion, using liquid or gas as the eluent. In the adsorptive procedure, the substance flows slowly through a column of adsorbent; as different substances pass at different speeds, they separate from each other and can sometimes be isolated and identified. In other cases, the chromatogram (a trace of the signal from the detector) is utilized to fingerprint a lubricant. Liquid chromatography is used for lubricants because of their low volatility. Paper chromatography, an adsorptive method, is often used to examine or establish the sludge or dispersive characteristics of a lubricant. Gel permeation chromatography, a size exclusion method, separates polymeric (oxidized oil/sludge) material from a lubricant base stock by molecular weight.

Circular pitch (gears): distance measured on the pitch circle between a point on the face of one tooth and the same point on the adjacent tooth; equal to pi divided by the diametral pitch.

Circulating oil system: a lubrication system in which the fluid that has passed through a bearing or a group of bearings is recirculated by a pump. System components may include settling tanks, filters, pumps, heat exchangers, etc. Pressure is usually controlled by a pressure control valve.

Clarifier: an apparatus or device that eliminates color or cloudiness from a fluid, mechanically or chemically separating out foreign material by gravity separation, centrifugal action, filtration, simple heating or chemical treatment.

Clay treatment: a process in which used oil, from which all water has been removed is brought into contact with activated clay at elevated temperatures ranging from 180-210°F; acidic by-products in the used oil are adsorbed on the surface of the clay. The batch process mixes the clay with the oil, the continuous process passes the oil through a bed of clay; in either case, and the oil is filtered before re-use.

Clay thickener: inorganic, non-melting grease thickener, commonly activated bentonite clay.

Cleanliness rating: a rating based on the number of particles of specified sizes in a measure of fluid. The ISO standard specifies particle counts at five microns and 15 microns.

Cleveland open cup: see flash point, fire point.

Closure plug (lube systems): removable plug on the end of a bore.

Cloud Point – the temperature at which a cloud or haze of wax crystals appears at the bottom of a sample of lubricating oil in a test jar, when cooled under controlled conditions.

Coalescing separator: a device that combines or unites separate particles of a substance through chemical affinity, physical trapping, etc. Coalescing filters often trap and remove water from lubricants. Coalescence involves merging particles of a dispersed phase.

Coastal pale oil: naphthenic petroleum oil refined from crude traditionally obtained from the Gulf or the Pacific coast.

Coefficient of friction: the number obtained by dividing the force that resists motion between two bodies by the normal force that brings the bodies together (see static friction, dynamic friction, stick-slip ratio).

Coefficient of friction – the force required to move one body over a horizontal surface at constant speed divided by the weight of the body. For example, if a force of 4kg is required to move a body weighing 10 kilograms, the coefficient of friction is 0.4.

Coefficient of friction of solids is independent of load. Coefficient of friction of liquids is a function of the viscosity of the fluid, speed and pressure of the application.

Cohesion: the property of a substance that causes it to resist being pulled apart by mechanical means.

Coking: undesired build-up of hard carbon deposits on equipment associated with high heat.

Cold test: test that determines the pour point of oil.

Collar thrust bearing: the simplest form of thrust bearing; a thrust collar in roll neck bearing service bears against the roll body at the fillet between the journal and roll body.

Colloid: a suspension of extremely small particles (5-5000 angstroms) in a liquid; the particles do not settle and are not easily separated by filtration. Colloids are considered ionized particulates immune to agglomeration. Greases are colloidal systems with thickeners dispersed in lubricating oil.

Colloidal lubricating solids: lubricating solids (especially graphite and molybdenum disulfide) that are pulverized to colloidal size and mechanically dispersed in a fluid.

Color standards: among the many different color tests, the most popular for steel mill lubricants are ASTM D-1500 color (for standard fluids) and visual color (for dyed fluids or greases). ASTM D-1500 utilizes an optical instrument to determine the darkness of oils by comparison with standard colored discs.

Complex soap (grease): a thickener in which the soap crystals or fibers are formed by the co-crystallization of two or more compounds, a selected soap and a completing agent such as a salt or an additive. The resulting complex soap usually increases the dropping point of the grease. Aluminum, calcium and lithium are common complex soaps.

Compounding: see blending.

Compound: in chemistry, 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 constituent elements. In petroleum processing, generally connotes fatty oils and similar materials foreign

to petroleum, added to lubricants to impart special properties; such lubricants are known as 'compounded oils".

Compressibility: the change in volume of a unit of fluid when subjected to a unit change of pressure. Typical hydraulic fluids exhibit compressibility at very high pressures, and compressibility may strongly affect frequency response in servo systems.

Compression set (elastomer): the deformation that remains in an elastomer after it has been subjected to and released from a compressive stress for a period of time. Compression set measurements are used to evaluate the creep and stress relaxation properties of rubber.

Concentricity (bearings): the uniformity of journal (or bearing) thickness measured in a plane normal to the axis of the journal; also used to describe the inside diameter axial exactness of a bore or the hole of the hose.

Condition monitoring: the use of specialized techniques that monitor the condition of equipment and detect the onset of failure in sufficient time to plan a maintenance intervention that prevents failure; these techniques include lubricant analysis, vibration analysis, thermography, motor current signature analysis, NDT surface inspections, ultrasonics, acoustic emission and process data.

Conjugate action (gears): transmission of uniform rotary motion from one shaft to another by gear teeth, where the normals (perpendiculars) to the tooth profiles at all possible points of contact pass through a fixed point, known as the pitch point, in the common centerline between the two shafts.

Consistency (grease): describes the hardness of a grease (its resistance to deformation), indicating relative softness or hardness with the application of force. Test method ASTM D-217 measures the extent of penetration of a cone under a fixed load and for a specific interval: the greater the penetration, the softer the grease. Using this method, NLGI grades the softest grease (deepest penetration) as 000, the hardest as 6.

Contact ratio (gears): measure of the extent to which more than one tooth carries the load; for spur gears, this should be no less than 1:2-1:4, i.e., 20-40% of the time.

Controlled volume pump/constant volume pump: see positive displacement pump.

Copper strip test (ASTM D-130 and D-4048): for specific periods of time at certain temperatures, exposes copper strips to petroleum products to measure the amounts of copper-corrosive substances they contain; the darkness of the polished copper strip determines the extent of corrosion.

Counterbalance valve: a hydraulic device for restraining a load that might otherwise fall faster than desired because of gravity.

Coupling: a frequently-used alternative term for "fitting": a straight connector for fluid lines; or a large-diameter device that connects the ends of two shafts, between a motor shaft and a gear drive unit, for example (these may be either solid or flexible, to allow for misalignment).

Cracking (oil): the application of heat and pressure that breaks down large molecules to form smaller molecules.

Crambe oil: a vegetable oil pressed from the seed of Crambe abyssinica, related to rape and mustard.

Cross porting (lube systems): a means of discharging lubricant from several injectors through a common outlet.

Crown gear (gears): a bevel gear with a plane pitch surface. Among bevel gears, the crown gear corresponds to the rack in spur gears.

Cup grease: see calcium grease.

Cutback solvent: see diluent.

Cutting fluid/oil: petroleum or chemical based products (or a combination of the two) that cools and lubricates tools when cutting metals; used in such processes as drilling, reaming, broaching, threading, milling, turning, shaving and tapping.

Cycle indicator pin (lube systems): a pin attached to the piston of a divider valve section; as the piston cycles, the pin extends from and retracts into the end of the section. Used to monitor divider valve action and control lube cycle.

Cylinder: a device that converts fluid power into linear force and motion.

Cylinder oil (steam cylinder oils): a medium to high viscosity oil used for once-through lubrication of cylinders in air compressors and steam engines, and for valves and other elements in the cylinder area. High viscosities compensate for

the thinning effects of the high temperatures involved. Steam cylinder oils are compounded with fatty oils to function where conditions are wet or saturated, or where low-pressure steam is present.

Cylinder stock: a heavy lubricating oil stock made from distillation residue of paraffin base crude; used primarily for blending.

Dedendum (gears): the distance between the pitch circle and the lower working, or flank, half of the tooth that still has the involute tooth form.

Degras (pronounced "de-grah"): animal oil extracted from the skin or wool of sheep, typically used to control corrosion.

Degreasing: the cleaning of grease and oil from metal parts in a machine designed to expose the metal parts to a liquid, a vaporized solvent or a special cleaning detergent (see vapor degreasing).

Demulsibility (typically measured using ASTM D-1401 or D-2711): the ability of a fluid insoluble in water to separate from water after thorough mechanical mixing.

Demulsifiers: additives that promote separation of oil from water.

Density: mass per unit volume.

Detergent (oils): a metallic salt additive used in engine oils to keep insoluble particles in colloidal suspension and prevent the formation of deposits and rust. With dispersants, detergents also remove existing surface deposits.

Detergent (cleansers): detergents in cleansers are surface-active compounds that lower the surface tension of water or water solutions and impart emulsifying and dispersing properties to them.

Dewaxing: a refinery process that removes paraffin wax from lubricating oils to lower their pour points.

Diagonal passages (lube systems): passages connecting the inlet and discharge bores.

Diametral pitch (gears): sometimes simply called "pitch"; the measure of tooth size, equal to the number of teeth divided by the pitch diameter. Mating gears have the same diametral pitch.

Dielectric strength (ASTM D-877): measures the capacity of an insulating material to withstand electric stress (voltage) without failure. Fluids with high dielectric strength (usually expressed in kV) are good electrical insulators.

Diester (dibasic acid ester): a synthetic lubricant formed by reacting dicarboxylic acid with an alcohol, having high viscosity index and low volatility. With additives, it finds service in compressors, internal combustion engines and fluid power systems.

Differential (chassis): a set or train of gears that change the direction of the vehicle propeller shaft to that of the axle shafts; also adjusts the amount of rotation between the right and left wheels on a particular driven axle to prevent wheel skidding when turning a corner.

Differential pressure: in an orifice meter, the difference between the pressures on the upstream and downstream sides of the orifice; also describes the pressure drop across a filter that increases as the filter clogs.

Diluent ("cutback solvent"): instead of heating, a solvent added to viscous lubricants or compounds to permit application in cold weather. The solvent evaporates after application, leaving the lubricant in place (see cutback solvent).

DIN (Deutsche Institute fur Normung): the German equivalent of ASTM.

Dip feed lubrication: a method that lubricates rubbing surfaces by dipping or partially submerging them in lubricant.

Direction valves (hydraulics): devices that channel the fluid in a hydraulic system to the proper location and/or prevent it from going to the wrong location.

Discharge passage (lube systems): passage leading from between the lands of the inlet piston bore.

Disk filter/perforated disk: a system utilizing metal disks as the filtering medium; frequently termed "metal disk filter".

Dispersant: a non-metallic engine oil additive that helps to prevent sludge, varnish, etc., by keeping particles suspended in a colloidal state. Similar to and ordinarily used with detergents, dispersants are capable of keeping large quantities of particles in suspension, and they are ashless when burned.

