Hydraulic Fluids and Lubricating Oils in Heat Transfer Systems: The Pitfalls

Link: Heat Transfer Fluid Users Guide

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Introduction

Functional fluids used in industrial applications fulfill a multitude of purposes—

- Lubricants of many varieties
- Hydraulic and Transmission Fluids
- Metal Working Fluids
- Dielectric Fluids

—to name just a few. Sometimes the base oils used for different functional purposes may be similar, and sometimes not. More important, the additives that enhance performance for one industrial function can be very disadvantageous for another.

Hydraulic Fluids and Lubricating Oils are specific examples of fluids formulated for particular properties; these are also the categories of petroleum-based liquids most often misapplied as heat transfer fluids.

Additives

While lubricating oils and hydraulic fluids have different requirements, both are formulated to minimize the wear between two metal surfaces that are operating under high temperature and pressure. Both contain corrosion inhibitors, demulsifiers, defoamers and AW (anti-wear) additives among others that extend the service life of the fluids. These additive packages are developed in pump tests where the equipment is operated at 5000 psi for 225 hours at 250°F.

These types of additives are not necessary in heat transfer systems. Heat transfer systems don’t have fluid flowing through any open tanks so defoamers are unnecessary. Water doesn’t hide for long in a heat transfer system – ask anyone who has ever seen a geyser of hot fluid and steam erupt from an expansion tank vent – so demulsifiers and corrosion inhibitors are not required.

But the most *problematic* of the additives are the AW additives. These compounds (typically a some form of a zinc organophosphate) are designed to decompose at temperatures as low as 400°F to produce a chemically bonded lubricating film between metal surfaces that are experiencing high heat due to friction. In a thermal-fluid heater, the fluid is *constantly* exposed to such temperatures on the inside wall of the heater tube. The heat causes the inappropriate additives to decompose and coat the heater tube surface creating an effective insulation barrier. This insulation reduces the transfer of heat into the fluid, forcing the burner to fire at a higher rate to achieve the fluid set-point temperature. This higher firing rate increases the stack temperature and results in higher fuel usage.

Base Oil

Many lubricating oils and hydraulic fluids are blended from API Group I base oils that are produced by solvent dewaxing. By definition, Group I oils contain more than 10% aromatics and 300 ppm of sulfur-containing compounds which, along with extremely high boiling components such as asphaltenes (tar) result in an oil that is yellow to amber in color. The lube and hydraulic additive packages (and generally modest operating temperatures) prevent these impurities from forming harmful deposits.

In heat-transfer systems these impurities are the weak structural links in the oil molecules and so are the first materials to chemically degrade. Asphaltenes readily form hard coke deposits inside the heater tubes under moderate overheating. While sulfur compounds can reduce fluid oxidation, they can also react under heat to form suspended solids that can cause sludge. And aromatics oxidize readily in a vented expansion tank to produce acids that lead to sludge.

Heat transfer oils produced and purified by the newer hydrotreating process have almost no residual impurities. Aromatics are less than 1% and residual sulfur compounds are less than 20 ppm. The almost water-white appearance of the new fluid is visible proof that the asphaltenes have been removed. This higher level of base oil purity reduces solids formation over the life of the fluid, extending its useful life and preventing energy-wasting heater deposits from forming.

Technical Support

Hydraulic and lubricating oils need to be tested frequently to make sure that the additives levels are still sufficient to protect the metal surfaces. These “lube oil” tests determine dissolved metals, water levels, flashpoint and particle sizes and loading. Results are reported as go/no go standards, so in many cases, all the supplier needs to do is recommend replacement of the oil to keep the systems operating.

Heat transfer fluids have very different degradation issues. Like hydraulic and lube oils, they need to be tested routinely to prevent problems. Unlike the other oils, almost all heat transfer fluid problems are caused by mechanical or operational issues that are usually not obvious while the system is operating. So while the test results (which should include Acid Number, Viscosity and Distillation Range) may indicate that the fluid should be replaced, simply replacing the fluid will not correct the underlying problem. Only a heat transfer fluid specialist can analyze the test results and determine why the fluid needs to be replaced. Very few lube oil and hydraulic fluid distributors have the background or experience to identify problems in a heat transfer system.

Founded in 1988, Paratherm Corporation has become a leading U.S. manufacturer of specialized heat transfer fluids and system cleaners. The firm offers a wide range of heat transfer fluids (currently 9 fluids and 3 cleaners) covering temperatures from -148°F to +650°F. The company has a network of distributors and warehousing locations throughout North America to offer regional service and quick delivery.
For information on Paratherm fluids for hot and cold process applications – contact Jim Oetinger (joetinger@paratherm.com) at Paratherm Corporation, 4 Portland Road, West Conshohocken, PA 19428. 800-222-3611 or 610-941-4900, (Fax 610-941-9191), info@paratherm.com – **www.paratherm.com.**