Technical information bulletin

3

Therminol heat transfer fluid filtration: how and why

Indirect heating of processes by organic thermal liquid fluids, such as Eastman Therminol® heat transfer fluids, generally offers highly reliable, low-maintenance operation. Occasionally, the Therminol heat transfer fluid can become contaminated by dirt infiltrating the system, resulting in the formation of sludge particles. This contamination can cause operational problems. The solid particulates can cause circulation pump shaft seal leakage, valve stem wear, plugging of flow passages and, on occasion, fouling of heat exchange surfaces. Contaminated fluid can sometimes be cleaned by in-system side-stream filtration. For seriously fouled systems requiring more extensive cleaning, the heat transfer fluid can sometimes be cold filtered outside of the system. Systems may be protected from solids problems by the installation of filtration equipment before start up.

What is the dirt?

It can be a variety of materials, such as construction site debris left in the system, mill scale that dislodges from the system piping during operation, or products of the reaction of heat transfer fluid with oxidizing agents (i.e., air, acids and process leaks to the heat transfer fluid). Contaminants can also form insoluble products with metals in the heat transfer system, i.e., rust or metal oxides. Some heat transfer fluids, when operated over their maximum use temperature limit, will form insoluble solids naturally.

What filters are used?

Experience shows that glass fiber-wound filter cartridges are generally the most satisfactory for in-system filtration, since they can withstand system temperatures of 750°F (400°C), have excellent dirt-holding capacity and are economical and disposable filter elements. Other filters made of metal can operate at these temperatures but are difficult to clean and usually expensive. Earth filtration is not effective at high temperatures and should be backed up by a mechanical filter.

The glass fiber-wound element size is generally 2.5 in. (6.4 cm) in diameter with 10-in. (25-cm) incremental lengths. The glass fiber is wound around a perforated metal tube with the closeness of the fibers and the fiber size determining the particle size removal capability of the element. The filtration is accomplished by the heat transfer fluid flowing radially inward past the overlapping glass fibers and out one end of the metal tube. The filter cartridges are fixed in the filter housing by a variety of end fixtures. The filter housing should be capable of high-temperature operation. To help assure safe operation, the housing should meet local and national codes for the maximum heat transfer fluid temperature and the maximum system pressures expected in the heat transfer system. Many filter housings use O-ring elastomer seals that are not safe for high-temperature operation because they can lose strength and, in some cases, partially dissolve in the heat transfer fluid. The seal should be made of a reinforced, flexible graphite flat gasket in a captured gland to help prevent fluid sprays in case of gasket failure. Spiral-wound gaskets are a good choice for the filter housing. If springs are used to fix the filter cartridges in the housing, they should be made of materials which do not have much spring rate reduction at the maximum operating temperature. For use in Therminol heat transfer fluid systems, carbon-steel housings are adequate for operation below 750°F (400°C). There are glass-wound filter element suppliers in most regions of the world.

If the choice is made to filter the heat transfer fluid at ambient temperature, a large variety of filter media and filter types can be employed along with low-temperature filter housings. For Therminol fluid filters, media made of polyester, nylon and cellulose fibers are generally compatible at ambient temperatures. The filter manufacturer should be consulted to determine the filter compatibility with Therminol heat transfer fluids and other heat transfer fluids.

Filter installation and operation

For the *in situ* high-temperature operation, the glass fiber-wound filters can be placed anywhere there is a pressure drop between 20–40 psi (1.4–2.8 kg/cm^2). The maximum flow rate through the filters should be no more than 1% of the main flow rate in the system and generally should not exceed 5 GPM (18 L/min) per 10 in. (25 cm) of cartridge length (see Figure 1). At the desired flow, the initial pressure drop through the filter should be 1 to 2 psi (0.07 to 0.14 kg/cm^2). Under these conditions, one or more heat transfer system volumes should pass through the filter each day. To help protect the filter from excessive pressure drop, a bypass pressure relief valve should be set at 25–40 psi (1.8–2.1 kg/cm^2). If there is a possibility of backflow through the filter, a check valve should be installed to help prevent filter rupture. High-temperature gaskets made of reinforced flexible graphite or spiral-wound gaskets should be used to seal the filter housing cover. Elastomer O-ring seals are generally not stable enough for high-temperature use, but with improving technology, your seal manufacturer should be consulted, especially for use temperatures below 400°F (204°C). As is good practice in the rest of the system, the filter piping should use welded construction to reduce leakage. The filter housing can be insulated, but the insulation should be of a type that will not absorb heat transfer fluid (e.g., cellular glass). The filter house should be placed in a convenient-to-service location.

During operation, the pressure drop or flow rate through the filter should be checked and adjusted daily to determine if the cartridges need changing. If the pressure rise across the filters is gradual, it often will hold more solids before plugging. Hard solid particulates build a coating which can cover the string-wound texture of the filter, giving a glossy surface when wet. The used filters should be disposed of in an environmentally acceptable manner.