Distillation (fractionation): the first step in separating crude oil into its various components uses a distillation tower, or pipe still, through which heated crude oil vapors rise to progressively cooler levels, so that the various hydrocarbons condense at different levels all the way to the top of the column. The lower boiling point and lighter weight fractions rise to the top, the highest boiling point and heaviest condense near the bottom, all others in between. Gases, light oils and fuels are drawn off at the top, while heavy products like heavy fuel oil and asphalt are drawn from the bottom, with other products in between. This step is conducted at atmospheric pressure. Vacuum distillation, mainly for lube stocks, is performed with heavy crudes or bottoms at sub- atmospheric pressure, permitting fractionation at lower temperatures. The still is called a vacuum tower.

Distillates: the lubricant and oil fractions produced in a distillation column, except for bottoms and the natural gas liquids at the top of the column-dividing head.

Divider valve (lube systems): a series-progressive lubricant-metering and distribution assembly containing an inlet section, at least three valve sections and an end section.

DN factor: used as a guide to lubricant selection for rolling contact bearings, it is also called a speed factor, the product of the bore of a rolling contact bearing, expressed in mm (D), and the speed in rpm. Values up to 300,000 permit use of normal NLGI 2 grease; higher values indicate fluid oil or specially formulated greases, and values in the 1,000,000 range require oil-mist or air-oil lubrication or specially formulated greases.

Double helical gears/herringbone gears (gears): have both right-hand and left-hand helical teeth, and operate on parallel axis; are used on all mill pinions.

Drawing compound: a compound, usually containing EP additives, used during metal forming at the surface of the die to improve die life and metal finish; also used in dies in wire mills.

Drop-feed lubrication/drip oiler: a system of lubrication that supplies lubricant to the bearing surfaces in the form of drops at regular intervals.

Dropping point (grease) (ASTM D-255 and D-2665): the temperature at which a portion of grease releases liquid or passes from a semisolid to a liquid state under specified test conditions. Though this test is a good high-temperature screening tool, it is not, by itself, an indicator of high-temperature performance;

continuous permissible operating temperatures may be as much as 100°F below the dropping point.

Drying oils: oils that absorb oxygen (reacting with it) to form relatively hard, tough, elastic films when exposed in thin layers to the atmosphere; generally added to paint to promote drying (e.g., linseed oil).

Drying film lubricant: a solid material, such as graphite, molybdenum disulfide, boron nitride, or a plastic like a poly-tetra-fluorine resin, used with loads in the boundary region of lubrication. These materials may be applied as pastes, by spraying, dipping, brushing in an air-drying carrier, burnishing or resin bonding.

DSC/DTA: differential scanning calorimetry (DSC) and differential thermal analysis (DTA) measure actual caloric heat changes to characterize physical changes (phase changes in waxes, gels, grease or asphalt) and chemical reactions (usually oxidation) in lubricants.

Dynamic viscosity: see absolute viscosity.

Dynamic demulsibility: refers to a test procedure that simulates temperatures and circulating conditions in a rolling mill to determine the water separation properties of an oil (see demulsibility).

Dynamic load (gears): load computed at the pitch line, including both static transmitted load and loads superimposed by inertia of the rotating masses, tooth form inaccuracies, spacing inaccuracies and misalignment. Buckingham's empirical equations take these forces into account: AGMA uses service factors for the same purpose.

Dyne: standard c-g-s unit of force, equal to the force that produces an acceleration of one centi-meter per second per second on a mass of one gram.

Eccentricity: in cylinders, the condition resulting from the inside and outside diameters not having a common center; a condition that occurs when a shaft rotating in a sleeve bearing does not have a common center with the bearing.

Elastohydrodynamic (EHL or EHD) lubrication: a thin-film form of lubrication in which an elastic deformation occurs between two non-conforming components in loaded contact: at the same time, the high load in this small contact area causes a temporary, extreme increase in viscosity that traps the lubricant momentarily in the contact area, greatly increasing its load- carrying capacity.

Elastomer: a rubber or rubber-like natural or synthetic material that can be stretched repeatedly and that returns to its approximate original dimensions when the stress is released.

Electrorheological fluids: fluids currently under development whose rheological properties change in the presence of an electric field. Typically, these fluids increase in viscosity in the presence of the field, then revert back to their previous viscosity when the field is shut off.

Electrostatic oiler: machine that uses electrostatically charged oil particles to deposit coating oils on steel sheets.

Emulsifier: a substance that promotes the formation of a stable emulsion. In industrial maintenance cleaning, emulsifiers are used to modify the surface tension of liquid droplets (dispersed phase) to keep them from coalsecing (agglomerating); the resulting emulsion suspends soil in solution.

Emulsibility: the capacity of a fluid insoluble in water to form an emulsion with water.

Emulsion: colloidal dispersion of one immiscible liquid in another; the second suspends, but does not dissolve, the first. Emulsions of oil and water are formed either by agitation or with the aid of an emulsifying agent. In the water-in-oil type, water droplets are held in suspension as the internal phase; in the oil-in-water type, oil droplets are held in suspension and water is the continuous phase. Both types exhibit a milky or cloudy appearance. The water-in-oil type is known as an invert emulsion, as the oil is the continuous phase.

End-of-line system (lube systems): system in which the two main supply lines are dead-ended at the last measuring valve; usually installed where lubrication points are in a line.

Endurance limit stresses (gears): stresses that can be imposed repeatedly, indefinitely, without causing surface fatigue failure. Following Buckingham, AGMA uses the endurance limit for reversed bending as the working stress in bending for gear teeth; these values approximate 250 times the Bhn.

Enveloping worm (gears): worm with one or more threads, increasing in diameter from its middle portion toward each end, to conform to the curvature of the gear; has more surface contact than a straight worm.

EP (Extreme Pressure) lubricants: lubricants formulated with additives to prevent sliding metal surfaces from direct contact and seizing under extreme loads; under such conditions, the high local temperature at the interface causes the additives to react, combining chemically with the metal surfaces to form a protective film that prevents welding or seizure. The principal EP additives are compounds of sulfur, phosphorus and chlorine; common laboratory tests for EP properties include ASTM D-2509 and D-2782 and ASTM D-2596 and D-2783.

EPA: Environmental Protection Agency

Essential oils (odor masks): natural oily liquids with marked characteristic odors obtained from plants, flowers, leaves, etc., often used for masking odors or imparting odors, especially to metalworking fluids or gear oil. Pine and lemon oils are most commonly used.

Ester: chemical compound produced by the reaction of an acid and an alcohol, resulting in an elimination of a molecule of water.

Evaporative loss: the portion of a lubricant that volatilizes in use or in storage; applies especially to lubricants containing solvents or water, with high vapor pressures (see ASTM D-972 and D-2595).

False brinelling: a form of fretting corrosion, caused by vibration, that occurs in rolling element bearings while sitting idle and subject to friction oxidation.

Fat: raw material used in the manufacture of most greases, composed of various fatty acids and glycerol (glycerine) that form triglyceride esters. Fats are found in nature but may also be made synthetically.

Fatigue: the phenomenon leading to fracture under repeated or fluctuating stresses whose maximum value is less than the tensile strength of the material.

Fatty acids: components of all animal and vegetable oils, with the general chemical formula of $C_nH_{(2n+1)}CO_2H$; palmitic, stearic and oleic are the most prominent.

Fatty oil: an oil of animal, vegetable or marine origin that is liquid at normal temperature, whose composition resembles that of solid fat, except for differing types and percentages of fatty acids. Owing to "polarity", these oils have a physical affinity for metal; they increase load-carrying ability by enhancing "oiliness".

FDA: Food and Drug Administration, an agency of the United States Department of Health and Human Services; reviews the toxicology of fluids and additives, among other things.

Feedback: the practice of using a measure of output to modify input; in hydraulics, the controlled output, such as position, velocity or pressure, would be measured and compared with the input valve to modify the input.

Ferrography (direct read and analytical): method that examines ferrous wear particles in used fluid; used in preventive and predictive maintenance programs.

Fibrous grease: describes a specific type of grease that exhibits a distinctive fibrous structure when portions of the grease are pulled apart. The gelling agents for many greases have unique fibrous structures, depending on the type of soap or thickener employed, that are easily distinguished under an electron microscope. Some greases are smooth and buttery to the feel, even though they are microscopic fibrous structures. It is customary to use the term "fibrous grease" for grease that resists being pulled apart.

Fillers: an extensive variety of solid substances, primarily inorganic powders or flakes such as mica, talc, graphite, molybdenum disulfide and others that are added to grease to increase bulk or incorporated into non-metallic bearing materials to improve lubrication under high loads, low speeds and/or high temperatures.

Fillet curve (gears): the concave portion of the tooth profile where it joins the bottom of the tooth space at the root circle.

Filter: a porous substance or device that cleans fluids by removing suspended matter.

Filter element: removable portion of a filter that houses the filtering medium.

Film strength: general term indicating the capacity of an oil to maintain an unbroken film on a lubricated surface under operating conditions; used without reference to the type of film. "Load- carrying capacity" is another general term used in calculations. Film strength additives are usually considered anti-wear additives, not EP additives.

Fingerprint neutralizer: a polar compound used in rust preventives for steel surfaces that prevents corrosion attacks from perspiration during handling.

Fire point (Cleveland Open Cup, or COC; ASTM D-92): the temperature to which a combustible liquid must be heated so that the vapor released will burn continuously when ignited under specific conditions.

Fire-resistant (FR) fluids: hydraulic fluids that exhibit fire-resistant properties; they include the water-in-oil emulsions known as invert emulsions, water-glycol fluids, non-aqueous synthetic fluids like phosphate esters, silicones and halogenated hydrocarbons and high water-based fluids (95% water) and microemulsions.

Fitted bearings: partial journal bearings in which the radius of the bearing surface is the same as the radius of the journal surface.

Fixed oils: obsolete term, generally applied to fatty oils, indicating fluids that tend to decompose during distillation instead of remaining intact during the process; such oils are also known as non-volatile oils.

Fixed pad bearing: an axial or radial load type of bearing equipped with fixed pads (or lands), the surfaces of which are contoured to promote the establishment of a hydrodynamic film.

Flammable fluids: describes fluids with COC flash points under 100°F, as determined by the National Fire Protective Association (NFPA) (see combustible fluids).

Flash point (ASTM D-92, D-93, D-56): the temperature to which a combustible liquid must be heated to give off sufficient vapor to form a flammable mixture with air; this mixture should burn momentarily without sustaining combustion when a small flame is applied under specific conditions. Because it indicates the temperature at which a flammable vapor is produced, flash point is generally the most useful single index of fire hazard potential.

Flexible coupling: a device that connects two rotating shafts, designed to accept limited varying amounts of misalignment between shafts; a common coupling for mill spindles is a spade and yoke design with mill slippers.

Fluid drive (hydraulics): drive in which hydraulic fluid transmits power from one part of the system to another, without a mechanical connection between them.

Fluid friction: friction resulting from fluid molecules sliding past each other during flow through a duct (pipe, tube, hose). Its value depends on the duct

diameter, flow rate, fluid density and viscosity. Where all other factors remain constant, the higher the viscosity, the greater the fluid friction.

Fluid power: energy transmitted and controlled by a pressured fluid.

Fluid power system (hydraulics): a system that transmits and controls power by moving pressurized fluid through fluid conductors to actuators, for accomplishment of work.

Flushing oil: oil used to flush dirt out of a newly constructed or rebuilt circulating or hydraulic system, generally after chemical cleaning.

Foam test: (usually ASTM D-892) measures the ability of a lubricant to resist foaming caused by excessive agitation, contamination or air ingression in suction lines.

