plastiXs manufacturing solutions
Paratherm™ HEAT TRANSFER FLUIDS
A Division of Lubrizol

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Preventing Fires in Thermal Oil Heat Transfer Systems

Thermal fluids have proven exceptionally safe in a wide range of industries. However, it is difficult to completely prevent fires in these systems because the necessary ingredients for a fire — fuel, air and ignition source — are present by design. The risk of fire can be minimized by observing sound design, installation and maintenance procedures.

Causes of Fires

Leaks – These are the result of catastrophic failures of pump seals, rotary unions, flex hoses and expansion joints. Sources of ignition have included: bearings that became red hot as they seized up; an electrical panel box left open; and an open motor several floors below the leak.

Insulation Fires – These fires occur when thermal fluid leaks into porous insulating materials such as calcite, glass fiber or mineral wool. The porous material allows the fluid to migrate away from the source of the leak and disperse throughout the insulation. The aluminum cladding prevents fresh air from reacting with the hot degrading oil. But if the cladding is removed for maintenance or an opening is accidentally cut into it, the soaked insulation can spontaneously ignite.

Undetected Loss of Flow – Thermal-fluid heaters incorporate safety interlocks that are designed to shut the heat source down if there is low flow through the heater and/or excessive outlet temperature. Although rare, fires can start due to a loss of flow (caused by pump or pump-coupling failure, a malfunctioning back-pressure control valve or a plugged Y-strainer) and a failure of the safety interlocks — either due to lack of maintenance or deliberate bypassing. If these circumstances occur while the heater is energized, the temperature of the heater tubing, shell or connecting piping will increase rapidly and possibly rupture due to thermal stress. The leaking fluid will ignite as soon as it is exposed to air. If the equipment does remain intact, the vaporized fluid can discharge through the relief valve and/or back up through the expansion tank.

Cracked Tubes in Fired Heaters – Cracks can occur if there is localized overheating or hot spots causing uneven thermal expansion of the tube. Flame impingement, or carbon deposits inside the tubes that insulate a small area can also cause isolated hot spots. Thermal fluid that leaks into the combustion chamber through the resulting cracks will burn as fuel while the heater is operating. When the burner is off, however, leaking fluid can accumulate in the combustion chamber. In the most serious case, the accumulated fluid formed a large pool inside the heater during a prolonged shutdown. During start-up, the pool caught fire and destroyed the heater.

Design, Installation and Maintenance Tips

Buildings – All areas that have the potential for leaks should be adequately ventilated to prevent the buildup of ignitable vapors (think vapors from a fuel tank). Smoke around a leak is a good sign — it indicates that vapors are not accumulating. Hydraulic systems and lines should not be installed near a heater since they have the potential to spray fluid long distances. The floor area around pumps, skids and heaters should be diked to contain any significant spills.

Piping – Expansion joints should be installed so that they move axially and not sideways. Valves should be installed so that stems are slightly below horizontal to allow leaked fluid to drip away from the valve body.

Insulation – Foamed glass is recommended since it will prevent the leaked fluid from spreading out.

This impervious material should be installed around any component that has potential for leaks (valves, strainers, pressure taps). Porous insulation (such as mineral wool, fiberglass and calcite) should be used very carefully in hot-oil systems — if at all. It can be used on straight pipe runs — but be sure to leave 18" on either side of a potential leak point. Flanges should not be insulated—install metal covers if required for personnel protection.

Overflow Tank – The overflow tank should be a vented, closed-head type with a drain valve. It should be located away from exit doors and the heater control panel. Never vent the overflow tank inside the heater room.

Pump Seals – Seals should be replaced as soon as they start to leak especially if there is any chance that the leaking fluid could enter the bearing housing. Drip pans should be kept free of fluid. Any vibration or noise should investigated immediately.

Fluid Maintenance

The risk of fire can also be reduced by maintaining the thermal fluid in good condition. Badly degraded thermal fluid has less margin of error for system upsets and problems. For example, high levels of low boilers increase the system pressure and can cause relief valves to lift at a lower fluid temperature. They also produce more vapors around a leak. Oxidation can accumulate carbon sludge which reduces the effective working volume of the expansion tank. Some degradation is inevitable — the trick is to minimize it.

Low Boilers are lower-boiling-point fluid components produced when the fluid molecules "crack" apart due to excessive temperatures (greater than the maximum recommended film temperature). Fluid cracking can be induced by low flow through the heater which reduces the energy transferred to the fluid causing the tube temperature to increase. Another leading cause is flame impingement on the heater coil.

Carbon sludge is an indication that the fluid has been oxidized (continuously exposed to air while hot). The oxidized fluid produces carbon as it passes through the heater even at normal operating temperature. The carbon can plate out on the inside of the coil (fouling) and cause hot spots. Most of the carbon remains suspended in the fluid and forms sediment in low-flow areas such as the expansion tank.

Both of these conditions can be detected by testing the fluid for degradation. The important point is that if the system is already having problems, it's probably too late for testing. The best time to have the fluid tested is before problems start. Even better, have the fluid tested annually starting with year one. Trend analysis of the test results can provide a valuable troubleshooting tool to detect and correct a system problem that is causing accelerated degradation. When symptoms are already present, a single fluid test will only indicate that the fluid is badly degraded and needs to be replaced.

888-792-2223 • sales@plastixs.com • www.plastixs.com

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