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## TECHNICAL NOTE DEFINITIONS AND ACRONYMS

**Activated Alumina (AA):** This is a purification media used on some turbines. It has the advantage of being manufactured and as such has a more controlled consistency. It may not be as good as fuller's earth at controlling resistivity and as such is not normally used on EHC systems. Sodium content can be an issue.

**AA:** See also Atomic Absorption in Metal Content.

**Absolute Rating:** As applied to particulate filtration this is the largest sized particle that will pass. However, it is not really applicable to fibre depth type filter elements. This is because the largest particle depends on the pressure drop, because not all particles are round and because the beta ratio is not a constant. In the past it had been stated that a particle size giving a beta ratio of 75 for the filter element was considered to be the absolute rating. Now beta ratios of 1000 are more common.

**Acid Number:** As fluid is used, acid like compounds can be formed. Normally controlled at <0.2 mg KOH/g by purification media such as fuller's earth. Too high at any time can lead to later problems and shortened fluid life. This is not the same as pH but can lead to corrosion and deposits.

**Adiabatic Compression:** See dieseling and also Air Release Time.

**Air Release Time:** As measured in ASTM D-3427 this is an indication of how quickly air bubbles will rise to the surface of the fluid. It is important because too long a time for a particular reservoir configuration can result in air bubbles being drawn into the pump suction. The result can be dieseling and accelerated degradation of the fluid. Used fluids and synthetic EHC fluids tend to have longer air release times.

**Appearance:** A visible monitoring test for no visible oil (on top), water (on top), particulates, fibres or cloudiness.

**ASTM:** American Society for Testing and Materials which is based in Philadelphia, USA. They are a source for test procedures on a wide variety of materials. There are hundreds that can be applicable to lubricants.

**Attapulugus Clay:** See fuller's earth.

**Beta Ratio:** For particulate filtration, this is the number of particles going in divided by the number of particles going out. The ratio varies with particle size, with differential pressures and with the age of the filter element. For the latter, some get better with age, but most will be worse. It is often determined in a Multipass Beta Filter Test per ISO 4572. However, it should be noted that field sampling on in/out samples has seldom yielded as good a beta ratio as those quoted in sales material.

**Buna-N/Nitrile Rubber:** A rubber often used in seals and 'o' rings for components in mineral oil systems, but which is not compatible with many of the ester-based fluids. Will be softened and/or may swell when in phosphate ester. It should not be used. See also Material Compatibility.

**Butyl Rubber:** A material that can be acceptable at lower temperatures for phosphate esters. See Material Compatibility.

**Caking:** A GE procedure in which the purification media is not immediately valved into the system but instead a closed loop is used to reportedly build up a layer of fines on the purification media and likely on the trap or back-up filter element. Now not required.

**Chlorine Content:** A routine test parameter. It can be important because a high value can cause servo-valve electrokinetic wear. The source is often chlorinated solvents. See also Electrokinetic Wear and Resistivity.

**Coking:** Black carbon particles that can be the result of severe overheating of the fluid. See also Colloidal Carbon.

**Colloidal Carbon:** Sub-micron sized particles of carbon that can be the result of dieseling of the fluid. Generally, very difficult to remove with filtration with fibres so might require electrostatics.

**Color:** A routine test parameter. The scale goes from 0 (clear) to 8 (black). New fluid is very clear and some darkening in service is typical although a rapid change would of concern. Very important to monitor in case of darkening.

**Compatibility:** See Mixing Fluids, Material Compatibility and also Buna-N/Nitrile.

**Desiccant:** A water absorbing material such as activated alumina used to dry some air being drawn into the reservoirs through the breathers. Some show when they are spent by changing color as for example, from blue when dry to pink when wet. Not generally as effective as a proper reservoir dry air purge system.

**Dieseling:** This is similar to diesel engines that rely on the combustion of air and fuel when compressed. In this case the pressure is provided by the main pumps and the cause is excessive air in the fluid and/or too high a vacuum on the suction side that allows the formation of free air bubbles. Temperatures in the wall of the air bubble being compressed can reportedly reach hundreds of degrees so that some fluid degradation is likely. It can also be called adiabatic compression which is the worse theoretical case scenario with no heat transfer into the fluid.

