Thermal Fluid System Safety Issues

The potential for fire should be considered in the design and operation of Thermal Fluid Systems.

I. Flash Point and Fire Point

The Flash Point and Fire Point of a thermal fluid are determined through laboratory testing of new fluid. The most common test method is the ASTM D-92 Cleveland Open Cup (C.O.C.). The cup holds a certain amount of fluid that permits a vapor space to exist directly above the liquid. During the test, a small flame is passed slowly over the fluid as the temperature of the fluid increases. The lowest temperature at which the vapor ignites is called the **Flash Point**. The temperature at which sufficient vapor is generated to support a continuous flame is the **Fire Point**. While these tests do provide data for comparison of a number of fluids, any extrapolation of these results into real life situations must recognize the 3 basic conditions required for a vapor ignition to occur:

1. **Fluid Temperature:** The fluid must be at or above the Flash or Fire Point(s) while in contact with air for any vapor combustion to occur. This situation may not always exist around leaks since the leaked fluid will cool rapidly on exposure to air.
2. **Vapor Concentration:** There must be enough vapor present to support combustion. Any dissipation of the vapor may reduce the concentration below the level required for ignition.
3. **Source of Ignition:** The source of ignition must be located within the vapor cloud. This is not common since good electrical installation practice dictates that potential ignition sources be located a distance from piping or be properly enclosed.

If any one of these three conditions is not met, then vapor ignition cannot occur.

II. Normal Leaks

Normal thermal fluid system leaks consist of fluid "seeping" out from threaded fittings, flange gaskets, mechanical seals and valve stem and pump shaft packing glands. Any droplets formed will cool rapidly on exposure to air. Extremely low volume leaks may produce a light gray smoke. This is an indication that the fluid is oxidizing immediately on exposure to air. This smoke may cause respiratory irritation if inhaled for a period of time as can any type of smoke.

There are several conditions under which "normal" leaks can present a risk of fire:

1. **Insulation Fires:** Certain types of insulation such as mineral wool, fiberglass or calcium silicate has an open or porous structure that allows fluid to wick away from the source of a leak. As the fluid disperses within the insulation, its surface area increases dramatically while its temperature remains at or close the system operating temperature. The danger is that a substantial percentage of the leaked fluid will remain unreacted within the insulation due to the limited amount of oxygen available. If the supply of oxygen is suddenly increased, the remaining fluid in the insulation will burst into flames. Prevent this situation by using non-porous insulation (such as Pittsburgh Corning Foamed Glass or equal) within several feet of areas prone to leakage such as valves, flanges, etc. If possible, flanges should be left completely uninsulated or, if necessary for personnel protection, covered with drip shields.
2. **Confined Areas:** If a low volume leak occurs within a tightly enclosed area, such as a cabinet, the available oxygen may be consumed allowing unreacted vapor to accumulate. This can be prevented by ensuring that all portions of a thermal fluid system are located in areas with adequate ventilation.

III. Catastrophic Equipment Failure

A catastrophic equipment failure may result in the rapid release of large quantities of thermal fluid. If the total system pressure is low and the fluid is operating below its atmospheric boiling point, then the leak will consist of liquid that may spray a short distance before falling to the ground. Higher system pressure may produce a finer spray that ejects a greater distance from the equipment, however, the relatively larger surface area of the droplets and their velocity will result in rapid cooling. In either case, there will be a certain amount of smoke present due to the hot fluid reacting with air.

Vapor leaks may occur if the fluid is operating above its atmospheric boiling point. Condensation of the vapor can form

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a potentially explosive airborne mist. Similar to "dust" explosions, mist explosions require that the fluid particles have a high surface area to volume ratio and of sufficient concentration to explosively ignite if exposed to a source of ignition. Only condensing vapor has proven to produce this type of particle.

Proper design, operation and maintenance of equipment are the most effective method of minimizing catastrophic failure. Any resulting fire hazards can be minimized as follows:

1. **Never operate a thermal fluid above it's boiling point:** This will eliminate the potential for mist explosions.
2. **Maintain good ventilation in the area around equipment:** This will provide rapid cooling of any leaks and will also disperse any unreacted vapors.
3. **Minimize the fuel available for a fire:** The expansion tank should be no larger than necessary and should be equipped with a low level switch to shut down the entire system. An automatic shut-off valve can be installed to isolate the expansion tank in case of a building fire.

IV. Loss of Circulation in the Heater

Severe potential for fires can exist if the thermal fluid flow is interrupted without causing the heater to shutdown. Under this no-flow condition, the temperature of the fluid inside the still energized heater increases rapidly to well above it's boiling point. Any equipment failures may result in spontaneous ignition of the leaking fluid. A high temperature cut-off switch should not be the only safety device on the heater since the loss of flow may reduce its accuracy. The most effective protection is to install a high/low pressure switch on the pump discharge or a low differential pressure switch across an orifice plate or similar type flow meter. The switch should be wired to shutdown the system immediately. Flow sensing devices that have a component immersed in the moving fluid are not recommended for use as low flow switches in thermal fluid systems since they tend to fail in the open mode.

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