Technical Information Bulletin

1

Cleaning organic heat transfer fluid systems

Heat transfer fluids will provide long and trouble-free service in properly designed and operated systems. However, less-than-ideal operating conditions can result in degradation of the heat transfer fluid, formation of solids, and even deposits on heat transfer surfaces. This bulletin will assist the operator in cleaning a heat transfer fluid system and restoring performance.

Consequences of contamination

Well-designed and efficiently operated heat transfer fluid systems are among the safest, most reliable, and most cost-effective heating designs possible. However, allowing the heat transfer fluid to become heavily contaminated or severely degraded can result in:

- Reduced heat transfer rates
- Diminished fuel efficiency
- Flow blockages in small-diameter or low-velocity areas
- Extended start-up times at low temperatures
- Fouling of heat transfer surfaces
- Overheating and damage, or even complete failure, of heater tubes

Contaminants and their sources

Combinations of the following four mechanisms are generally responsible for causing fouling in heat transfer fluid systems.

Rust, dirt, and pipe scale: Rust and dirt are the most common sources of solids in heat transfer fluid systems. Ordinarily, they infiltrate the system during construction or maintenance.

Oxidation: By far the most common source of contamination is oxidation of the heat transfer fluid. Small amounts of oxidation are rarely a problem; however, excessive oxidation can create solids and high-viscosity compounds which impair system effectiveness.

Thermal degradation: The thermal degradation rate of any organic thermal liquid is a function of fluid chemistry, system operating temperature, and time. Products of degradation can include higher-molecular-weight compounds and even solids (coke). Carbon formation and buildup can occur when metal surfaces reach excessive temperatures.

Process contamination: Though less common than oxidation or thermal degradation, process contamination can be a major problem in heat transfer fluid systems. Solids, sludges, decomposition products, and reaction products are possible.

Cleaning techniques

The following information is presented as a general guide to the user. Many factors should be considered when developing a cleaning procedure for your heat transfer fluid system, and this general procedure is not intended to cover all situations. Consult with your Eastman technical specialist when developing a cleaning program for your specific situation.

If your system has problems with	Consider these cleaning techniques
Solids	Small-diameter particles suspended in heat transfer fluid can be effectively removed via filtration. Solids adhered to surfaces or deposited in low-velocity areas cannot be removed until they are presented to the filter. Glass fiber string-wound cartridges are commonly used and highly effective for this application. Proper filter sizing will consider the solids concentration and required flow rates. Filter housing construction must be adequate for expected temperatures and pressures. For high concentrations of solids, bag filters or other high-surface-area designs can be employed. Filters with nominal particle-removal ratings of 100 micron or less should be considered for initial system treatment. Continuous filtration through 10-micron-rated filters will maintain system cleanliness. **See Technical Information Bulletin #3, Therminol and Marlotherm heat transfer fluid filtration: how and why.**