**Durad EHB:** See Turbofluid 46B.

**EH:** Electrohydraulic, is a term used by some manufactures to be used with fluid as in EH fluid or the pump package as in EH skid or unit.

**EHC:** Electrohydraulic Control is a hydraulic system that combines high pressure hydraulic fluid with electrical actuation and sensing to operate the various steam valves.

**Electrokinetic Wear:** This is a phenomenon in which streaming currents are generated in the area of the control surfaces and which can result in the removal of metal very quickly. The result can be excessive internal leakage that if bad enough can make it difficult to maintain system pressure. This is prevented by keeping a low chlorine content and a low fluid resistivity.

**EPR:** Ethylene Propylene Rubber that can be acceptable for use with phosphate esters. However, it is not compatible with mineral oil. See Material Compatibility

**Ester:** An organic compound comparable to an inorganic salt. Formed by the reaction of an inorganic acid with an alcohol. Many forms are used for lubrication including phosphate esters, diesters and polyol esters. Only triaryl phosphate esters are approved by turbine OEM's for control systems.

**Fluid Compatibility:** This can be of concern with mineral oil-based fluids because of the considerable differences in base oils and additive packages. However, approved phosphate ester fluids have been found to be compatible with one another and in fact one of the leading fluids being supplied is a mixture of different phosphate esters. Also, additive interaction is not believed to be possible because one line of fluids is purported to have no additives. Lastly, in most cases the mixing of approved fluids has been okayed by the fluid and turbine suppliers.

**Foam:** A mixture of air and fluid that might be found floating on top of the fluid in the reservoir. A slight amount of foam is not unusual but excessive amounts can interfere with the release of air and could even come out breathers. In extreme cases it can be thick enough that foam is sucked into the pump suction. Foaming tendencies and stability characteristics can be measured with standard tests such as ASTM D-892 or ISO 6247. New fluid should produce very little foam while in-service contamination and/or fluid degradation will cause it to get worse.

**FRF:** Fire Resistant Fluid, a fluid that through specific testing is shown to be more fire resistant than other fluids such as mineral oils. Other considerations include the ability to be self-extinguishing and calorific values.

**FTIR:** This stands for Fourier Transform Infrared spectroscopy that is an analytical method used for the analysis of organic components. Can be used with phosphate esters to detect some contaminants and to identify degradation by-products.

**Fuller's Earth (FE):** Used to control the acidity. It is a kaolin, reportedly containing free alkalinity, principally as magnesium oxide and hydroxide. It is processed from a naturally occurring material called attapulgus clay or attapulgite as is found in Georgia and Florida. There are several types, grades and sizes of granules available.

**Gels:** See Salts/Soaps.

**Hatch Test:** This is a test for phosphate and is being used in some cases to indicate the amount of phosphite and therefore the tendency for gel formation.

**Hydrolytic Stability:** The tendency of a fluid to react with water. Normally tested according to ASTM D-2619 in which a 'beverage' bottle containing 75g of the fluid, 25ml of water and a copper strip is rotated at 5 rpm at 93°C for 48 hours. Like all esters, the presence of water can reverse the preparative reaction. The result is that as in thermal and oxidation degradation, hydrolysis can produce acidic products. It reportedly proceeds stepwise and is considered to be autocatalytic. When uninhibited, the various triaryl esters have considerable differences in hydrolytic stability. The trixylenyl (TXP) phosphate is generally considered the best followed by the isopropylphenyl phenyl (IPPP) and then the t-butylphenyl (TBPP) phosphates.

**Hydrolysis:** A chemical reaction in which the fluid reacts with water so as to be changed into other substances. See also hydrolytic stability.

**ICP:** See Metal Content

**Ion Exchange Resin:** Material commonly used in power stations to remove metallic contaminants from water to be used in boilers. With the correct resins and procedures, it can also be used to treat degraded phosphate ester fluids. There are many types available including both anion and cation exchangers. Most are based on beads made in the form of a polymer-based matrix structure. One polymer used is polystyrene. They typically work as adsorbents to remove undesirable compounds.

