Fluid Hacks

Tips to Optimize Your Thermal Fluid Operations

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A collection of tips and practical guidelines from industry experts on thermal fluids and related operations...summarized advice intended to take the guesswork out of dealing with heat transfer fluids and to improve the overall user experience. For more detailed information on these *Fluid Hacks* and other heat transfer fluid related tips, subscribe to TipSheet, Paratherm's monthly technical email series.

Leaking Systems: Control the Drips, Prevent the Gushes

The quickest way to detect a leak: SMOKE. When hot thermal fluid is exposed to oxygen in small quantities (like a slow leak), the fluid will immediately oxidize and produce smoke. The amount of smoke depends on the size of the leak, the temperature of the fluid and to some extent the airflow in the area.

Small leaks can produce an exaggerated amount of smoke because there isn't enough fluid to form a drop. This steady weeping smokes and then cooks onto the metal near the leak.

With larger leaks, the fluid usually cools quickly as it drips or sprays into the air. This cooling reduces the vaporization of fluid which helps lessen the amount of smoke. However, if the leak is large enough that it uses up all the fresh air — or if ventilation is insufficient — vapor can accumulate and cause a potential fire hazard.

Minimizing leaks starts with running a tight system; pun intended. As fluid temperatures cycle over time, system elements will naturally expand and contract, loosening fittings. Flanges are the most common source of leaks. Re-torque flanges on a periodic maintenance interval to decrease leak potential. Threaded fittings should be kept to a minimum; when used they should be reinforced with fluorocarbon thread sealant or Teflon tape and tightened down.

Avoid major fluid discharges by ensuring that:

- All drain valves are closed before adding fluid to the system
- All block valves are closed before opening a line

- Pressure valves are installed in areas where they are not exposed to "accidental forced removal" from the likes of heavy equipment. Isolating valves should be installed just in case
- Leaking pump seals are to be replaced before they flush out the bearing grease
- Expansion tank levels are checked before startup to prevent overflow from the vent
- Proper procedures are followed to remove any accumulated water from the system

Say No to H_2O

Unless you are purposely using an aqueous based heat transfer fluid (glycol/brine), you want to avoid water in your thermal system at all costs. This isnt as easy as you would think; water eventually shows up in more systems than not and the source is often a mystery to the system operators. It doesn't take a high volume of water to create serious problems; a commonly used visual example is that it only takes a 12oz can of water to generate a 55-gallon drum equivalent of volume displacement in saturated steam. Once it finds its way into your system, the dedicated removal process will make you wish you would have read this section in its entirety the first time...

Maintain a "hydrophobic" thermal fluid system by following these minimal precautions:

- Never "hydro-test" a new system with water!
- Do not store drums of fluid outside where water can collect in the drum head. The expansion/contraction of the fluid with temperature changes can pull water in through the bungs. If storing drums outside is unavoidable, they should be laid on their sides.
- Ensure that the transfer pump used to charge fluid into the system is 100% dedicated to the thermal fluid only. Keep the pump away from anyone that is likely to "borrow" it for other purposes and clearly label the pump to identify its purpose.
- If your system is vented and located in a humid environment, give some serious thought to installing a nitrogen blanket on the expansion tank. If the tank temperature drops below the dewpoint, condensation will form on the outside and the inside of a vented expansion tank

Maintaining Control Under Pressure (Gauges)

Maintaining your thermal fluid system's design flow rate is critical for system performance. Quantitative output can be provided by flowmeters, but for a simpler and less costly method of tuning a system, users should consider the installation of pressure gauges.

While pressure gauges don't provide the data for actual flow calculations, they can track valuable information for troubleshooting. For example, should a Y-strainer become blocked, a compound pressure/vacuum gauge installed on the pump suction will identify it before it becomes a major problem. Similarly, a malfunctioning control valve can be readily detected by pressure gauges installed on the inlet and outlet lines of a heat user.

Suggested pressure gauge locations:

- Inlet and Outlet of the heater
- End of the supply header, beginning of the return header
- Pump suction and discharge
- Before and after every heat user (between the control valve & the user)

DANGER! Flash Point!

