CHEMICAL ENGINEERING
FACTS AT YOUR FINGERTIPS
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Heat Transfer Fluids and Systems

STARTUP

1. Verify control and safety systems: It is vitally important to verify all control and safety systems are calibrated and ready for operation and are functioning properly
2. Check for leakage
3. Remove moisture from the system, using dry, compressed air or other suitable means. Fill the system with heat transfer fluid
4. System filling
   a. Fill the system to desired level avoiding any unnecessary aeration of the fluid
   b. Open all valves, then start the main circulation pump in accordance with the manufacturer's recommendations. Allow for thermal expansion of fluid in determining the cold charge level
   c. Circulate the heat transfer fluid through the system for about 3 to 4 hours to eliminate air pockets, and to assure complete system fill before firing the heater
5. Start the heater
   a. Bring the system up to temperature slowly to help prevent thermal shock to heater tubes, tube/heater joints and refractory materials; and allow operators to check the functioning of instruments and controls. The slow heat-up will also allow moisture trapped in all sections of the system to escape as vapor. Inert gas should sweep the expansion tank to remove noncondensables and residual moisture to a safe location. Hold the temperature stable above 100 °C (212 °F) until no signs of moisture remain (knocking or rattling of pipes, no moisture from vents, and so on)
   b. Bring the system to operating temperature, put the "users" online, and place the expansion-tank inerting system into operation
   c. The fluid should generally be analyzed within 24 h of plant startup and annually thereafter
   d. Check and clean startup strainers as needed

The system should be heated and cooled for at least two cycles with the filter in place since the resulting expansion and contraction will loosen mill scale. Reinsulate any surfaces left bare for leak-checking purposes.

OPERATIONS

Heaters: Proper fluid-heater operation will help ensure long life of the fluid. Common heater problems include flame impingement, excessive heat flux, control overshoot, low fluid flow, and interlock malfunctions.

Piping and pumps: A leak-free system will help to ensure safe and reliable operation. Some key features of a leak-free design are as follows:

- Maintain valves and pump packing and seals
- Avoid the use of threaded fittings (welded or flanged connections are preferred)
- Realign pumps and retorque flanges once system achieves operating temperature after initial system startup
- Confirm with your fluid supplier what the proper elastomers are. Not all elastomers are compatible with all heat transfer fluids

FLUID ANALYSIS

Fluid testing helps detect system malfunction, fluid contamination, moisture, thermal degradation, as well as other factors that impact system performance (see Table). For systems operating near the fluid's maximum temperature, annual analysis is suggested.

Test result	Potential effects	Possible cause	Possible actions*
Viscosity increase	Poor heat-transfer rate, deposits, high vapor pressure, pump cavitation	• Contamination • Thermal degradation • Fluid oxidation	4, 5 4, 5 3, 4
Total acid number increase	System corrosion, deposits	• Severe oxidation • Acidic contamination	3, 4 4, 5
Moisture increase	Corrosion, excess system pressure, pump cavitation, mechanical knocking	• System leaks • Residual moisture in new or cleaned unit • Unprotected vent or storage	2 2 2, 3
Insoluble solids increase	Poor heat transfer, wear of pump seals, plugging in narrow passages	• Contamination • Dirt • Corrosion • Oxidation • Thermal stress	1, 4, 5 1, 4 1, 3, 5 1, 3 1, 4
Low- and high-boiler increase**	Pump cavitation, poor heat transfer, excess system pressure, deposits	• Low boilers • High boilers • Contamination	2 4 4, 5

* For detailed guidance on actions, please consult with your fluid engineering specialist.
** For an excellent discussion on low and high boilers, please consult Ref. [4].

Possible actions

1. ***Filtration:*** Small diameter particles suspended in heat transfer fluid can be effectively removed via filtration. Filters with 100-μm or less nominal-particle-removal ratings should be considered for initial system treatment. Continuous filtration through 10-μm rated filters can maintain system cleanliness
2. ***Venting:*** If low boiler concentration and/or moisture is allowed to reach excessive levels in the fluid, problems such as pump cavitation, increased system pressure and flash-point depression can occur. Intermittent, controlled venting to a safe location is a common solution to minimize the potential for problems caused by excessive low boiler or moisture concentration
3. ***Inerting:*** An effective method of minimizing fluid oxidation is to blanket the expansion tank with a clean, dry, inert gas, such as nitrogen, CO_2, or natural gas
4. ***Dilution/replacement:*** Can be used to remove some fraction (or all) of the fluid and replace with virgin fluid to maintain fluid properties within normal ranges. Caution is advised when using reclaimed fluid, which can return degradation products and/or contaminants into the system
5. ***Cleaning:*** If a system flush is necessary, several different methods are available. Specialty-engineered, heat-transfer flush fluids may be used to remove sludge or tar from piping/equipment. Hard carbon deposits on heater surfaces ("coke") generally require the use of mechanical cleaning techniques like sand or bead blasting, wire brushing, or high-pressure water jetting. For process contamination, consult with your fluid supplier for suggested cleaning methods

SHUTDOWN

Prevent overheating of fluid due to residual heat in the heater.

1. Shut off burner completely with the circulating pump still operating. Continue to run the pump at full capacity to dissipate residual heat in the heater
2. When the heater has cooled to the manufacturer's recommended low temperature, shut off the circulating pump and switch off required heater electrical controls
3. Caution must be exercised during shutdown to ensure that no area in the system piping is totally and completely isolated. This will prevent a vacuum from forming, which could damage (implode) equipment
4. Operate heat tracing, if needed

References and further reading

1. Gamble, C.E., Cost Management in Heat Transfer Systems, *Chem. Eng. Prog.*, July 2006 pp. 22–26.
2. Gamble, C.E., Cleaning Organic Heat Transfer Fluid Systems, *Process Heating*, Oct. 2002.
3. Beain, others, Properly Clean Out Your Organic Heat Transfer Fluid System, *Chem. Eng. Prog.*, May 2001.
4. Spurlin, others, Defining Thermal Stability, *Process Heating*, Nov. 2000.
5. "Liquid Phase Design Guide," Pub #7239128C, Solutia, Inc., 1999.