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Fire Protection in Thermal Fluid Heating 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 components for a fire (*fuel, air and heat*) are present. The risk of fire can be minimized by observing sound design, installation and maintenance procedures.

Causes of Fires

Leaks- Can be the result of failures of pump seals, rotary unions, flex hoses or expansion joints. Sources of ignition have included: bearings that became hot as they seized; an electrical panel box left open; or an open motor 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 fuel through the heater and/or excessive outlet temperature. Although rare, fires can start when there is a loss of flow (*due to pump failure, malfunctioning control valves, etc.*) and a failure of the safety interlocks (*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 can 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- Localized overheating or hot spots can cause uneven thermal expansion of the tube. Hot spots can be the result of flame impingement or carbon deposits inside the tubes that insulate a small area. The fluid that leaks into the combustion chamber through the resulting crack will burn as fuel while the heater is operating. When the burner is off, however, fluid can accumulate in the combustion chamber. In the most serious case, the fluid forms a pool inside the heater during shutdown and catches fire when restarted destroying 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 (Smoke around a leak can be 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. 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- These 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. It should be installed around any component that has potential for leaks (valves, strainers, pressure taps). Porous insulation (*such as mineral wool, fiberglass and calcite*) can be used on straight pipe runs- 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 Tanks- These 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 be investigated immediately.

Fluid Maintenance (See next page for continuation)

Note: The information and recommendations in this article are made in good faith and are believed to be correct as of this date. You, the user or specifier, should independently determine the suitability and fitness of brands of heat transfer fluids (*such as Paratherm; © 2007 Paratherm Corporation, or others*) for use in your specific application.

“The Barn” built in the 1930’s to house Welsh ponies, serves as Mid-South’s offices.

Fluid Maintenance

The risk of fire can also be reduced by maintaining the thermal fluid in good condition. Degraded thermal fluid has less of a 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 produce carbon sludge which reduces the effective working volume of 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*). 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. A single fluid test will only indicate if the fluid is badly degraded and needs to be replaced.

Thermal Magnetic Circuit Breakers Vs Motor Circuit Protectors (MCP's)

By: Dileep Pargaonkar

Ignorance, as the saying goes, is bliss. In real life however, nothing could be further from the truth. For example, ignorance will invariably land us in a heap of trouble when dealing with safety matters relating to industrial electric codes and practices. Pleading ignorance in a court of law, when ignorance has been the cause of loss of property or life will prove to be a poor defense at best.

As a case in point, let us examine one of the most common violations encountered in a typical industrial facility, namely the practice using Motor Circuit Protectors (MCP's or HMCP's) instead of thermal magnetic circuit breakers in non-motor branch circuit applications.

While these devices do share some common features (<u>and unfortunately look very similar unless examined closely</u>); each is designed with a special purpose in mind.

A thermal magnetic breaker (such as Cutler Hammer/Westinghouse types, FD, HFD, FDC, etc), as the name implies, contains both a thermal element and a magnetic element. The thermal element is designed to trip the breaker to protect downstream electrical equipment from excessive heat caused by *overload* conditions. By keeping track of the current flow and the time, this element trips the breaker <u>before thermal damage can occur</u>. The magnetic element on the other hand, is designed to trip the breaker only upon the occurrence of a *short-circuit* condition when a current of a much larger magnitude flows. Unlike the thermal magnetic breaker, <u>the motor circuit protector contains only the magnetic element</u>, its only purpose being to protect a motor branch circuit from damaging *short-circuit* currents. The NEC (National Electric Code) allows the use of MCP's in motor branch circuits only when protection from thermal damage is accomplished <u>separately</u> by means of a eutectic, bi-metallic or electronic overload.

Now let us see what can happen when a Motor Circuit Protector is used in a non-motor application as the sole means of protection. Suppose a 15 amp MCP is stalled to protect a 15 amp rated heater fed by #12 AWG wire rated for 20 amps. On the surface it might seem as if the 15 amp rated MCP should be able to protect both the heater and the wire. However, since the lowest adjustable setting on the MCP is 45-amps (3*15 amps), *even at the lowest possible setting the MCP will never trip until it sees a current equal to or exceeding 45-amps.* Thus the MCP will indefinitely allow a damaging overload current far beyond the rating of the equipment it is supposed to protect. Such incidents can and often do lead to catastrophic failures, fires and consequent loss of property and life.

Compounding this issue further is the fact that unlike thermal magnetic breakers, MCP's carry no stand-alone short circuit ratings. They are rated *only when tested as part of a combination motor controller assembly.* Thus the practice of rigging together MCP's and motor starters in the field (not tested together as in an MCC) is questionable at best. An MCP installed in this fashion may prove to be inadequate to clear the available fault current; unfortunately this will become known only when it's too late.

The following quidelines should be used before installing a circuit breaker:

1. Determine the circuit breaker type based upon the application.
2. Examine the circuit breaker closely before installing.
3. In a non-motor application verify that the breaker is <u>not</u> an MCP. A thermal magnetic breaker will have clear markings identifying it as such, plus the short circuit rating will be clearly listed for the voltage at which it will be applied. The MCP will also carry clear identifying markings.
4. <u>Never apply a circuit breaker without making sure that it is adequate for the available short circuit current</u>.
5. MCP's should only be used in conjunction with motor controllers with whom they have been tested for the purpose of determining their combined short circuit ratings. The short-circuit rating of the MCP/controller combination should always exceed the available short circuit current.

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