Trouble-free EHC fluid operation

Phosphate ester fluids used in electro-hydraulic control (EHC) systems require careful maintenance if they are to perform at their peak, Peter Dufresne of EPT, a world leader in critical lubrication management, reveals the importance of detecting fluid problems in advance, and how maintenance practices can be improved to prevent costly servo valve failures.

EDF Energy's Heysham 1 power station in Lancashire, UK, uses EPT's EHC fluid conditioning system.

Phosphate ester fluids are the preferred hydraulic fluid for electro hydraulic control (EHC) systems due to their self-extinguishing fire properties. In this application, self-extinguishing fluids are important because of the high operating pressures and the proximity to high-temperature steam. While the benefits to health and safety are obvious, phosphate ester fluids require additional fluid maintenance to preserve their key properties within a relatively narrow operating range. Every year, incorrect, inadequate or obsolete practices result in excessive maintenance costs and servo valve failures that amount to millions of dollars in lost revenue at plant level and billions of dollars industry-wide. A detailed understanding of how phosphate ester fluids break down and how existing maintenance programmes fail to address these primary causes of fluid failure is therefore critical, as well as detecting fluid problems in advance and improving maintenance practices in order to prevent failures.

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Phosphate ester fluid breakdown

Phosphate ester fluids require acid removal systems to maintain their fluid chemistry. In most cases the fluid-conditioning system is supplied by the turbine manufacturer as part of the initial turbine installation. These fluid-conditioning systems do not address the causes of fluid breakdown, but partially mitigate the effects by reducing the acidity. While acid-removal systems are essential, their selection and application should never adversely impact the factors controlling the rate of fluid breakdown. Lubricant and fluid breakdown is caused by hydrolysis and oxidation. There are three key aspects that regulate the rate of hydrolysis and oxidation in this application: water, oxygen and metals. Hydrolysis can be minimised by controlling water. Oxidation cannot be eliminated, but it can be managed by carefully controlling water, oxygen and the presence of any metals that act as catalysts. An important question to ask is: does your existing phosphate ester fluid-conditioning system manage these three primary contributors of fluid breakdown or does the system actually increase the rate of oxidation?

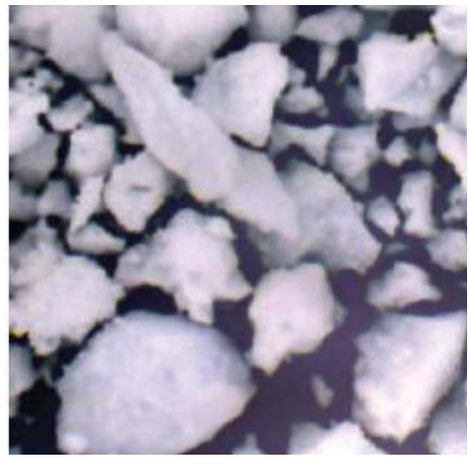
Water: misunderstood and overlooked

When phosphate ester fluids are maintained at less than 300ppm of water, the fluid breakdown rate is approximately a tenth of that witnessed at a water level of more than 2,000ppm (based on an internal estimate). Phosphate ester fluids are hygroscopic in nature and as a result will hold a high amount of water in solution (>1,800ppm) compared with other fluids.

Since phosphate ester reservoirs are vented into the atmosphere, the water and gases in the fluid reservoir will always move towards equilibrium with the water and gases in the atmosphere that has direct contact with the fluid. In humid environments this is a significant problem, because the fluids will have unlimited access to water vapour, increasing the fluid breakdown rates by as much as ten times. Generally, the fluid-conditioning system supplied with the turbine has no impact on water levels and as a result this key variable to oxidation is left unmanaged.

Oxygen: abundant and highly reactive

In a normal phosphate ester fluid reservoir, the atmosphere above the fluid reservoir is primarily comprised of nitrogen and oxygen. Oxygen readily reacts with almost all other elements to form breakdown compounds .The fluid-conditioning system supplied with the turbine is not capable of managing oxygen levels and therefore cannot manage this key component of fluid breakdown.



A 10x magnification of Selexsorb® reveals very small, abrasive particles, a portion of which will pass through existing filtration and artificially increase fluid resistivity values.