Follower plate: a plate fitted to the surface of lubricating grease in a container, designed to employ atmospheric pressure to assist gravitational forces in delivering grease to the inlet of the dispensing system.

Foot valve: a check valve installed at the entrance to the suction line.

Force-feed lubrication: describes a kind of self-contained lubricator, designed to pump small quantities of oil sequentially from its small reservoir into individual tubes leading to the various points to be lubricated. Lubricators are usually belt driven, to ensure delivery of oil during operation. These lubricators find service in once-through applications, with each feed line independently adjusted, metered to deliver feeds in drops per min.

Forging compound: a general term signaling a product used at the die: cold forging requires anti-friction and EP properties to prevent metal pickup and extend die life; compounds used in hot forging employ solid lubricants with thermal stability that resist burn-off and the formation of deposits on the die.

Form oil: an oil used to lubricate wooden or metal concrete forms to keep cement from sticking to them.

Four-way slide valve (lube systems): device that alternates pressure between the two main supply lines.

Frequency response: how well a servo or proportional valve output follows the electrical input. The concept is critical in system design because of system stiffness.

Fretting corrosion (ferrous corrosion): a combination of corrosive and abrasive wear that results from fretting of ferrous metals where the wear particles oxidize to a reddish, abrasive iron oxide (Fe_2O_3).

Friction bearing: obsolete term for plain bearing or sliding bearing (see plain bearing).

Front cone (gears): the inner ends of the teeth in a bevel gear with elements perpendicular to those of the pitch cone. Though the surface of the gear blank at the inner ends of the teeth is customarily formed to such a front cone, occasionally it takes the form of a plane on a pinion or a cylinder in a nearly flat gear.

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

Fungicide: a substance that kills, prevents or retards the growth of fungi. Fungicides and biocides are most often used with fluids like soluble oils that contain water.

FZG: acronym for German gear test rig, also known as the four-square gear oil tester. The test uses small gears driven under increasing loads in a heated oil bath until failure, at which point a 10-mg weight loss has occurred. Results are expressed as load stage at the time of failure.

Gall/galling: surface condition on one or both mating surfaces where excessive friction results in localized welding with subsequent spalling and a further roughening of the surface.

Gas oil: partially refined liquid petroleum distillate having an intermediate viscosity between that of kerosene and that of lubricating oil.

Gas turbine: burns a liquid or gas fuel, producing a pressurized gas that passes through a turbine-powered shaft. The turbine also powers the compressor that supplies the air at the required pressure.

Gate valve: a valve with a sliding gate that opens the entire area of the pipe.

Gears: machine elements that transmit motion by means of successively engaging teeth.

Gear oils: the variety of specially formulated oils for all types of gears and operating conditions; AGMA, SAE, the military and industry have their own requirements, some of which overlap. In general, gear oils are carefully formulated and highly refined, with additives tailored to the application in question.

Gear pump: a versatile, positive-displacement pump in which fluid is propelled from the intake to the discharge by being trapped in the gear casing, in the space between the teeth of the rotating gear.

Gear shield/gear compound: a highly adhesive lubricant, formulated with asphaltic compounds or polymers, for once-through use on gearing like open gears.

Gel (grease): a solid, elastic mixture of a colloid and a liquid possessing a yield point and a jellylike texture.

Gel permeation chromatography: a size-exclusion chromatography method that separates fluid components by molecular weight (e.g., size and shape) (see chromatography).

GL-4,5,6 service: transmission and axle lubricants classified according to SAE J308.

Gland (follower): adjustable follower that compresses packing in a stuffing box.

Glycerine/glycerol: syrupy liquid obtained by saponification of certain natural fats and oils; a by-product of the manufacture of fatty acids or their salts (soaps), correctly termed glycerol.

Glycol: a class of polyol compounds like ethylene glycol, commonly used to lower the freezing point of water; especially useful in antifreeze. Formulated with 35-50% water, they function as fire-resistant fluids.

Gouging (gears): describes a condition which may develop when gear teeth lack hardness. It is usually limited to the bottom or lower part of the tooth surface, or it may occur when gears are fitted too tightly, or if there is some interference between the driving and driven gears. It is sometimes the result of no tip relief (rounding off the sharp edges at the top of the tooth).

Graphite: a form of carbon available as natural or synthetic material: natural graphite is either flaky or amorphous, synthetic graphite is crystalline; it is processed to colloidal size and abrasive contaminants are removed from the

natural form. Graphite is used as a solid lubricant, in dry form or mixed with oil or grease.

Grease: lubricant composed of an oil or oils thickened with a soap, soaps or other thickener to a semifluid to solid consistency. May also contain other additives.

Grinding oils: oils formulated for grinding service where grinding wheel life, metal surface finish, etc., are important.

Gum: sticky, rubbery deposit, black or dark brown in color, resulting from the oxidation of lubricating oils or from unstable constituents in gasoline that deposit during storage or use.

Half bearing: bearing that surrounds only one-half of a journal, e.g., the AAR journal bearing, available as upper or lower arch bearing; also known as 180° arch bearing. All nonsleeve bearings are designated as partial journal bearings.

Halogenated solvents: solvents formulated with one of the halogens, usually chlorine or fluorine. Halogenated solvents are associated with the atmospheric depletion of ozone.

Hardness – resistance of metal to plastic deformation, usually by indentation. It also includes resistance to scratching, abrasion or cutting. It is the property of a metal, which gives it the ability to resist being permanently deformed when a load is applied.

Head (hydraulics): the pressure exerted by a fluid on a unit area because of the height of the surface of the fluid above the point where pressure is measured; may be expressed as psi or "feet".

Heat exchange: a device that transfers heat from one fluid to another (see cooler, intercooler). Oil coolers are common in mill circulating oil systems that use water to cool hot oil from the return reservoir before returning it to the mill units.

Heating element: a submersible oil heater, often utilized for heavy oil storage tanks. Since excessive temperatures of such heating elements can degrade lubricants, they are sometimes derated in watts/sq in. and placed in sealed wells to avoid this problem.

Heat transfer oils: oils utilized as heat transfer media; typical applications include asphalt plants, grease plants, etc. These oils have low volatility and contain additives to inhibit cracking and sludging.

Heavy-duty engine oils: oils having oxidation stability, bearing corrosion preventive properties and the detergent dispersant characteristics necessary to make them generally suitable for use in both high-speed diesel and gasoline engines under heavy duty service conditions.

Helical gear (gears): cylindrical in form with helical teeth.

Helix angle: angle of inclination to the axial direction, equivalent to the angle between the normal plane through the "twisted tooth" and the transverse plane of rotation, symbolized by β.

Herringbone gears (gears): two helical gears on the same shaft, one with a right-hand helix and the adjacent one with a lift-hand helix, giving the appearance of a herringbone.

Hertz contact stress: stress (psi) measured along a narrow band of contact between two gear teeth under load; based on formulas devised by Hertz. Momentary stresses exceeding 200,000 psi are not uncommon in heavily loaded gears. Also may occur at contact points in rolling element bearings.

Hexane: a straight chain paraffinic hydrocarbon containing six carbon atoms (C_6H_{12}); useful as a solvent.

High-pressure indicator(s) (lube systems): various divider valve accessories that provide visual indications of line blockage or locked pistons. Some also provide relief to atmosphere, permitting the system to continue lubricating unaffected points; others that are sealed require immediate system shutdown and repair.

High solvency naphthas: special naphthas characterized by their high solvent power (low precipitating tendency) for various resins, oils and plastics; their high aromatic content promotes solvency (see Kauri-butanol/KB value).

High water-content/high water-base fluids: (abbreviated HWBF) fire-resistant, thickened or unthickened water-based fluids; typically containing 90-99% water.

Horsepower: unit that measures the rate at which work is done and rates power output; one hp is equal to 746 watts of electrical energy, or the energy required to lift 33,000 pounds, one ft in one min.

Hot plate/crackle test: qualitative test to determine the presence of entrained water in a high flash-point oil; when oil is dripped onto a hot surface, an audible "crackle" indicates the presence of water.

Humidity cabinet test (ASTM D-1748): metal panels are installed in hot, moist controlled cabinet to test rust preventives; quality is measured by the number of hours preceding initial corrosion.

Hyatt bearing (flexible bearing): roller bearing with rollers constructed of flexible coils of strip steel that are hardened, then ground to size; designed to withstand considerable deflection in the alignment of shaft or housing.

Hydrated grease/soap: scap grease one of whose structural components is water, e.g., a water-stabilized calcium soap grease that owes its stability to hydrated calcium soap.

Hydraulic oil: low-viscosity mineral oil for hydraulic and/or fluid power systems, generally less than 500 SSU at 100°F.

Hydraulic (fluid power) system: see fluid power system.

Hydrocarbon: a compound composed of carbon and hydrogen, the basic element of countless organic compounds and the principal constituents of petroleum. Hydrocarbons in petroleum fall into three basic categories: the straight-chain paraffins (aliphatic); the cyclic (ring) chain (naphthenic) and the cyclic chain (aromatic).

Hydrodynamic lubrication: often referred to as "full film lubricant"; a film of oil or other fluid completely separates moving components under load, thus maintaining low friction and eliminating wear.

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

Hydrophilic: having an affinity for water; capable of uniting with or dissolving in water (see hygroscopic, hydrophobic).

Hydrophobic: lacking affinity for water: incapable of uniting or mixing with water.

Hydrostatic lubrication: system of lubrication that supplies the lubricant under high pressure, to promote a fluid film between opposing surfaces.

Hygroscopic: capable of attracting or absorbing moisture.

Hypoid gear lubricant (gears): lubricant with extreme pressure (EP) characteristics for use with hypoid gears, e.g., in the differential of an automobile.

Hysteresis (hydraulics): a condition encountered particularly when dealing with servo or proportional valves, in which a given input signal produces different amounts of spool movement when increasing and decreasing. It is caused by unevenly distributed friction.

ICP (inductively coupled plasma): quantitative analytical technique for measuring metal contents of fluids.

Idler gear (gears): gear placed between two other gears to change a mechanism's direction of rotation.

Inboard bearing (bearings): the bearing supporting a shaft nearest the coupling or drive mechanism.

Indicator (lube systems): device that shows movement of discharge piston.

Inhibitor: additive that prevents or retards undesired chemical changes, especially to metal surfaces; common inhibitors prevent oxidation, corrosion and rust.

Injector (lube systems): part that dispenses a measured amount of lubricant to a point of lubrication.

Injector body (lube systems): steel cylinder that serves as a container for lubricant passage, valve port, line connections and grease fitting assembly.

Inlet disc (lube systems): channel-lipped disc that directs lubricant through the valve port.

Inlet section (lube systems): top section of divider valve that contains the inlet connection, internal porting, tie rod holes and mounting holes.

Insolubles (oil): (ASTM D-893) a term used in the analysis of used oil, especially when determining the presence of oxidation products. The procedure dilutes the sample with pentane, causing the precipitation of oxidized material and other contaminants, collectively known as pentane insolubles. These

insolubles are then treated with toluene to dissolve the oxidation products. The difference in weight between the pentane and toluene insolubles is called insoluble resins or oxidation products.

Insolubles (grease): (ASTM D-128) components of a lubricating grease that are insoluble in the prescribed reagents; generally denotes fillers, additives and certain types of thickeners as well as impurities.

