DURATHERM
Heat Transfer Fluids

FLUID MAINTENANCE AND CHANGE-OUT PROCEDURES

With literally thousands of uses for heat transfer fluids, it is nearly impossible for any heat transfer fluid manufacturer to recommend an exact oil change interval or maintenance schedule.

Each application has its own unique characteristics that can contribute to the degradation of a heat transfer fluid. As well, each heat transfer fluid will react differently in different user environments.

To give an example of the extremes, the same heat transfer fluid used in, for example a PVC extruder, may have a life cycle as short as a few months while that same fluid in a larger 'closed' system can last upwards of 10 to 15 years.

To begin we should understand the two basic ways in which a heat transfer fluid can become degraded:

Oxidative (Most Common In Open Systems)

The scientific definition of oxidative degradation is the reaction of oxygen (in air) with the fluid by a free radical mechanism to form larger molecules that end up as polymers or solids. These thicken the fluid thereby increasing its viscosity. A more viscous fluid will be more difficult to pump, have poorer heat transfer characteristics and will have an increased chance of forming coke within the system. Oxidation is also accompanied by an increase in the acidity (TAN) of the fluid.

As with most chemical reactions, oxidation occurs more rapidly as the temperature is increased. At room temperature, the reaction rate is hardly measurable. However, at elevated temperatures, the effect is exponential and can impact the fluid life in systems not utilizing oxidation-reducing measures such as nitrogen blanketing the expansion tank.

In layman's terms, oxidation occurs when hot fluid is exposed to air. Signs of fluid oxidation become evident with the formation of sludge within the system – most notably in low flow areas such as reservoirs or expansion tanks.

Thermal

Thermal degradation, or thermal cracking, is the breaking of carbon–carbon bonds in the fluid molecules by heat to form smaller fragments or free radicals. The reaction may either stop at that point – in which case smaller molecules than previously existed are formed – or the fragments may react with each other to form polymeric molecules larger than those that previously existed in the fluid. In heat transfer terminology, these two types of degradation products are known as "low boilers" and "high boilers".

If thermal degradation occurs at extremely high temperatures the effect is it not only to break carbon–carbon bonds but to also separate hydrogen atoms from carbon atoms resulting in the formation of coke. In this situation, coke will start to foul the heat transfer surfaces very quickly and the system could soon cease to operate.

The degrading effect of low boilers is a measured decrease in the flash point and viscosity of the fluid as well as an increase in the fluid's vapor pressure. High boilers on the other hand, tend to increase the viscosity of the fluid – as long as they remain in solution. However, once their solubility limit is exceeded, they begin to form solids that can foul the heat transfer surfaces as they build up over time.

In layman's terms, thermal degradation is the result of overheating the oil past its boiling point. As the fluid boils, much like water, it produces a lighter component in the form of vapors. Excessive overheating or cracking can cause reduced viscosity as well as pose safety concerns. Along with the creation of these lighter components, the overall flash point, fire point and auto ignition temperatures of the fluid will be reduced to possibly unsafe levels.

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Now that we understand how a fluid can breakdown, we can now break heat transfer systems down into two rudimentary types, open and closed.

Open Systems

An open system will have oil coming in contact with air at some point in the system; this may be at the bulk operating temperature or may be at a lower temperature. However, if the oil temperature at which it contacts air is not well below 93°C (200°F), this is considered to be an open (to atmosphere) system and it will be susceptible to oxidation. These systems tend to be smaller in nature and used in manufacturing processes in the plastic, die cast and other industries that utilize portable, electrically heated temperature control units or 'oil heaters'.

Closed Systems

A closed system will usually have an inert gas buffer – typically nitrogen – at any point where the oil may come in contact with the atmosphere/oxygen (usually in the expansion tank). These systems are typically larger in nature and will generally be heated by a gas or oil fueled boiler. This inert buffer will generally eliminate most of the concern for oxidation. Please note however that some boiler manufacturers have developed expansion tanks that through proprietary plumbing, effectively eliminate hot oil from coming in contact with the atmosphere. For all intents and purposes, these can also be considered closed systems.

