Rev. 700

Fluid Degradation Problems with Improper Shutdown of Thermal Oil Systems

The performance and operating life of your heat transfer fluid can be maximized if you pay close attention to shutdown procedures. Otherwise the fluid can be overheated and "bruised," and the system itself may ultimately be damaged. Here's what happens.

Normal System Operation

During normal operation, the thermal fluid heater provides both radiant and convective heat to heater tubing located in the firebox. This heat is transmitted through the tube wall to the fluid's film layer. Because the fluid is in a turbulent state, its film layer is constantly mixing with the bulk of the fluid — and quickly transferring the heat. With the circulating pump providing high flows, the fluid quickly carries heat out to the user, and returns a little cooler to pick up more heat.

At normal operating temperatures, the heater's refractory and structural metal members may be almost as hot as the flame itself. Should the system be shut off, it would take a while for the heat stored in these materials to completely bleed off and exit the stack. Because some heaters come equipped with more refractory than others, and although firebox temperature may be the same, more time is required to bleed off the additional stored heat.

The fluid, allowed to circulate after the heater is shut down, will continue to carry these BTU's from the heater and disperse them throughout the system.

Improper Shutdown

If, however, the *entire* system goes down at once, the heater will stop firing and the pump will cease to move the fluid. Heat stored in the heater's refractory and structural metal will be released into the firebox.

With the blower off, this heat is in no rush to exit the stack. Heater tubing containing the heat transfer fluid continues to see intense heat. Standing stagnant, the fluid cannot remove this heat and starts to boil as its skin temperature exceeds the recommended limit. If you listen carefully, you can actually hear this boiling take place.

Film Boiling

Most liquid-phase heat transfer fluids have multiple boiling points. Smaller molecules generally boil at lower temperatures and the larger molecules at higher temperatures.

Although the flame is out and natural convection currents flow inside the firebox, internal temperatures can still remain hot enough to vaporize the fluid's small and mid-sized molecules. Once these molecules are boiled off, larger molecules remain. The higher the percentage of large molecules, the higher the viscosity of the heat transfer fluid.

The thicker the fluid, the less quickly it will flow through the system (or, the more horsepower will be required to achieve the same flow*). This can result in significantly reduced system performance. And, flowing less quickly, the fluid may now linger too long in contact with the heated surface, becoming further overheated and damaged.

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* *Common practice is that the pump remain in operation until the heater outlet temperature drops to 250°F or below. While acceptable, this can waste electricity—par-ticularly in well-insulated systems where cool-down can take extended periods of time. The pump need run* ***only*** *until excess heat bleeding from the refractory and structural metal members has exited the firebox. Note that it is possible to install a thermostat and relay designed to automatically shut down the circulating pump when a predetermined temperature is reached.*

We suggest you have the heater manufacturer specify how much pump run-time is required to exhaust excess stored heat in your type of heater. In some heaters with minimum amounts of refractory, good air circulation and good stack draw, the period may be as short as 30 to 60 minutes.

If the thermostat and relay are used, the heater manufacturer should advise the location of the sensor and temperature set points for the thermostat.

CAUTION: *Even in systems operating at or near 250°F, the pump should* ***still*** *be allowed to run until stored heat escapes. Otherwise, fluid damage can occur.*

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When flow is substantially reduced, the fluid's film layer can quickly reach excessively high temperatures. This may cause the fluid to degrade, resulting in a system fouled with sludge and hard baked-on carbon deposits.

Shutdown Procedures

When shutting the system down, turn the heater off but keep the circulating pump running. The objective is to allow heat stored in refractory and structural metal to exit the firebox. You may want to monitor stack temperature and heater outlet temperature. When the heater outlet temperature has decreased to 250°F or lower, it is normally safe to shut the pump down.*

You may want to keep the heater blower running if possible. By forcing cool air into the firebox, heat can be more quickly pushed out the stack.

Power Failures

Power failures will occasionally happen. If emergency power is available, we suggest you consider tieing in the system's circulating pump and blower. The cost of replacing heat transfer fluid and the associated downtime can dwarf the cost of an emergency power hook-up.

(888)-792-2223 • E-mail: sales@plastixs.com • Web: www.plastixs.com

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