Insulating oil/transformer oil: clean, dry, high-quality, oxidation-resistant oil of low viscosity and high dielectric strength, designed for extended service in circuit breakers, transformers, switches and other electrical apparatus; most commonly utilized for cooling in transformers.

Intensifier (hydraulics): device that converts low-pressure hydraulic or pneumatic power to high-pressure hydraulic power.

Interfacial tension (IFT): the energy per unit area existing at the boundary of two immiscible liquids, like water and oil; obtained by measuring the force required to rupture the interface. ASTM D-971 measures the force required to draw a platinum ring through the interface in dynes/cm. A lowered IFT promotes emulsification and indicates that oxidized products are forming in the oil.

Intermediate base crude: see mixed base crude.

Invert emulsion: water-in-oil emulsion, typically containing 40% water, utilized as a fire- resistant fluid; oil is the outer or continuous phase of an invert emulsion, in contrast to the normal (oil-in-water) emulsion, where water is the outer phase.

Involute tooth form: profile of a tooth face generated by unwinding a line from a base circle where the end of the line scribes the involute shape.

Iodine number: the amount of iodine absorbed by an oil under prescribed conditions; like the bromine number, it measures the percentage of unsaturates in an oil.

ISO: International Standards Organization

ISO viscosity classification system: internationally accepted system, in which each viscosity grade (VG) corresponds to the midpoint of the viscosity range expressed in centistokes at 40°C; originated with a Saybolt (SUS) system developed jointly by ASTM and STLE, later changed to centistokes to gain

international acceptance. The original Saybolt system rated viscosity at 100°F; the ISO system rates viscosity at 104° (40°C).

Journal: the part of a shaft or axle that rotates or angularly oscillates in or against a bearing, or about which a bearing rotates or angularly oscillates.

Journal bearing: a sliding bearing of either rotating or oscillatory motion inside which a journal operates.

K factor: denotes Buckingham's surface durability analysis, based on gear geometry, harness and surface endurance limits; the higher the K factor, the greater the surface durability.

Kauri-butanol/KB value: measure of the aromatic properties of a solvent, based on its power to dissolve kauri gum; aromatics have high KB values, paraffinic solvents low KB values.

Kinetic/dynamic/sliding friction: the resistance to a force maintaining a relative motion between two surfaces, sliding instead of rolling; varies with surface conditions, surface materials, presence and type of lubricant (see friction).

Kinetic viscosity: value obtained by dividing the absolute viscosity of a fluid by its mass density.

Labyrinth seal: a series of grooves or "labyrinths" cut into the metal or housing surrounding a shaft to act as a seal or packing and frequently used for steam turbine shafts; controlled clearance seals without any rubbing contact that allow some tolerable leakage. They function by causing the fluid to accelerate and decelerate in succession through the labyrinth, dissipating its pressure energy and thus reducing the flow of leakage.

Lacquer: a deposit resulting from the oxidation and polymerization of fuels or lubricants exposed to high temperatures, similar to but not harder than varnish.

Laminar flow – occurs when particles move in a straight, parallel flow path.

Lantern ring: a metal spacer, placed at the midpoint of a series of packing rings, with holes around its circumference to permit the introduction of lubricant into a packed stuffing box.

Lard oil: animal oil prepared from the fat of swine, principally composed of olein, the glycerol ester of oleic acid (glyceryl trioleate).

Lead angle (gears): the angle between any helix and a plane of rotation, the complement of the helix angle; used for convenience in worms and hobs, and understood to be at the pitch diameter unless otherwise specified. Formerly, in screw thread practice, "helix angle" was used instead of "lead angle".

Lime-based grease: term formerly applied to calcium soap greases. Such greases are water-resistant but limited to low temperatures and cannot be used as multi-purpose greases.

Line of action (gears): line tangent to the base circles of the mating gears, normal to the mating profiles and passing through the pitch point. All points of tooth contact fall on this line.

Liner: a separator, generally in the shape of the container; in grease drums or kegs, a disposable plastic liner reduces the amount of unusable grease left in the container and facilitates lawful disposal.

Lip seal: better known as an "oil seal"; a circumferential dynamic seal composed of a flexible sealing element made from an elastomer that is "bonded" to a metal casing, or "cased" by a metal locking ring in a metal casing. Through the interference fit created by a metallic spring or the lip elastomer, between the single or multiple lip and the shaft, the lip exerts a force on the shaft sufficient to seal the fluid.

Lithium-based greases: normally greases formed with a lithium soap known as 12-hydroxy stearate soap, the thickener for many multi-purpose greases; they are reasonably water-resistant, highly shear stable and capable of operating at temperatures of up to 350°F before melting.

Lithium complex greases: see complex soap (grease).

Load limit for wear (gears): value computed from equations developed by Buckingham; uses the endurance limit stress for the materials used in the gear set.

Load wear index: a measure of the ability of a lubricant to minimize wear at applied loads; one of the numbers reported when a lubricant is tested according to ASTM D-2738. Higher numbers naturally indicate greater wear-minimizing characteristics.

Long and short addenda: process of lengthening the addendum of the driving gear teeth and shortening that of the driven gear teeth, effectively increasing the

thickness of the driving teeth and decreasing that of the driven teeth, which are loaded less frequently than the driving gear.

Loop system (lube systems): system in which the two main supply lines form a loop, usually installed when lubrication points are within a relatively confined area.

Lubricity: see oiliness

Lubricant: substance interposed between two surfaces in relative motion for the purpose of reducing the friction and/or wear between them.

Lubrication: reduction of friction or wear between two load-bearing surfaces by the application of a lubricant; includes boundary lubrication (thin or interrupted fluid film, especially bearings where wear occurs); mixed film, where some liquid pools support the load; elastohydrodynamic (high-pressure loads increase the lubricant's viscosity and load-carrying capacity, especially in gears); hydrodynamic (a thick fluid film lubrication, especially in journal bearings) and hydrostatic (external pump pressure used to form a thick fluid film, as in start-up of journal bearings).

Lubrication zone (lube systems): part of a larger lubrication system that can be isolated from other portions of the system for control purposes; generally contains some type of inlet valve, a master divider, secondary dividers and distribution tubing network to lubrication points.

LVDT: abbreviation used for "linear variable differential transformer", a position sensor used to control the armature stroke of a solenoid on a servo or proportional hydraulic valve.

Manifold: a conductor with multiple connection ports, generally made from a solid block of metal with internally drilled passageways to minimize the amount of piping required.

Manifold (lube systems): two or more injectors in the same mounting assembly.

Master divider valve (lube systems): in a series-progressive system, the first divider downstream from the pump; or the first divider value in a lubrication zone. Output is directed to secondary divider valves and/or lubricant points.

Measuring valve (lube systems): component that dispenses a measured amount of lubricant to a point of lubrication.

Mechanical seal: a dynamic interfacial spring-loaded mechanical device consisting of a stationary face component in a housing and a rotating face component on the shaft. Sealing takes place between the two flat sealing faces perpendicular to the shaft axis.

Mechanical stability: see shear stability.

Median life: approximately five times the L10 (rating) life of a bearing.

Micron: 10^{-6} m; one millionth of a meter.

Mineral oil: originally, the name given to petroleum because it occurs as a mineral, to distinguish it from oil obtained from animal and vegetable sources; more commonly, a lubricant made from petroleum.

Mineral seal oil: a cut between kerosene distillate and gas oil, widely used as a solvent or penetrating oil.

Mineral spirits: highly effective solvents derived from petroleum or coal (see petroleum spirits).

Mixed base crude/intermediate base crude: crude oil, neither predominantly paraffinic or napththenic in character, found in the Mid-Continent and other districts.

Mixed base grease: usually refers to a mixture of greases formulated with sodium and calcium soaps, though other combinations are available; though such compounding offers modest benefits, it is not sufficient to make them multi-purpose greases.

Mixed film/imperfect film lubrication: lubrication in which the lubricant film is not continuous over the bearing area.

Mixed film lubrication – lubrication accomplished by a combination of a viscous fluid compounded with boundary and/or extreme pressure additives. Example – worm gears.

Mobility: analogous to fluidity, the property of a lubricating grease that permits flow under pressure, as in centralized grease dispensing systems. Mobility is evaluated by low-temperature testing that simulates winter field conditions.

Mold oil: oil that ensures easy separation of a ceramic, glass, metal or other object from the mold in which it is cast (see form oil).

Molybdenum ("moly") disulfide: often wrongly termed "molysulfide"; a dark powder used as a dry film lubricant in oxidizing atmospheres, at temperatures of up to 800°F, to reduce friction under boundary conditions. A natural material, moly disulfide is processed to remove abrasives, produced in micronic particle sizes and made available as a paste, an additive for greases, a dispersant in oil or a bonded dry-film coating.

Motor: technically, an electric motor; in hydraulics, a device that converts fluid power into rotary mechanical force (torque) and motion.

Motor oil/multi-grade oil: an engine oil that meets the requirements of more than one SAE viscosity grade classification, formulated with viscosity index (VI) improvers; "W" indicates winter grade.

MSDS: acronym for "Material Safety Data Sheet", available for all raw materials and products; includes handling, storage and waste treatment practices recommended for safety.

Multi-purpose greases: greases with good mechanical shear stability, capable of operating throughout a wide temperature range and functioning in the presence of water, readily pumpable over long distances; such greases can be used in any type of bearing served by a centralized system (see lithium base grease and complex greases).

Multi-stage pump: centrifugal pumps with two or more impellers mounted on the same shaft; the discharge from one impeller is conducted to the suction eye of the next impeller, etc.

Multi-state compressor: compressor that directs air through a series of two or more cylinders during compression; "inter-cooling" denotes cooling as the air passes between cylinders.

Naphtha: generic term describing a variety of light petroleum distillates such as mineral spirits and many petroleum solvents.

Naphthenes/naphthenic base or oil: also known as cyclo-paraffins: a class of saturated hydrocarbons with a ring structure, distinct from both aromatics and paraffinic hydrocarbons; because of their low wax content, naphthenic base petroleum oils have low pour points and good solvent properties (see hydrocarbon).

Naphthenic acids: complex organic acids obtained from the gas oil cut of crudes, used in the manufacture of soaps, paint dryers and emulsifying/demulsifiying agents.

Neatsfoot oil: pale yellow animal oil made from the feet and shin bones of cattle, principally used as a leather dressing.

Needle bearings: rolling bearings with rod-shaped cylindrical rollers that are long and thin in relation to their diameter.

Neoprene: chloroprene polymer synthetic rubber with high resistance to weather, chemicals, petroleum oil and heat.

Neutralization ("neut") number: serves as an indication of the acidity or alkalinity of an oil. For acidity, the number is the quantity of base expressed in milligrams of potassium hydroxide (KOH) required to neutralize one gram of oil to a specified end point. For alkalinity, the number is the amount of acid expressed in milligrams of potassium hydroxide required to neutralize one gram of oil. See strong acid, strong base, total acid number (TAN) and strong base number (TBN).

Neutral oils: unfiltered lubricating oils of low or medium viscosity obtained in petroleum distillation and prepared without chemical treatment; they are so named because they have not been treated with an acid or an alkali.