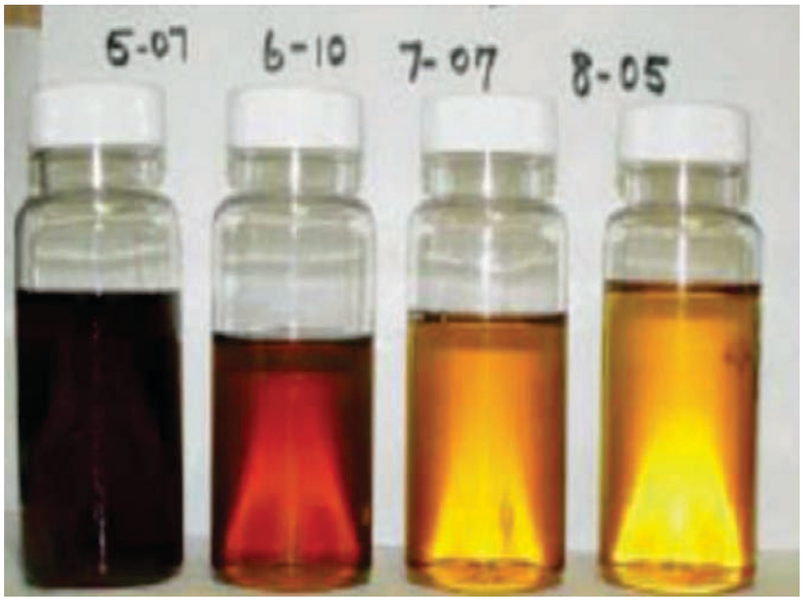
Metals: the source of all fluid deposits

There should be no metals in phosphate ester fluid other than phosphorous from which the fluid is made. Metals act as catalysts that drastically accelerate oxidation. A fluid with low metals of 10ppm will have a breakdown rate one hundred times less than that of a system with high metals (>100ppm) and high water (>2.000ppm). Aside from significantly increasing the rate of oxidation, metals produce chemical reactions that create solids. Metals are the basis of all fluid deposits and gelling products in phosphate ester systems. Depending on the type of acid- removal filter in your fluid-conditioning system, it is highly likely that the filter is contributing metals to your fluid.
Water, oxygen and metals that regulate the rate of oxidation and fluid breakdown are not managed by the fluid treatment system supplied with the turbine. As a consequence, phosphate ester fluid systems suffer from unnecessarily high levels of acid production that make these fluids difficult to maintain. To effectively manage phosphate ester fluids, you need to control hydrolysis and oxidation - and this requires a different set of maintenance tools.

How to detect fluid problems early

Aside from the standard analysis that includes acid number, water, particulate, viscosity and resistivity, all phosphate ester fluids should be routinely tested for dissolved metals, suspended solid filtration at 0.45 microns, and if using Selexsorb have resistivity tested pre and post 0.22 micron filtration.

- Dissolved metal testing measures the amount of catalyst in your fluid, which correlates to the rate of fluid breakdown and the propensity for fluid deposits to form on servo valves.
- Patch testing and patch weight at 0.45 microns will quantify the weight of solid contamination that is suspended in the fluid. A dark patch result can be an indicator of fine carbon produced from a severe form of fluid breakdown known as thermal degradation.
- Testing resistivity before and after 0.22 patch filtration will isolate the impact of silica, which comes from Selexsorb and is a dielectric that commonly interferes with the resistivity test, providing an artificially high resistivity value, and therefore a false assurance to users that servo valve problems will not occur.



EHC fluid cleaned using EPT's fluid-conditioning system.

Updating fluid maintenance practices

The key to preventing problems in phosphate ester EHC applications is to manage hydrolysis and oxidation levels rather than attempting to treat the symptoms of fluid breakdown. Power plant maintenance professionals require better tools so that they can manage hydrolysis and oxidation and adopt a preventative rather than a reactionary programme. Existing treatment systems are often ineffective, and use acid-removal filters that contribute metals that actually accelerate fluid breakdown and are the basis of deposit formation. Products that contribute metals should not be used on your fluid and existing metals should be removed with ICB™ filtration.

Since 1994, EPT has worked with lubricant and turbine users from over 25 countries using a comprehensive approach to fluid maintenance that deals with the root causes of fluid breakdown. EPT's fluid-conditioning programme severely restricts the three variables that control the rate of fluid breakdown so there is less acid and other contamination to remove. The company's fluid-conditioning systems remove up to 90% more contaminants than traditional systems, and do not contribute metals. This combined approach of managing the rate of breakdown and using conditioning systems that remove significantly more contaminants offers best-in-class protection against EHC system failures and lost revenue. EPT's systems are supported with a comprehensive fluid analysis and monitoring programme that highlights when action is required in order to keep your EHC system running trouble-free.■

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