Slow down!! Take some time to fully understand the purpose of this property and its relevance to HTF operations before you jump up and pull that fire alarm. Systems regularly operate at temperatures well above the defined fluid flash point; in fact it is more common than not. The reason is that the factors that ultimately contribute to the determination of the flash point are never likely to occur in a properly designed thermal fluid system.

Flashpoint is defined as the exact temperature at which a fluid generates a high enough concentration of *vapor* to be ignited when put in direct contact with an *ignition source* in the presence of *fresh oxygen*. Three key elements are at play here: Concentrated thermal fluid vapor, an ignition source (flame, spark, red hot metal), and fresh oxygen. Keep in mind that the tests used to measure flash point (ie ASTM D92, D93) are performed in a controlled laboratory environment designed to specifically to achieve ignition. Thermal fluid systems are designed to avoid it.

In practice, closed-loop heat transfer fluid systems separate the heated fluid from oxygen and any potential ignition sources throughout the entire process. What about leaking fluid outside of the system? Doesn't a processing environment inherently have a variety of potential ignition sources? The fired heater perhaps? See the previous *Fluid Hack* that talks about leaks and consider the fact that the accumulation of concentrated fluid vapor outside of the loop (where the oxygen source is) is not likely to occur in a properly ventilated environment. Even so, fluid vapor that leaks out at that temperature level will likely oxidize and immediately turn into non-combustible smoke.

Basically, it would take a series of significant failures to result in a fluid ignition; say a cracked heater tube that sprays fluid into the flame or a violent discharge of fluid out of the expansion tank directly into the heater exhaust stack. At that point, the flashpoint gets thrown out of the window...any standard fluid will ignite under those catastrophic conditions. So leave the flashpoint worries to the warehouse managers and shipping coordinators and direct your focus on selecting a fluid with properties that have a relevant impact on your operation.

Time to Change Fluids?

Draining Systems — Before draining your system, have the fluid analyzed by the manufacturer to determine if flushing or cleaning is actually necessary. If it is, you'll get more of the crud out by keeping the fluid as hot as possible (200ºF — 210ºF) while draining. Also, run the pump until cavitation occurs…this keeps system contaminants from settling out.

Charging Systems — Throttle the block valve on the main pump discharge for cold circulation (or cycle a gear pump on and off) to prevent pump damage. Add fluid when the pump cavitates and slowly increase the flow rate until the entire system is full. Make sure you fill all the loops.

Heater Startup — Increase the system temperature slowly to between 210ºF and 250ºF. Pump cavitation and expansion tank "geysers" mean there is water in the system. The only way to completely remove water is to flash it to the atmosphere. System is dry when pump is stable at suction temperature of 230ºF.

Fluid Hacks: At a Glance

Charging a System:

Avoid filling systems from the top-down (ie from the expansion tank) as you will effectively trap air into the loop resulting in troublesome pressure fluctuations & pump cavitation. Removing air from the system is a painstaking process. Instead, fill the system from the lowest convenient point to push the air up and out of the system in its natural progression. Open all high point vents/valves and close as the fluid reaches each point.

Removing Water:

Avoid flashing moisture off into concentrated steam by controlling the temperature rise slowly to just above the boiling point of water (target around 230ºF at standard atmospheric pressure). Open the warm-up or boil-out valve on the bypass leg to the expansion tank. This will allow hot fluid to flow directly into the tank and raise tank headspace temperature. As water boils, steam will escape through the vented expansion tank. Continue until no further visual evidence of steam and CLOSE THE WARM UP VALVE!

Prevent Rapid Degradation:

- Never operate above the maximum fluid operating temperature
- Maintain designed fluid flow rates through the heater
- Monitor differential pressure through the heater and low level switch in the expansion tank
- Never operate with the "warm-up" or "boil-out" valve open to allow for hot fluid flow directly into the expansion tank, unless you are actively removing water. Keep this valve CLOSED under normal operating conditions
- Install a low pressure inert gas blanket to displace air in the headspace of the expansion tank. Nitrogen is most common.
- Follow proper start-up and shut-down procedures