Newtonian fluid: fluid classification by response to shear rate and shear stress. The ratio of shear stress to shear rate is a measure of a fluid's viscosity; when that ratio remains constant at any shear stress or rate of shear, the fluid is termed "Newtonian".

N-heptane/normal heptane: hydrocarbon compound (C_7H_{16}) with an octane rating defined as zero; used as a reference fuel ingredient in motor fuel octane number tests.

NLGI: National Lubricating Grease Institute; an organization of grease manufacturers that works with ASTM to develop technical standards.

NLGI number/NLGI grade: arbitrary numbers assigned by the NLGI that classify greases by their hardness, as determined by the cone penetration procedure (ASTM D-217); numbers range from 000 for the softest grease to No. 6, the very hardest (see consistency, penetration).

NLGI automotive grease classifications: specialty or mult-purpose greases meeting the requirements of ASTM D-4950 for chassis (category LA or LB) or wheelbearing (category GA, GB or GC) can be registered with NLGI and subsequently marked with a trademarked NLGI symbol that shows which performance categories the grease meets.

Normal plane (gears): in helical gears, the plane perpendicular to the teeth.

Nuclear Magnetic Resonance/Magnetic Imaging: Nuclear Magnetic Resonance (NMR) provides non-destructive, magnetic radio-wave analysis of new and used lubricants, especially to pinpoint chemical changes in carbon, hydrogen an phosphorus in lubricants; may also be useful as a tool for condition monitoring of gear oil and motor oils.

Non-Newtonian fluid: fluid requiring an initial stress to start flow, as the ratio of shear stress to shear rate does not remain constant. In this category, greases are among the substances that do not exhibit viscosity as Newton defined it; "apparent viscosity", depending on the rate of shear, can be computed for such materials, but the viscosity derived will apply only to the shear rate used in making the computation.

Nonsoap grease: grease thickened with something other than a metallic soap, e.g., clay, carbon black, silica gel or one of many synthetic organic compounds.

Norma-Hoffman bomb test: (ASTM D-942) a static accelerated grease oxidation test that measures the rate at which a grease absorbs oxygen.

Normal/standard pressure: unless otherwise specified, this term refers to 14.7 psi or 760 mm of mercury, i.e., normal atmospheric pressure at sea level.

Normal/standard temperature: in most laboratory work, 25°C, equivalent to 77°F.

Oakum: shredded rope or hemp fiber impregnated with some form of light tar and used as a caulking or packing for joints.

Octane number: number indicating the knock rating or resistance to detonation of motor gasoline, defined as the percent by volume of isooctane (C_8H_{18}) in a mixture with n-heptane; this mixture has the same knock rating under standard engine test conditions as the test fuels.

Oil: common term applied to slippery liquids consisting of various hydrocarbons; found in nature as petroleum, animal, vegetable or marine products, or synthesized in industry.

Oil-air lubrication: see air-oil lubrication.

Oil groove(s): frequently termed "oil ducts"; one or more grooves cut into the surface of bearing metal, the location and design of which are important for proper distribution of the lubricant. They prevent excessive oil loss from the bearing, serve as reservoirs to replenish lubricant supply and distribute the oil.

Oiliness: property of a lubricant that yields low friction under conditions of boundary lubrication, because of its affinity for metal surfaces. Polar compounds in the lubricant enhances this property, causing a physical adherence (absorbance) to the surfaces; the lower the friction, the greater the oiliness.

Oil mist or flog lubrication: oil atomized by compressed air, then conveyed by the air in a low- pressure distribution system to multiple points of lubricant application. At these points, as the mist flows through a nozzle of the proper type and size, it may condense as small quantities of liquid oil that lubricate the machine elements. The nozzles, or reclassifiers, include fog, spray mist and liquid fittings.

Oil pad: oil-saturated felt pad, generally used on plain bearings, that lubricates the rubbing surfaces; oil is supplied to the pad by wick, capillary, syphon, etc.

Oil ring: a loose ring, generally of greater in diameter than the shaft, the inner surface of which rides the shaft or journal, causing the ring to rotate; the ring dips into a reservoir from which it carries lubricant to the top of the shaft for distribution to a bearing.

Oil seal: one of many contact sealing devices used to reduce or eliminate oil leakage or to exclude foreign matter from a lubrication system (see lip seal). Oil seals are generally used on moving parts while gaskets seal non-moving parts such as housing (see gaskets).

Oil strainer: strainer that uses a metal screen or disc as the filtering medium; usually rated according to mesh size, not micrometer size.

Open gear lube: extremely heavy gear lubricants with viscosities in the asphaltic fluid range.

Organic acid: an organic compound with acid properties, obtained from such organic substances as animal, vegetable and mineral oils; for example, a fatty acid. Chemically, organic acids most often contain a carboxyl group (COOH).

O-ring: an "O" –shaped automatic or squeeze-type packing manufactured from metallic or elastomeric materials, used for static and dynamic applications. The seal is compressed against the shaft or collar and energized by the pressure of the fluid being sealed to prevent leakage.

OSHA: Occupational Safety and Health Administration

Outboard bearing: one of two bearings supporting a shaft farthest from the drive unit. Some extend outside the machine, e.g., a shaft extended from a machine upon which is mounted a direct connected generator, pump, etc.

Oxidation: chemical process in which oxygen combines with another substance; enhanced by elevated temperature and the presence of a catalyst, such as copper, water or foreign matter. Oxidation of lubricants eventually produces acids and polymers, resulting in metal corrosion and sludge formation. Oxidation inhibitors function by interrupting the oxidation process at the first step, the formation of peroxides that serve as catalysts for the entire process (see inhibitors).

Oxidation stability: resistance of lubricants to chemical reaction with oxygen; several test methods are used.

Packing: deformable substance used for sealing between locations at which fluids are present under different conditions, usually where relative motion occurs at the boundary between the fluids.

Packing box: the portion of the casing or cover through which the shaft extends and into which a seal or packing is placed to limit leakage; also known as a stuffing box.

Packing gland: an adjustable follower that compresses packing in a stuffing box.

Packing gland assembly (lube systems): assembly that is screwed into the measuring valve body.

Pad lubrication: see oil pad.

Panel coker: a testing device that involves dripping cold fluid onto a hot panel to determine the detergency and deposit-forming tendencies of the test fluid.

PAO: see polyalphaolefins.

Paraffin wax: a high-VI crystalline substance removed from paraffinic crudes after distillation, composed of unbranched straight chain hydrocarbons that are solid at room temperature. Waxes are primarily used for water proofing and candles; in small quantities, they degrade the low-temperature properties of lubricants.

Paraffinic base: characterizes certain petroleum products prepared from paraffinic crudes (crudes that contain high percentages of straight chain aliphatic or paraffin hydrocarbon molecules).

Partial bearing: see journal bearing.

Particle count: the object of various test procedures employed in condition monitoring. The ISO Solid Contaminant Code rates the number of particles (per volume) larger than five microns (silting condition) and the number of particles (per volume) larger than 15 microns (presence of wear material); the two rating numbers are separated by a slash. The ISO standard supersedes most other methods, but some utilize ISO codes to report particles larger than two microns.

Pascal's Law: axiom stating that the pressure on a confined fluid is transmitted undiminished and with equal force to all equal areas of the container.

Penetration (grease): (ASTM D-217) the depth, in tenths of a millimeter, that a standard cone penetrates a semisolid sample under specified conditions. Test methods include undisturbed (sample tested in its container); unworked (sample transferred to worker cup); worked 60 X (transferred to worker cup and worked with 60 strokes); prolonged worked (worked more than 60 X) and block (sample of block grease cut into a cube) (see consistency).

Penetrating oil: usually a solvent based oil; loosens rusty nuts or bolts by penetrating the rust barrier, thereby facilitating disassembly without destruction.

Penetrometer: instrument for measuring the penetration of semisolid substances like greases.

Pensky-Marten Closed Cup test: closed cup test for determining the flash point of fuel oil or open gear lubricant; sometimes used for lubricants suspected of being contaminated with fuel or solvent.

Pentane insolubles: see insolubles.

Petrolatum: product made from the residuals of paraffinic crudes, consisting primarily of high molecular weight amorphous waxes, with some grades containing microcrystalline waxes. It is pale to yellow in color, with oily or grease-like characteristics, used in some lubricants and rust preventives or a lay-up lubricant for some kinds of wire rope.

Petrolene: a petroleum naphtha containing asphalt, used in protective coatings.

Petroleum: oily liquids or semisolids found in the earth, composed of hydrocarbons and primarily such nonmetallic elements as sulfur, oxygen, nitrogen, etc. Though the composition of these dark, highly complex mixtures varies, they are often lighter than water and highly flammable. Only a small percentage of crude petroleum can be processed for lubricants.

Petroleum spirits: solvents obtained from petroleum with boiling ranges from 300-400°F and flash points exceeding 100°F (see mineral spirits).

Phenols: a class of aromatic chemicals used chiefly as antioxidants in lubricating oils like hydraulic fluids and circulating oils. Because of its biotoxicity, the EPA prohibits discharge of the parent chemical ("free phenol" or C_6H_5OH) into waterways; therefore, most phenols utilized in lubricants are sterically hindered. However, some refining extraction processes still use free phenol to remove aromatic, naphthenic and unsaturated hydrocarbons from lube base stocks.

Phospate esters: a class of synthetic esters with superior fire resistance; used primarily as FR fluids, they are formulated with these general properties: specific gravity greater than one, good lubricating capability, fair high-temperature stability, poor hydrolytic stability, and poor viscosity-temperature linkage. Though they are harmful to paints and some seal materials, one such ester, tricresyl phosphate, has long been used as an anti-wear additive in lubricating oils.

Pillow block: denotes bearing support on a site other than the machine itself.

Pilot-operated: in hydraulics, the technique of using a small valve to control a much larger one.

Pinion: the smaller of two mating or meshing gears, usually the driving gear. In the steel industry, the term "mill pinions" describes a mating pair of gears in a one-to-one ratio, each of which is coupled to a mill roll, one above the other in the mill stand; employed in both unidirectional and reversing mills, they are driven by a mill motor and mill drive coupled to the pinion stand.

Piston (lube systems): sliding part contained in the cylinder of the injector, consisting of a rod, extension and packing.

Piston stop plug (lube systems): the lower portion of the adjusting assembly.

Piston rings: used in engines to maintain a gas-tight seal between piston and cylinder, to assist in cooling the piston and to control cylinder wall lubrication; the three rings include a fire ring, a compression ring and an oil ring.

Pitch (gears): used in gear geometry to characterize features governing tooth size, shape, spacing, etc.; common terminology includes pitch circle, pitch diameter, pitch point, normal circular pitch and normal diametrical pitch (see Section 7).

Pitch circle (gears): curve where the imaginary pitch cylinder and plane normal to the axis of rotation intersect.

Pitch diameter (gears): diameter of the pitch circle of mating gears in imaginary line contact along the centerline between the two shafts.

Pitch line: corresponds in the cross-section of a rack to the pitch circle in the cross-section of a gear.

Pitch line velocity (gears): linear speed at the pitch line, measured in fpm or m/s.

Pitch point (gears): point of tangency of the two pitch circles of the mating gears, lying on the common centerline between them.

Pivot bearing: axial-load, radial-load bearing that supports the end of a shaft or pivot (as on the balance wheel of a watch).