**Kaolin:** See Fuller's Earth.

**Karl Fischer:** See Water Content

**Kidney Loop:** A filtration and/or purification system in which a small percentage of the main flow is bled off for treatment. Another option is a system with an independent pump with the fluid being taken off the reservoir. It can also be called a bypass system.

**Material Compatibility:** Phosphate esters are also used extensively as plasticizers and as such they can soften and/or cause swelling of unsuitable materials. A number of suitable materials are available. For example, these can include fluorocarbon rubber (FPM), polytetrafluoroethylene (PTFE), butyl rubber, ethylene propylene rubber (EPDM), nylon, polypropylene (PP) and polyethylene (PE). Common materials such as Buna-N and nitrile rubber are not suitable. Compatibility is given different definitions but one set of limits for solid materials is a 15% swell or 5% shrinkage. This is after being immersed for 168 hours in the fluid at 140°F (60°C). Interestingly, some materials such as butyl rubber and ethylene propylene that are compatible with phosphate esters are softened by mineral oil.

**Metal Content:** This can be a useful test because high amounts of magnesium (Mg), calcium (Ca) or sodium (Na) may be from the purification media. They can lead to the formation of soaps and/or gels and/or have a negative effect on foaming or air release values. Knowing the amounts of other metals such as iron, copper and zinc can also be useful in trouble shooting. Generally measured along with a dozen or so other metals by Inductively Coupled Plasma (ICP), Rotating Disc Electrode (RDE) or Atomic Absorption (AA).

**Micron:** A metric unit that represents 1/1,000 of a mm or 0.000039". By comparison the smallest dot that can be seen with the eye is about 40 microns.

**Mineral Oil Content:** One of the routine monitoring tests because even a little contamination with steam turbine oil or other minerals oil can impair fire resistance, soften EPR or butyl seals and/or shorten fluid life.

**MPC:** This is the membrane patch test developed for mineral oils as D7843. It has been used for phosphate esters but can require a different procedure and interpretation. Basically, fluid is mixed with a nonpolar solvent and run through a 0.45-micron filter patch. Colorimetry values and the patch weight can be reported. Used as an indication of fluid degradation and the potential for deposits.

**'Natural' Phosphate Ester:** A phosphate ester made with raw materials from the so called 'natural' sources like coking coal or petroleum refinery processes. Such feedstocks were usually one of the cresylic acids which include cresols, xylenols and alkylphenols. See also Phosphate Ester.

**Nominal Rating:** This is sometimes used to describe filtering ability but because there is no agreed definition, it can vary between manufacturers. It is much better to know the beta ratio for the particles size ranges of concern. As an example, one back-up filter element commonly used on some purification systems had a reported rating of 0.5 microns nominal. While satisfactory in many cases, the beta ratios were not as good as those on the much more expensive and difficult to change pump discharge filters.

**Oxidation:** The normal chemical reaction of many materials in the presence of oxygen in the air. It is accelerated by higher temperature. If the bulk fluid temperature is not too high, this might show up as more rapid darkening or a greater generation of acidic compounds. This is normally slow and can be controlled with the purification media. Excessive heating or hot spots on the other hand can cause irreversible damage and possibly the formation of deposits.

**Particle Count:** A routine test. Important because too high even once can lead to shorter fluid lives, servo and/or solenoid valve problems with sticking and screen/filter blockage. Resample and determine source if still high. Often expressed in terms of the number of particles in specified size ranges for a 100ml sample or as an ISO Cleanliness Code.

**Phosphorous:** A solid non-metallic chemical element with atomic number 15 and atomic weight 30.9738. Found in a wide variety of chemicals for industrial, residential and agricultural applications. Phosphites, phosphonates and phosphates are said to be used as additives in lubricant formulations as stabilizers, antiwear additives, antioxidants, metal passivators and extreme pressure additives.

**Phosphate Ester:** An organophosphorous compound that is an organic salt of orthophosphoric acid. The trisubstituted esters or tertiary esters are used as synthetic lubricants and of these the triaryl esters are ones used as control fluids. Triaryl esters have been known for over a hundred years being reportedly first synthesized about 1854. They are commercially produced by the reaction of an aliphatic and/or aromatic organic alcohol and the inorganic phosphoric acid.