Now Let's Discuss the Maintenance Aspect of Heat Transfer Fluids:

Closed Systems

As noted above, most closed systems if operated properly, should not have a major concern for fluid degradation. Typically these systems are not run above the recommended bulk or skin temperature of the fluid nor is oxidation of great concern due to the use of an inert gas blanket. However, due to factors beyond one's control such as power or pump failure or inadvertent changes to a system (partially open or closed valves, decommissioning user loops etc.), these systems can experience thermal degradation, often undetected by the user on a day-to-day basis.

The first order of maintenance for any system is to consult your fluid vendor and equipment manufacturer before making any changes to your system. A properly engineered system is built around the user's needs and the fluid itself. While most fluids are in the same range with respect to physical properties, unaccounted for changes in a system's design or function can negatively impact a fluid.

The second order of maintenance is to follow a recommended fluid analysis program to track the overall health of your fluid. Usually available as a complimentary service or for a nominal fee from your fluid vendor, a comprehensive fluid analysis program aids in the early detection of any changes to your fluid. By taking a proactive approach and making use of your fluid manufacturer's fluid analysis program, it will allow time for system corrections to be implemented (to stop the fluid degradation) and will often improve the fluid's condition.

Fluid changing in closed loop systems is usually infrequent and measured in years. However, at some point, a complete change over of the system's fluid will be necessary. This can often involve multiple steps including, in some cases, the use of a cleaning fluid and or flushing fluid.

It is always best to understand the condition of both your fluid and system prior to changing fluids regardless if you are refilling with the same fluid or switching to a different one. A fluid analysis is critical at this point as is a general inspection of the system itself, looking for leaks and, if possible, inspecting the inside of the pipes and boiler.

Changing a fluid requires multiple considerations and is best discussed with your fluid vendor prior to change. However, the most important step is to completely drain the old fluid prior to refilling. Degraded fluid will quickly contaminate new fluid so it is extremely important to remove all – at least 95% – of the previous fluid from the entire system!

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Open Systems

Open systems tend to run at temperatures well below the maximum recommended bulk temperature of a fluid. While this helps reduce the potential for thermal breakdown, open systems are still most susceptible to oxidation.

Severe oxidation can, in extreme situations, shorten a fluid life to as little as a number of hours. It is crucial to understand your system's design and how it incorporates protective features that limit the possibility of oxidation. Often equipment manufacturers use heat exchangers to cool the fluid prior to its exposure to air, or they may use bypass valves set on timers to help with venting at start up but then close them to reduce oxidation levels after a desired temperature is reached. If these systems fail to operate properly, the oil life can and most likely will be shortened.

As a fluid oxidizes it forms an acid. These acids, while generally not at corrosive levels, can build-up and eventually polymerize and drop out of the fluid in the form of heavy, grease like sludges.

Again, fluid analysis is your best maintenance tool to maintain peak efficiency. When first using a heat transfer fluid in an open system, fluids should be monitored regularly to understand how often a particular system requires fluid changes. While manufacturers of equipment can provide guidelines as to the life expectancy of a fluid, not all fluids are made equal. Simple differences in operating environments and temperatures can impact oil life. The only way to know how often your fluid should be changed is through the use of detailed fluid analysis.

Once you establish a maintenance schedule, it is important to understand how to efficiently and effectively remove all the spent fluid prior to refilling. A fluid that has degraded contains an acidic compound that when left to mix with new fluid will increase the rate of degradation of any new fluid added.

Smaller, open-type systems can have numerous areas where fluid can become trapped. Areas like heat exchangers, filter housings, horizontal piping runs, etc. should be examined for any residual fluid. Oftentimes blowing dry air or nitrogen through lines will help in removing old oil. If this is not possible, most fluid manufacturers have a light, economical flushing agent that can be used to flush out any residual fluid prior to refilling.

Maintaining your fluid change-out schedule will keep the internal components of your equipment clean and running at their maximum efficiency longer.

Neglecting maintenance schedules can be problematic and can ultimately cause a complete system failure resulting in extensive and expensive repairs.