Pivoted pad bearing: an axial or radial-load bearing with a surface consisting of one or more pads or shoes pivoted to tip, thereby promoting the establishment of a hydrocarbon film.

Plain bearing: any simple sliding bearing, as distinguished from fixed pad, pivoted pad or rolling bearings. Depending on the direction of the load on the bearing surface, plain bearings are classified as guide bearings, journal bearings or thrust bearings.

Planetary gear: a train of internal gears consisting of a sun gear, to which input power is applied, and planet gears that give the output power.

Plunger (lube systems): slide valve that controls the valve port.

Plunger spring (lube systems): spiral spring in the injector body cylinder.

Poise: the standard unit of absolute viscosity in the cgs system; expressed in dyne-s/cm^2.

Polar compounds: chemical compounds whose molecules exhibit positive electrical charges at one end and negative charges at the other. This characteristic, known as "polarity", endows such compounds with an affinity for metal surfaces. As lubricant additives, they serve as "oiliness agents"; they have good metal-wetting properties and some polar compounds promote emulsification between water and oil.

Polyalphaolefins (PAOs): a class of synthetic lubricant bases formed by polymerization of an olefin monomer, such as ethylene or propylene, whose properties after polymerization include good oxidation stability at high temperatures, good hydrolytic stability, compatibility with mineral oils and low volatility. They have found service in turbines, gears, compressors and automotive engines.

Polybutene: synthetic lubricating oil, a polymer of butene (C_4H_8); principal uses include insulating oils, gas compressor oils and process oils in the aluminum industry.

Polyglycol: a polymer of ethylene glycol ($C_2H_60_2$) used as a synthetic base stock; water-soluble polyglycols serve as thickeners or anti-freezes in FR fluids; insoluble forms are used as heat transfer and hydraulic fluids or high-temperature bearing oils.

Polyesters: synthetic resins, usually obtained from polymerization of a dibasic acid with a dihydric alcohol, not usually used as lubricant stocks. (see diesters).

Polymers: organic compounds created by polymerization that become progressively heavier and acquire diverse properties as the multiple linkages increase. The original monomer may be a gas or a liquid; according to the extent of polymerization, the final product will be a high molecular weight liquid or solid that retains the same proportion of elements as the original monomer.

Polymerization: the chemical combination and recombination of the same unsaturated hydrocarbon with itself to form an extensive chain; the chemical process of combining similar molecules to form larger molecules.

Polyolesters: a class of synthetic esters formed by reacting fatty acids with a polyol such as glycol; physical properties vary according to the polyols and acids used. Polyolesters formulated as lubricants have low volatility and good oxidation stability at high temperatures: they are used as base oils for turbines, compressors, jet engines and automotive engines and as base fluids for certain greases.

Polyureas: polymeric thickeners for grease, made from isocyanates and amines. Greases thickened with polyureas have high oxidation resistance and high dropping points; they work well in ball bearings for electric motors.

Porous bearing: bearing made from porous material such as compressed metal powders; the pores serve as reservoirs or passages for lubricant.

Positive displacement oil pumps: vane, gear or piston pumps that build up high pressure on the discharge side because the capacity output of the pump is positive. If the discharge is not utilized, the oil pressure regulator or by-pass prevents damage (see controlled volume pump, gear pump).

Pour point: (ASTM D-97) the lowest temperature at which a lubricant will pour or flow under specified conditions.

Pour point depressant: an additive in lubricating oil that lowers the pour point, by preventing any wax present from crystallizing to form a solid mass.

ppm: parts per million.

Precipitation number: (ASTM D-91) the number of milliliters of solid matter precipitated from a mixture of oil and petroleum solvent under specified conditions; chiefly used to determine the presence of asphalts in semi-refined or black oils, or to examine sludge in used oils.

Precision: see tolerance.

Preloading: procedures employed during assembly and mounting to remove all looseness or play in a bearing, usually performed on shafts or spindles in machine tools and precision machines that must rotate without clearance in either the axial or radial direction. Preloaded bearings are not used where deflection is excessive.

Pre-lubed bearings: bearings lubricate by the manufacturer to preserve their integrity during storage.

Pressure angle (gears): angle between the line of action and a line tangent to both pitch circles. This angle remains constant with involute form teeth at any point in the contact path. Common pressure angles are 14.5° and 20°; when stronger teeth are needed, larger angles are used. Pressure angles increase with center distance.

Pressure, atmospheric: see normal pressure.

Pressure control valves: devices that control the pressure in a hydraulic system, including relief, unloading, counter balance, sequence and pressure-reducing valves and, occasionally, brake valves.

Pressure drop: loss of pressure caused by restriction in a hydraulic system, where restriction includes valves, orifices and pipes; synonymous with "pressure differential" or "upstream minus downstream pressure" across any device in a hydraulic system.

Pressure, gauge, (psig): pressure differential above or below atmospheric pressure.

Pressure-reducing valve (hydraulics): device that keeps pressure in a branch of a hydraulic circuit below the pressure in the remainder of the circuit.

Pressure viscometer/viscometer (grease): a capillary instrument used to determine apparent viscosity.

Preventive and predictive maintenance (PM and PDM): two basic programs that use selected features of condition monitoring procedures in managing maintenance practices and costs to increase plant productivity; PM programs schedule maintenance at regular intervals, while PDM programs schedule maintenance on the basis of information obtained from sophisticated condition-monitoring tests.

Priming: in pump operation, filling the liquid end of a pump with liquid to remove vapors and eliminate the possibility of becoming vapor bound.

Principal reference planes (gears): pitch plane, axial plane and transverse plane, all intersecting at a point and mutually perpendicular.

Process oil/process lubricants: in the steel industry, materials used in direct contact with the product being produced, e.g., rolling oils in hot and cold rolling mills, wire drawing compounds, forging compounds, slushing oils for rust protection, stamping and drawing compounds, quenching oils, wire rope laying-up lubricant, etc.

Profilometer: a device that profiles or measures surfaces to determine smoothness.

Proportional valve (hydraulics): a hydraulic valve that produces an output proportional to its input signal, that can be adjusted electronically, remotely; uses proportional solenoids with constant force for a given signal.

Proximity switches (lube systems): magnetic (dry contact) switches that detect divider valve piston movement without a cycle indicator pin attached to the piston.

Pumpability: see mobility.

Pycnometer: a device for measuring densities of liquids.

Pyrolysis: chemical decomposition by the action of heat.

Pyrometer: a device for recording high temperatures that uses a thermocouple or an infrared pyrometer to measure invisible light emitted by the hot object.

Quench oils: paraffin oils with high flash points, usually exhibiting excellent oxidation and thermal stability, suitable for either tempering or martempering. Testing methods include ASTM D-3520, an older quench speed test, and a newer computer-recorded Diacpot test that gives quantitatively more information about the quenching process.

R&O oil: oils with rust and oxidation inhibitors, usually applied to highly refined circulating oils used for long term service, as in compressors, hydraulic systems and turbines.

Rack (gears): a gear with teeth spaced along a straight line and suitable for straight line motion.

Rack and pinion gear (gears): a power-transmitting unit that changes linear or reciprocal movement to rotary motion when the rack gear is the driving member and vice versa when the pinion gear is the driving member.

Radial load bearing: bearing in which the load acts in a radial direction with respect to the axis of rotation.

Rag layer: the layer that forms at the interface when oil and water are separated by gravity. A mixture of solids oil and water, it looks like sludge.

Rancidity: biodegradation of fats or fluids causing an unpleasant odor.

Rapeseed oil: see vegetable oil.

RBOT: see bomb oxidation stability.

RCRA: Resource Conservation and Recovery Act.

Reciprocating pump: device designed to pump with a reciprocating motion, similar to an engine piston.

Refractive index: (ASTM D-1218) number indicating the angle through which a ray of light is deflected as it passes through a solid or fluid medium; the number that expresses the ratio of the sine of the angle of incidence to the sine of the angle of refraction. Typically used for monitoring water-based fluids or solutions.

Relief valve: a hydraulic mechanism designed to limit or control pressure by opening an auxiliary fluid passage at a predetermined or set pressure.

Re-refined oils: spent mineral oils that have been collected, sent to a refinery and reprocessed by distillation, often with hydrofinishing.

Residual oil: oil from the bottom of the distillation column (see bottoms).

Resin: a solid or liquid compounding material, generally a solid or semi-solid, composed of carbon, hydrogen and oxygen; includes polyesters, polystyrenes and acrylics used in the manufacture of varnishes, plastics and elastomers. Some lubricating resins are residual oils.

Reyn: standard unit of absolute viscosity in the English system, expressed in lb-s/in^2. (see viscosity).

Rheology: the study of the deformation and/or flow of matter in terms of stress, strain, temperature and time. Apparent viscosity and penetration of grease are examples of rheological properties.

Rheopectic: term applied to greases that thicken and harden when subjected to shear; the opposite of thixotropic.

Ring lubrication: see oil ring lubrication.

RMA: Rubber Manufacturers Association, Inc.

Rolling element/rolling contact/anti-friction bearing: generic terms for all types of rolling bearings (ball, cylindrical roller, tapered roller, spherical convex roller, spherical concave roller and needle roller), all of which roll between rings or races except for needle bearings.

Roller bearing: describes all rolling bearings except for ball bearings (see rolling element et al).

Rolling oil: hot and cold rolling mills, especially cold mills, use formulated coolants.

Rotary bomb oxidation test (RBOT): see bomb oxidation stability.

Rotor: part that rotates in the pumping chamber, sometimes given specific designation such as gear, screw, impeller, etc.

Rubbing oil: low-viscosity mineral oil used with or without an abrasive as a polishing medium.

Rust preventive: a compound containing a rust inhibitor, used to coat metal surfaces to prevent rust and corrosion; base material maybe a petroleum oil, a wax, an asphalt and/or solvent, depending on the environment and the duration of the protection sought.

Rust test (grease/oils): (ASTM D-665 and D-1748) test that measures the effectiveness of a lubricant at preventing the rusting of ferrous parts in the presence of water.

SAE: Society of Automotive Engineers

SAE numbers/SAE oil viscosity classification: number assigned by the SAE to crankcase, transmission and rear axle lubricants to indicate their viscosity ranges; may be converted to ISO and/or ASTM/STLE classifications.

Salt spray test: (ASTM B-117) determines the effectiveness of a slushing oil in preventing rust and corrosion.

Saponification (grease): process in which a fat or some other compound of an acid and an alcohol reacts with an alkali to form a soap and glycerin or other alcohol.

Saponification (analysis): the process used to measure the ester content of a material (see saponification number).

Saponification number: (ASTM D-94) the number of milligrams of potassium hydroxide required to saponify the fats and/or esters in a one-g sample of a given material.

Saturates: synonym for alkane hydrocarbons, or saturated hydrocarbons.

Saybolt SUS/SFS: (ASTM D-88) the number of seconds required for 60 ml of a fluid to flow through the orifice of the standard Saybolt Universal viscometer (SUS) or a Saybolt Furol viscometer (SFS) at a given temperature under specified conditions. Since the orifice of a Saybolt Furol viscometer is larger than that of a Universal viscometer, it is used for more viscous fluids.