**Purification:** A process whereby impurities and/or fluid degradation by-products are removed from the fluid. In most cases a small flow of fluid is continuously circulated through a bypass purification system. This fluid is often taken off the system line and only requires a pressure reducing device. The purification media can be in cartridges or bulk and there should be a particulate filter to catch fines.

**Purification Media:** Generally adsorbent solids in which one substance attracts another and retains that material on its surface. Contact time is required, and adsorption is reported to be a diffusion process in which the adsorbate must pass through the liquid itself and finally by capillary diffusion, into the interior pores to the active-adsorptive surfaces. Naturally occurring adsorbents are fuller's earth, bentonites and bauxite. Synthetic adsorbents include silica gel, activated alumina, activated carbon and magnesium silicate. See also Fuller's Earth.

**Resistivity:** This is a measure of the electrical resistivity of the fluid and it must be kept high to prevent electrokinetic wear of servo-valve spools. Normally controlled by fuller's earth purification media. See also Electrokinetic Wear.

**Salts/soaps:** Metal salts have been found in gel deposits and the most likely source is the magnesium and calcium found in fuller's earth or the sodium found in other types of purification media. These tend to float on the fluid and are often found deposited as a ring on the internal surfaces of the fluid reservoir, on internal piping and on the floats for level indicators. They can also be carried into the system and deposit on filter housings, filters and screens.

**Selexsorb:** This is an Alcoa patented purification media containing both  $\gamma$ -zeolites and activated alumina. Reportedly more effective than fuller's earth in controlling the acid number. Note to be used with badly degraded fluid. Does not contain Mg or Ca but does have some Na.

**Solids Treatment:** See Purification Media.

**Steaming Currents:** The electric currents formed in the servo-valve internals and which can lead to accelerated wear and excessive internal leakage. See Electrokinetic Wear and also Resistivity.

**'Synthetic' Phosphate Ester:** A phosphate ester made with raw materials from other than the so called 'natural' sources of coking coal or petroleum refinery processes. Chemical process derived feedstocks could include isopropyl and butyl phenols. See also Phosphate Ester.

**TAN:** Total Acid Number, see Acid Number.

**Triaryl Phosphate (TAP):** The name for the subgroup of tertiary or trisubstituted phosphate esters used as control fluids.

**Turbofluid:** A family of Lanxess Reolube fluids used as fire resistant control fluids. This includes the following;

Turbofluid 46XC	A 'natural' trixylenyl phosphate ester
Turbofluid 46B	A 'synthetic' tertiary butyl phenyl phosphate ester

**Viscosity:** Control fluid is usually an ISO VG 46. Viscosity should not normally vary if the make-up is the same viscosity. A significant change may be the result of degradation, contamination or testing.

**Viscosity Index (VI):** A numeric value that is a measure of a fluids tendency to thin out at high temperatures or thicken up at low temperatures. Calculated based on viscosity measurements at 40 °C and 100°C. Phosphate ester control fluids tend to thicken up more than mineral oils of the same viscosity grade and most systems have a minimum operating temperature requirement. Running with cold fluid will increase pressure drops across filters and screens.

**Water Content:** Generally limited because of the concern about hydrolysis. Typically measured using ASTM D-1744 which makes use of a Karl-Fischer reagent. It should be noted that unlike non-detergent mineral oils, phosphate esters can contain considerable amounts of dissolved water. This is normally kept under control with the purification media and/or the use of desiccant breathers. In extreme cases, vacuum dehydration or reservoir dry air purge systems may be required to lower a very high-water content such as that arising from a cooler leak. See also Hydrolysis and Hydrolytic Stability.

**Zeolite:** This is any of a large group of natural hydrous aluminium silicates of sodium, calcium, potassium or barium. They can also be called molecular sieves and may be of both natural and synthetic manufacture. Generally used as beads that have small pores in their crystal lattices that can absorb molecules. Can be used for drying.

Disclaimer - This material has been compiled to be of assistance to users. It is not intended to be complete in all regards. While it is based on what is believed to be current and correct information, no responsibility can be taken for errors or actions or nonactions not specifically recommended.