FEATURESNEWS

Heat transfer fluids:

By Forest Machine Magazine

JAN 8, 2021

The blueprint for successful maintenance

Heat transfer systems are designed to carry thermal energy away from a heat source to a point of use using a heat transfer fluid. With each system designed and sized around the physical properties of brand new, uncontaminated fluid, the system performance is dependent on keeping the fluid in optimal condition.

The challenge for operators is that the heat transfer fluid – the lifeblood of the system – will slowly degrade, leading to fouled surfaces where the exchange of heat occurs. The extreme conditions wood product machinery endures only increases the rate of degradation. This in turn increases the energy required to maintain the desired temperature, which eventually decreases efficiency and productivity. The inevitable outcome is longer downtime for maintenance, which requires unplanned expenditure.

The question for forestry machine operators is therefore how to keep the system as efficient and productive as it was on the first fill, with a fluid that will degrade over time and use? To do so, it's first important to understand the three causes of fluid degradation.

Thermal cracking

Thermal cracking is the process by which the fluid begins to degrade and chemically breakdown due to intense pressure in the heater part of the system. This process 'cracks' the molecules within the fluid, reducing their boiling point. This in turn increases the volatility of the fluid which directly translates to a reduction in the flash point, fire point and possibly auto-ignition temperature. Large quantities of low boilers can pose a reliability problem by causing pump cavitation. A more volatile fluid also becomes a safety hazard in the case of a leak.

It's also possible for thermal degradation to form carbon-containing solids, resulting in abrasive residue forming within the heat source, which

can contribute to obstructed lines and elbows and damaged pump seals. The carbon residue can deposit on the internal surface of the heater coil or on the electrical elements, which is problematic. The heater, set to a certain fluid outlet temperature, must then produce more thermal energy to pass through not only the pipe wall but the layer of residue to get to the fluid. With additional heat comes additional degradation. It's a vicious cycle.

To reduce the impact of thermal cracking, safe and proper venting of the lighter components of the fluid is key to maintain fresh-oil properties. In most systems, circulating some of the hot fluid into the expansion tank will allow the molecules with a high vapour pressure to exit the fluid, enter the headspace and escape with the gases. Depending on the system, the vapours can then be released into the atmosphere, or condensed and collected into a drum or tank at a lower point and disposed of in accordance with local regulations. Machine operators should also take care over start-up and shutdown processes too as rapid start-up and improper shutdown can drastically increase the rate of thermal degradation. Starting a system at ambient conditions and raising the temperature to 204-260°C (400-500°F) should take place over several hours to minimize heat flux. The heating profile should be mild in the beginning but once the fluid has reached 150°C (302°F), a more aggressive heating pattern can be used.

Oxidation

Oxidation occurs through the reaction of the heat transfer fluid with oxygen in the air, which in turn causes fluid degradation. This reaction is largely related to temperature. The higher the temperature, the faster the rate of oxidation. A general rule is with every 10°C (18°F) temperature increase, the rate of oxidation doubles, so the useful life of the oil is reduced by 50%.

The tell-tale signs of oxidation are the gradual discolouration of the fluid, increased viscosity and the formation of sludge. The sludge settles in low flow or cooler areas and in severe cases, pipes can be obstructed by as much as 50%.

Oxidation products, like sludge, is particularly dense and insoluble in oil, so draining the fluid from the unit will not remove all of it. Once sludge is present, the only options to help restore the system's initial efficiency levels are manual removal, circulating a properly formulated cleaning agent or both. Without proper removal, the sludge will act as a catalyst and accelerate corrosion and fluid degradation. To prevent this, it's important to monitor and manage the oxidation level of the fluid. Under the guidance of a fluid analysis program, a partial system replacement periodically will go a long way to maintain system efficiency and should be viewed as preferable to letting oxidation take its toll and eventually force a system shutdown for days while cleaning, flushing and recharging takes place.

In closed systems, the most effective way to eliminate oxidation is to install an inert gas blanket in the expansion tank. Substituting air with an inert gas, often nitrogen, and ensuring the pressure is maintained slightly above atmospheric levels will remove oxidation from the equation and fluid oxidation will be a thing of the past. It's also important to carry out regular inspections and maintenance as leaks will negate the purpose of gas blanketing and effectively release money into thin air.

Contamination

Internal process leaks can damage both the heat transfer system components and the fluid itself. The urgency required to fix the leak depends on the chemistry of the contaminant, the fluid used and the severity of the situation. In some cases, the contaminant may be inert to the fluid but may react with traces of moisture to form sludge which threatens to accelerate corrosion and fluid degradation.

Beyond internal process leaks, contamination can occur from the elements, condensation, foreign liquids and airborne pollution. This is particularly pertinent in wood product manufacturing when considering the extreme environments systems are expected to function in. For systems where the expansion reservoir is outside and vented to the atmosphere, it is critical to at least have a 180° goose neck vent pipe on the top to avoid rainwater, snow or abrasive dust circulating through the system. Newly commissioned systems are also prone to have contaminants. Newly constructed heat transfer systems are often pressure-tested with water but are seldom flushed with a virgin mineral oil before the first charge. Water in the system can directly cause accelerated corrosion, increased fluid oxidation and wear pumps, so new systems should be flushed with a suitable and compatible fluid.

Invest in used oil analysis

transfer fluid degradation and ways to mitigate the issue, oils will naturally degrade over time. This is why regular fluid analysis is important, even if there is no reason to think there are issues with the system. Proactive testing, along with best practices in system monitoring, can help detect potential problems early, before a costly reduction in productivity or worse, a system failure occur. Testing also allows for better planning as it may indicate the time frame for a fluid change-out which can be properly planned and budgeted for.

It's therefore strongly advised that testing occurs during the first month, three month and year of operation for brand new systems, just after any fluid change and annually for large and business critical systems. This should also include in-depth used oil analysis which sees a fluid sample sent to the supplier's laboratory to run tests and interpret the results .

The analysts will look at the overall condition of the fluid and for insight into the condition within the system. This is increasingly beneficial when regular samples are provided. Useful information can be extracted from a one-off sample, but established data trends of samples taken consistently from the same sampling point provide more valuable data and increases the accuracy of a diagnoses for maintenance planning purposes.

Focus on maintenance

The degradation of heat transfer fluid is inevitable but the time it takes for the fluid to deteriorate isn't. Heat transfer systems used in wood product manufacturing are designed around the properties of fresh heat transfer fluid. To ensure a safe, predictable operation, it's vital to keep the difference between the current state and what is expected from a fresh fluid within a narrow range. By investing time in regular inspections, maintenance and used fluid analysis, machine operators or mechanics will not only increase the life of heat transfer fluids and machinery, but they'll keep workers safe and also avoid costly reductions in productivity and potential downtime. Gaston Arseneault, technical services manager at Petro-Canada Lubricants.

www.lubricants.petro-canada.com