Seal swell: an increase in elastomer volume or linear dimension of a specimen immersed in liquid or exposed to a vapor; harness and durability of the elastomer may also be affected. Swell characteristics vary with the elastomer, but high aniline point oils cause less swell than low aniline point oils.

Secondary divider valve (lube systems): divider valve that receives flow from the master divider valve.

Seed oils: see vegetable oils

Self-aligning bearing: bearing held by four points or in some other arrangement that permits an automatic change in the position of the bearing to conform to an out-of-line shaft or journal.

Self-lubricated bearing: bearing supplied with lubrication in the bearing material, i.e., graphite in a powdered metal bearing or oil in a wood or microporous bearing; not generally suited for heavy loads or high operating temperatures.

SEM (scanning electron microscope): tool used to examine failed bearings, wear particles and debris.

Semisynthetic (metalworking): a metalworking lubricant containing water.

Semisynthetic: a lubricant formulated with 20% or more of polymeric fluid as a base stock component.

Sequence valve (hydraulics): device assuring that actuators move in a certain sequence in a hydraulic system.

Sequestering agent: a compound that reacts with metallic (positively charged) ions in a solution to keep them in solution, thereby preventing the metallic ions from forming a sludge or depositing on the workpiece.

Series-progressive (lube systems): positive, single-line lubrication system utilizing piston divider valves for metering and distribution; each divider valve must cycle completely in sequence before downstream valves and pistons are activated.

Servo valve: a high-performance directional and flow control valve usually operated by a torque motor; similar to a proportional valve but superior in terms of frequency response and hysteresis.

Shear stability/mechanical shear stability: measure of the change in consistency of a grease after it has been subjected to prolonged shearing by means of a mechanical device like a grease worker (10,000 strokes) or a roll test; the percentage change in penetration values is an indicator of shear stability.

Silicones: generic term for a class of synthetic lubricants that replace carbon atoms with a chain of alternating oxygen and silicon; also known as siloxanes. These fluids are water-resistant polymers with very high viscosity indexes, excellent fluidity at low temperatures and good oxidation and thermal stability at higher temperatures. They do not have high load-carrying capacity.

Sintered metal: a bronze or iron bearing material frequently used where self-lubrication, low coefficient of friction, accurate dimensions and simplicity of installation without machining are desirable.

Sleeve bearing: a 360° cylindrical plain bearing, sometimes called a bushing, that supports a journal or roll neck, aptly called a sleeve.

Sliding velocity (gears): computed differential sliding speed in either the arc of approach or arc of recess.

Slinger (seals): prevents oil leakage from high-speed journal bearings; uses centrifugal force to throw oil that leaks through the bearing into a groove that returns the oil to the reservoir.

Slumpability: characterizes the capacity of a grease to flow towards a suction inlet without a follower plate.

Slushing oil: oil or grease-like material applied to metal as a temporary protective coating against rust, corrosion, etc.

Soap: a compound formed by the reaction of a fatty acid with an alkali; soaps used as grease thickeners are most stearates.

Soda/sodium base grease: grease prepared from lube oil and a sodium soap.

Soil load (cleansers): the percentage of soil contained by a cleaning solution, usually expressed in volume/volume units. Soil load content in an alkaline cleaner bath is ordinarily determined by an acid split procedure.

Solenoid: a coil, that when energized, attracts a sliding iron core; used to control position of a spool in a valve body.

Solid bonded lubricants: powdered lubricants like graphite, molybdenum disulfide, etc., are adhesively bound to clean, solid surfaces through proprietary processes to form thin tightly-bonded films; used for lightly loaded bearings in specialty applications.

Soluble cutting oil/soluble oil: oil with an emulsifier that forms an emulsion, used as a metalworking fluid or hydraulic fluid.

Solvent: a compound capable of dissolving a given substance to form a solution. Water is a polar solvent, hydrocarbons are non-polar.

Solvent extraction: a refinery process that utilizes oil and a polar solvent like phenol, N-methyl pyrolidone, furfural, etc., to selectively separate unsaturates from lubricant distillates, in order to improve properties such as oxidation stability, viscosity index and additive response.

Sour crude/sweet crude: sour crudes contain appreciable quantities of hydrogen sulfide, disulfides or other sulfur compounds; sweet crudes do not.

Specific gravity: the ratio of the density of a substance to the density of water, often at a specified temperature.

Spherical roller bearings: rolling bearings designed with barrel-shaped rollers, suitable for most heavy-duty service (see rolling element bearings).

Spider (gears): a design consisting of a ring or solid center with projections, used to space and align gears, e.g., the part that controls the sun gears in automotive differential gears.

Spindle oil: light-bodied, high-quality R&O oils fortified with anti-wear agents, used principally for lubricating high-speed metalworking machine spindles like grinders. (NOTE: these machinery spindles are not to be confused with the mill spindles that couple mill pinions to mill rolls; that application requires completely different kinds of lubricants for the spindle carriers and the coupling ends).

Spiral bevel gear (gears): quieter and stronger than the spur gear; assumes some of the sliding action of a worm gear, but more than one tooth carries the load.

Splash lubrication: system in which parts of a mechanism dip into a lubricant sump and splash the lubricant onto themselves and/or other parts of the machine by mechanical or other means.

Split bearings: bearings divided into two parts that completely encircle the journal when fitted together, often with shims on each side for adjustment or fitting; can be adjusted to compensate for wear to the bearing or the journal, or both, by removing shims or by filing to fit the two parts together to any desired clearance.

Spun bearing: bearing of which the bearing material is centrifugally spun instead of poured; this method of applying the material yields a finer grain and better bonding of the bearing material to the shell or back.

Spun gear (gears): gear with a straight tooth parallel to the shaft axis, also known as an involute gear.

Squeeze film: phenomenon occurring when two surfaces suddenly come together, trapping the lubricant momentarily, as with gear teeth or rolling element bearings; high fluid pressure develops in the film, raising its viscosity and helping to keep the moving surfaces apart. This phenomenon also occurs during elastrohydrodynamic lubrication.

SRV: a reciprocating test device for evaluating friction and wear.

Static friction: force just sufficient to initiate relative motion between two bodies under load.

Static grounding: use of a grounded conductive material to prevent the accumulation of static electric charges.

Static electricity: accumulated stationary electrical charges generated by friction.

Static transmitted load (gears): tangential pitch line force transmitted from one gear to another without regard to dynamic efforts.

Stator: may refer to the stationary member in a steam turbine, a hydraulic torque converter or the framework surrounding the armature of a direct current motor or generator.

Steam refined: term applied to unfiltered residual cylinder oils from which lighter fractions have been distilled by the direct application of steam.

Step bearing: plane-surface bearing that supports the lower end of a vertical shaft.

Stick-slip (slip-stick): a condition occurring in slow moving or oscillating sliding bearings under near boundary conditions, where there are fluctuations of velocity and friction coefficients, including periods of static friction. It is a critical factor in precision machine tool operations, where such conditions can result in erratic motion and improper machining of parts.

STLE: Society of Tribologists and Lubrication Engineers (formerly, the American Society of Lubrication Engineers, or ASLE).

Stoke: the standard unit of kinematic viscosity in the cgs system, expressed in cm^2/s.

Strainer filter: see oil strainer.

Stray mist suppressant: (ASTM D-3705) a polymer added to mist oils to reduce the stray mist.

Strong acid/strong base numbers: (ASTM D-974) the quantity of acid or base, expressed in equivalent numbers of milligrams of KOH, required to neutralize strong acid (pH 4/g) or base (pH 11/g) constituents.

Stress concentration factor (gears): factor affecting beam strength, related to the radius of the fillet at the tooth base; the larger the radius, the lower the stress concentration.

Stub teeth (gears): gear teeth in which the working depth is less than 2.0 divided by normal diametral pitch.

Stuffing box: see packing box.

Subplate sections (lube systems): baseplates that support the working valve sections of stackable subplate divider valves, containing internal porting, outlet ports and tie bolt holes.

Sun gear: the center gear that remains in mesh with the planet gears (see planetary transmission).

Surface finish: the surface roughness of a component as measured by a surface profilometer.

Surface tension: the attractive force exerted by molecules below the surface upon molecules at the surface/air interface. The strength of the surface tension varies with the polarity of the liquid; high-polar substances like water have higher surface tension than low-polar substances like organic solvents and oils.

Surfactant: any surface modifying material that imparts anti-wear, extreme pressure or rust inhibition properties, spreadability, etc.

Surfactant (cleansers): a compound that reduces surface tension when dissolved in water or aqueous solution, or that reduces interfacial tension between two liquids or a liquid and a solid. The three types of surfactants are wetting agents, detergents and emulsifiers.

Synthetic lubricants/fluids: man-made products created by chemically combining specific compounds, producing substances with specialized lubricating qualities to meet specific objectives. This group includes the following subgroups: synthesized hydrocarbons, principally polyalphaolefin; organic esters, e.g., the diesters and polyol esters; polyglycols, some of which are used in water-glycol FR fluids; phosphate esters, FR fluids with good lubricating characteristics; and others, e.g., silicones, silicate esters, polyphenyl esters and fluorocarbons.

Tall oil: a natural mixture of rosin acids obtained by acidifying the black liquor skimmings of the alkaline paper pulp industry. "Tall" is an abbreviation of the

Swedish word "tallolja"; meaning pine; the material was first investigated in Sweden. Tall oil is used in the manufacture of cutting oils.

Tallow: animal fat prepared from beef and mutton, sometimes a combination of solid and fluid fats; acidless tallow is used in the formulation of compounded cylinder oils to increase wettability properties in the presence of steam. Ordinary tallow contains 25% fatty acids; acidless tallow contains less than 0.5%.

Total acid number: (TAN): see neutralization number, strong acid/strong base numbers.

Tapered pad/land bearing: a fixed pad (land) bearing in which the surfaces of the pads are tapered to promote the establishment of a hydrodynamic film.

Tapping and plugging: refers to the use of a non-tapered tap, known as a bottoming or plug tap, after starting threads with two previous tapered taps.

TBN: see neutralization number, strong acid/strong base numbers.

Tricresyl phosphate/TCP: a colorless liquid used as a lubricant additive and plasticizer.

Teflon: polymer of tetrafluoroethene, also known as PRFE; material trademarked by DuPont.

Temper oil/martempering oil: heavy mineral oil kept at relatively high temperatures for long periods of time, suitable for tempering operations. Hot metal is placed in a bath of oil, at a temperature of 400-600°F, after which the metal and oil are permitted to cool slowly; in the alternative, the hot bath may be used to heat the metal slowly and uniformly without oxidizing the surface.

Texture (grease): the property of a grease that is observed when a small portion is compressed, then slowly drawn apart, described in the following terms: brittle, tends to rupture or crumble when compressed; buttery, separates in short peaks with no visible fibers; long fibers, tends to stretch or string out into a single bundle of fibers; resilient, capable of withstanding moderate compression without permanent deformation or rupture; short fiber, shows short break-off with evidence of fibers; stringy, tends to stretch or string out into long threads with no visible evidence of fibrous structure (see bulk appearance).

Thermal Gravimetric Analysis/TGA: a measure of weight loss under specific conditions; normally, temperature is maintained (isothermal) or increased in an

atmosphere of nitrogen or oxygen; used to study oil volatility and oil residues, for example, contaminated roll oils.