If your system has problems with	Consider these cleaning techniques
Sludge, high-viscosity fluid, or residues	Eastman Therminol® FF flushing fluid was specifically developed for this application and is highly effective in flushing sludge, fluid residues, degradation products, and other deposits prior to installation of new heat transfer fluid. ***Drain the system*** Bring the fluid temperature to 200°F (93°C) and shut down the heater. Continue operating the circulating pumps as long as possible to keep loose solids and sludge in suspension. Drain the system through all low-point drains. **Caution must be taken to avoid contact with hot fluid and piping.** In areas where gravity draining is not sufficient or possible (e.g., heater coils), compressed nitrogen may be effective in blowing additional fluid from the system. It is important to remove as much of the degraded heat transfer fluid as possible to maximize the effectiveness of Therminol FF in cleaning interior system surfaces. Fluid removed from the system must be stored, handled, and disposed of in accordance with applicable regulations. Consult the SDS and your environmental, safety, and health professionals' guidance. In many cases, used heat transfer fluids may be returned to Eastman. Contact your heat transfer fluids representative for more information. If not already present, install a fine-mesh strainer in the system return line to the main circulating pumps. ***Flush the system*** Fill the system with Therminol FF to a proper operating level,[1] including the expansion tank where solids tend to deposit. Filling from low points is suggested. Circulate the entire system at ambient conditions to thoroughly mix the Therminol FF with residual heat transfer fluid. Check the return-line strainer periodically for plugging from solids which may have been dispersed from fouled areas of the system. For larger systems, less Therminol FF may be used by cleaning system subsections one at a time. Gradually, heat the circulating Therminol FF to about 225°F (107°C) and, using your standard operating procedures, vent any moisture that may have entered the system. When all the moisture has been vented, raise the temperature of the circulating fluid to about 350°F (177°C) to maximize the solvent characteristics of the Therminol FF. Maintain full circulation of the entire system for 16 to 24 hours at 350°F (177°C). Cool the fluid to 200°F (93°C) and repeat the draining procedure. **Caution must be taken to avoid contact with hot fluid and piping.** Remove as much of the Therminol FF and used fluid mixture as possible. Therminol FF that is removed from the system must be stored, handled, and disposed of in accordance with applicable regulations. Consult the SDS and your environmental, safety, and health professionals' guidance. In many cases, used Therminol FF can be returned to Eastman. Contact your heat transfer fluids representative for more information. ***Inspection after cleaning*** Once the system has been completely drained, visually inspect the system in the areas of low fluid velocity to check for solids which may have fallen out of suspension. Remove any solids discovered. ***Heat transfer system start-up after cleaning*** Install new side-stream filter cartridges and place the filter in operation. If the system does not have a side-stream filter to continuously remove solids during normal operation, installation of one should be considered prior to installation of new heat transfer fluid. Refill the system with new heat transfer fluid, and start up following proper start-up procedures. Care should be taken to vent any moisture which may have entered the system during flushing, draining, or refilling. Small amounts of Therminol FF should not have an adverse effect on the operation or service life of the new fluid.

[1] *Typical volume expansion of Therminol FF from ambient to 350°F (177°C) is approximately 10% to 12%.*

If your system has problems with	Consider these cleaning techniques
Sludge, high-viscosity fluid, or residues *(continued)*	***Compatibility of system components and new fluids with Therminol FF*** Mechanical components in most high-temperature heating systems which use organic heat transfer fluids are generally compatible with Therminol FF. This includes piping, flanges, gaskets, pumps, valves and valve packing, filters, and insulation. Small amounts of Therminol FF remaining in the system will not have an adverse effect on the operation or the service life of the new heat transfer fluid. Therminol FF is not recommended for use in vapor phase heat transfer fluid systems.
	Chemical cleaning of heat transfer fluid systems Chemical cleaning can be an alternative to the Therminol FF procedures presented previously. Chemical cleaning is generally more costly and requires significantly more time to return a system to operation, and several steps are necessary to ensure effectiveness. System owners are typically responsible for waste disposal. Multiple flushes after cleaning will generate significantly more waste. If chemical cleaning techniques are to be employed, consult your heat transfer fluids representative and a chemical cleaning supplier about detailed plans and procedures. A general outline of the process follows: • Drain heat transfer fluid from system • Solvent flush circulation • Drain solvent flush • Acidic solution circulation • Flush with water • Caustic and detergent solution circulation • Flush with water • Dry thoroughly
Process contamination	Removal of process contamination from heat transfer fluid systems must be treated on a case-by-case basis. Degradation products of the process contaminant as well as the possibility for reaction products with the heat transfer fluid must be considered. Consult your heat transfer fluids representative in the event of a process contamination.
Hard coke	When the system has been severely fouled by hard coke deposits, removing the highly inert carbon layer generally requires the use of mechanical cleaning techniques, such as sand- or bead-blasting, wire brushing, or high-pressure water jetting. To maximize the effectiveness of mechanical cleaning techniques, the procedure for cleaning with Therminol FF should be employed first. This will remove loose solids and sludge. Severely overheating a heat transfer fluid can result in hard coking of heating surfaces. High-temperature steam-air decoking of fired heaters has been reported to be effective when properly controlled.

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