Thermal conductivity – a measure of a material's ability to conduct heat

Thermal cracking: a process utilizing heat to break high molecular weight substances into smaller units; facilitated in a controlled manner during refining by the presence of a catalyst.

Thief (sample) Bomb: device for obtaining samples of liquid from different depths in a tank.

Thin film/mixed film lubrication: a condition of lubrication in which the lubricant film is so thin that the friction between the surfaces is determined by the properties of the surfaces as well as the viscosity of the lubricant (see boundary lubrication); also known as mixed film lubrication.

Thixotropy: the property of a material like lubricating grease that is manifested by a softening in consistency as the result of shearing, followed by a hardening in consistency that begins immediately after the shearing stops. With thixotropic cleansers, shearing may occur with shaking, mixing, vibrating, pumping or stirring.

Thread cutting oil: Petroleum based product formulated to cool and lubricate the threading tools that produce external threads on metal rods or pipes. Single-point tools can be used, but the majority of threading is performed by feeding special threading dies into the workpiece until the desired length of thread is reached.

Thrust bearing: an axial-load bearing.

Thrust collar: see collar thrust bearing.

Timken OK load: measure of the EP properties of a lubricant. The Timken testing machine uses a lever arm that can be loaded to bring a stationary block to bear against the rotating outer race of a bearing until scoring occurs. The maximum load prior to scoring is called the OK load.

Tolerance: term describing deviation from the prescribed dimensional specifications for bore, O.D. and ring widths of standard bearings; the slighter the deviation, the smaller the tolerance and the closer the bearing comes to precision. The Annular Bearing Engineering Committee has standardized the tolerances for ball bearings, and the Roller Bearing Engineering Committee has

developed similar tolerances for roller bearings; higher numbers mean greater precision.

Tooth depth (gears): sum of the addendum, dedendum and a small clearance space.

Total acid/total base numbers: total acid number (TAN) and acid number are synonymous, indicating the strong acid number values. Total base number (TBN) reflects all basic constituents, including the strong base component (see strong acid/base numbers).

TQIT: bearing manufacturers' nomenclature describing tapered roll-neck, interference-fit bearings used in high-speed, heavy-duty rolling mills where close gauge and shape tolerances are required.

TQO: nomenclature used by tapered roller bearing manufacturers to denote the straight-neck, loose-fit roller bearings used on heavy-duty, low-to-medium speed rolling mills.

Traction fluids: fluids displaying high traction coefficients; under high stresses they develop a glass-like structure, simultaneously transmitting shear forces and protecting the contacting surfaces from wear. Cycloaliphatics are superior traction fluids.

Tramp oil: describes undesired oil scum in a system, e.g., lubricants or hydraulic fluids that mix with rolling oil systems in cold mill areas.

Transducer: an electrical device that converts a signal from one form of energy to another.

Transformer oil: oil suitable for use in a transformer, to dissipate heat, keep the insulation on the wire pliable and retard the oxidizing effect of the air. Since it circulates between coils of wires that carry high-voltage currents, it must resist the flow of current through it from one coil to another; otherwise, the transformer short-circuits. Such resistance is termed dielectric strength; oil that is extremely dry, clean and acid-free has high dielectric strength.

Transverse plane (gears): in helical gears, a cross-section (perpendicular) to the line of action.

Tribology: the science and technology of interacting surfaces in relative motion and associated subjects and practices. This term, first used in 1966, effectively coordinates many technical disciplines such as chemistry, metallurgy, machine design, lubrication engineering, etc., for solving friction and wear problems.

Trunnion: either of two opposite pivots or cylindrical projections from the sides of an assembly, supported by bearings, that offer a means of swiveling or turning an assembly or part of an assembly. Trunnion bearings are used with basic oxygen furnaces.

Tung oil/chinawood oil: a drying oil from the seeds of tung trees that dries to a soft, opaque white film.

Turbulent flow: characterizes flow in eddies and currents through a pipe, in contrast to streamline, or laminar, flow; turbulent flow causes fluid friction loss. Flow quality depends on a combination of factors; pipe diameter, fluid density, viscosity and velocity.

Ultrasonic cleaning: sends high-pitched sound waves through a liquid solvent to remove dirt, grease and small metal particles quickly and effectively from small corners and crevices.

Unloading valve (hydraulics): a device that directs hydraulic fluid back to the reservoir at low pressure when there is no demand on the system.

Unworked pen/penetration: (ASTM D-217) the penetration at 77°F of a sample of grease that has experienced minimum handling in transfer to the test apparatus and that has not been subjected to the action of a grease worker.

Vapor degreasing: cleaning procedure to remove oil, grease and lightly attached solids from metals. An appropriate solvent, e.g., hexane or cleaners solvent, is boiled; as the vapors condense on the metal surfaces, contaminants fall into the reservoir.

Vapor phase corrosion inhibitors: fine, volatile powders made from stable nitrites of organic amines that prevent rusting; after vaporizing, they are adsorbed by metal surfaces. They are also marketed as treated papers; see VCI paper.

Vapor pressure: measure of the volatility of a liquid at specified temperatures and pressures (or vacuum).

Variable displacement pumps: pumps that can be adjusted to deliver a variable volume while the speed remains constant.

Varnish: in lubrication, a deposit resulting from oxidation and polymerization of fuels and lubricants; like lacquer, but softer.

Volatile corrosion-inhibiting (VCI) paper: corrosion-inhibiting papers and films impregnated with vapor phase corrosion inhibitors to prevent corrosion of ferrous and non-ferrous metals; may be used to wrap new parts to prevent corrosion during storage or shipping (see vapor phase corrosion inhibitors).

Vegetable oils: oily fluids with varying percentages of fatty acids, obtained from vegetable sources; examples are coconut oil, rapeseed oil, sunflower oil, crambe oil, etc.

Vent valve (lube systems): device for relieving supply line pressure.

Venturi: tube, constricted at the middle and flared at both ends, in the pathway of a fluid, to reduce fluid pressure in the constricted area.

Venturi meter: a form of flow measuring device containing no moving parts that operates on the principle of velocity to pressure conversion with values taken on each side of the venturi tube.

VI: see viscosity index.

Vibrational analysis: analytical method used to monitor bearing conditions during operations.

Virgin oil: a fresh oil product not recycled or reclaimed.

Viscometer/viscosimeter: an apparatus for determining the viscosity of a fluid.

Viscosity: the property of a fluid, semi-fluid or semi-solid substance that causes it to resist flow. Its numerical value is based on the ratio of shear stress to the rate of shear during flow. The standard unit of absolute viscosity in the English system is the reyn, expressed as lb-s/in.^{2}. The standard unit of viscosity in the cgs and ISO system is the poise, expressed as dyne-s/cm^2. Conversion from one system to the other is as follows:

$$\text{reyn} = \text{poise} \times 1.45 \times 10^{-5}$$
$$\text{poise} = \text{reyn} \times 6.895 \times 10^{4}$$
$$\text{centipoise} = \text{poise} \times 10^{-2}$$
$$\text{microreyn} = \text{reyn} \times 10^{-6}$$

For Saybolt seconds, convert to centistokes, then to centipoise before converting to reyns. Specific calculations are:

$$cp = cSt \times \text{specific gravity}$$

$$cSt = 0.22 \times \frac{SUS - 180}{SUS}$$

(see absolute viscosity, kinematic viscosity).

Viscosity Index/VI: common measure of changes in viscosity with temperature; the higher the viscosity index, the smaller the relative change in viscosity with temperature.

Volatile organic/VOC: as potential hazard or pollutant, applies to any carbon compound that can be evaporated using standard test methods, except for carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates and ammonium carbonate. Because of the complexities involved in measuring VOC, no universal definition has been formulated. VOC control is often enforced by local government agencies.

Volatility – the tendency of a fluid to evaporate. High evaporation rate means high volatility.

Vapor phase inhibitor/VPI: corrosion inhibitor in the form of vapor, also referred to as a vapor corrosion inhibitor (see VCI).

Waste yarn lubrication: lubrication system that delivers the lubricant to the bearing and journal surface by the capillary action of an oil-soaked fibrous material like yarn or textile waste, in contact with a relatively slow moving journal. Like pad lubrication, this form of lubrication has been used in over-the-road railway cars.

Waste, oily: term applied to all fuels, lubricants and petroleum products that may cause environmental pollution because of leakage and spills or as part of plant waste.

Water glycol: FT hydraulic fluid composed of water and one of the glycols.

Water resistance (grease): the ability of a lubricating grease to withstand the addition of water to the lubricant system without adverse effects, generally rated by the following criteria: washout resistance (ASTM D-1264); water absorption; water corrosion resistance (ASTM D-1743) and water sprayoff resistance (ASTM D-4049).

Wax: the aliphatic paraffin series of hydrocarbons with high boiling points and high molecular weight; classes include paraffin (crystalline), microcrystalline and

petrolatum (amorphous and microcrystalline). Petrolatum is obtained from the heavy residual stock; heavier grades are used for rust prevention and wire rope lubrication (see petrolatum).

Wax appearance point – the temperature at which wax begins to precipitate out of a distillate fuel.

Wear of metals – the loss of surface material due to motion between two surfaces in contact.

Wetting agent (lubricants): an oiliness additive; an additive that adsorbs to metal to enhance the spreading of a lubricant.

Wetting agent (cleansers): a surfactant that, added to water, causes the water to spread more easily over the surface of another material. Wetting agents do not usually impart any detergent or emulsifying properties to water.

White oils: light-colored, usually highly-refined mineral oils frequently employed in pharmaceutical and medicinal preparation and used as bases for creams, salves and ointments. White oil lubricants are used where color and/or environmental concerns are important.

White petroleum jelly: the whitest grade of petrolatum.

Wick lubrication: lubrication system that uses a wick to deliver the lubricant to the bearing surface.

Wiping: the smearing or removal of material from one point, often followed by the redeposition of the material at another point, on the surfaces of two bodies in sliding contact; a form of wear.

Worked penetration: (ASTM D-217) penetration of a sample of lubricating grease immediately after it has been brought to 77°F and subjected to 60 strokes in a standard grease worker.

Worm gear: a screw-thread-like gear consisting of worm and worm wheel; the worm, made of steel, is the driving gear, and the worm wheel, made of non-ferrous metal, is the driven gear. Worm drives have relatively low gear ratios.

Yarn: a fibrous material like wool, twisted into a loose thread and added to greases for special applications.

Zahn viscometer: a crude funnel viscosity device for factory and laboratory use, consisting of a wire bail that holds a cone-shaped cup with an orifice at the bottom. After the cup is filled with the sample, the test consists of recording the temperature and the time required for the test sample to flow from the filled cup. Cups with orifices of various sizes are available.

Zinc dialkyl dithiophosphate/zinc diaryl dithiophosphate/ZDDP: a popular anti-wear additive used in motor oils and hydraulic fluids; though it also has oxidation inhibiting properties, it cannot be used in engines employing silver bearings.

Zerk fitting: a common grease fitting, one of many types of fittings used in lubrication and hydraulics).

ZN/P curve: a graphic representation of the effects of speed (N), load (P) and viscosity on the coefficient of friction μ as a shaft rotates in a plain bearing. The dimensionless equation states that the coefficient of friction μ is a function (f) of the ratio (viscosity X speed)/load or $\mu = (f)ZN/P$.