Sizing the filter

The fluid analysis program (see TF-38, technical information bulletin No. 2) determines the insoluble solids particle-size level above 1 micron for used fluid samples. The insoluble solids level is determined by laboratory filtration through a 1-micron membrane filter with the solids on the filter being washed with acetone or pentane. These particles, which are larger than 1 micron, are responsible for the vast majority of heat transfer system problems. The units used to express the insoluble solids level are milligrams per 100 milliliters of filtered fluid or parts per million (ppm). Assuming the heat transfer fluid and insolubles have a density of 1 gram per milliliter, 1 mg/100 mL is equal to 10 ppm. The filters can generally capture between 40,000 and 100,000 milligrams of solids per 10 in. (25 cm) of filter length. Conservatively assuming the dirt-holding capacity of the filters to be only 40,000 mg per 10 in. (25 cm) of filter element length, the number of 10-in. (25-cm) filter elements needed to clean up a system above the 1-micron nominal particle-removal rating of a glass string-wound filter usually can be determined through the following formula:

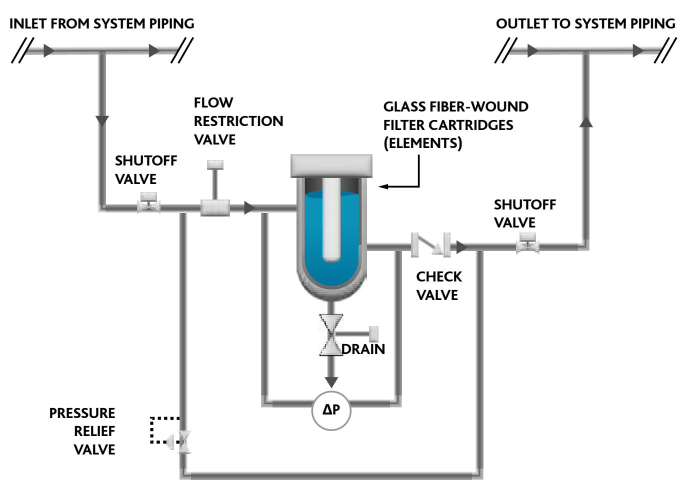
N = 0.00025 (V) (IS)

Where N = number of 10-in. (25-cm) filter element segments

V = heat transfer system volume (liters)

IS = insoluble solids (mg/100 mL)

Figure 1. Filter in side-stream operation



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While 1-micron filters could be used initially, there is always a danger of filter blinding or surface compaction. The better technique is to use a combination of nominal particle-removing elements starting out with coarse filtration, i.e., 50–100 micron elements, and working down to 1–10 micron element levels. The filter element change-out frequency needs to be balanced against the filter housing size, and the filter suppliers should be consulted on the filter housing sizing. Sometimes, depending on the nature of the insoluble solids and their concentration in the heat transfer system, the best cleanup method is disposal of the heat transfer fluid and total system cleaning (see TF-37, technical information bulletin No. 1, Cleaning organic heat transfer fluid systems). After the cleanup, a 5-micron filtration should be kept in the system permanently for continuous cleanup and as a diagnostic element to help detect any future contamination, should it occur.

Note:

- The side-stream filtration should be less than 1% of the primary system flow rate and should not exceed 5 GPM (18 L/min) per 10 in. (25 cm) of cartridge length.
- Use the restriction valve to set the initial pressure drop through the filter between 1 and 2 psi (0.07–0.14 kg/cm^2). A 20–40 psi (1.8–2.8 kg/cm^2) pressure drop should be available for filtration.
- The pressure relief valve is used when the differential pressure across the filter can exceed 50 psi.
- The check valve is needed when there is a possibility of back flow through the filter.

Total Lifecycle Care™ program

With more than 60 years of expertise, Eastman offers industry-leading support through Total Lifecycle Care. This comprehensive program provides help from start-up through a system's life cycle. This ensures optimal performance and reliability. We help our customers reduce downtime, maximize fluid efficiency and life and enhance productivity.

Through Total Lifecycle Care, we are creating a future in which technology, expertise and care unite to ensure your systems run smoothly, maximizing productivity and driving success.

FLUID GENIUS™

In-service heat transfer fluid sample analysis — Eastman provides comprehensive testing services to extend heat transfer fluid life and ensure system performance by detecting contamination, moisture and degradation through key tests like acid number, viscosity, insoluble solids and moisture content.

Fluid Genius is a web-based portal and sampling service that simplifies fluid sample management by providing expert analysis, fluid condition monitoring, life-span prediction, early maintenance alerts, technical support and access to a comprehensive knowledge base. Learn more at fluidgenius.net.

Expert global assistance — Get direct access to experienced technical service specialists who can help answer questions regarding heat transfer fluid selection, system start-ups, system design and operational issues.

System design support — Eastman collaborates with leading manufacturers to provide expert support in heat transfer system design, performance, fluid selection and compliance. We offer seminars, technical visits and on-site audits to improve system reliability and efficiency.

Operational and safety training — Eastman's customized training programs improve expertise in fluid selection and heat transfer system operation for technicians, supervisors, maintenance staff and engineers through core and specialized sessions to enhance design and safety and reduce costs.

Safety awareness training — Eastman provides safety training that focuses on system design, start-up, operation and maintenance. This training equips teams with the knowledge to maintain and operate systems as well as safely and effectively handle heat transfer fluid.

Start-up assistance — Eastman reviews start-up procedures and offers suggestions to reduce typical problems. Customers can also get help by calling their local Eastman technical specialist or through on-site assistance. This extends to regulatory compliance. Our industry expertise in safe fluid usage ensures companies stay in line with environmental and safety regulations.

Flushing fluid and fluid refill — Therminol FF flushing fluid is specially formulated to clean liquid-phase heat transfer systems. After flushing with Therminol® FF, refill the system with the appropriate Therminol heat transfer fluid to ensure optimal performance. Contact your local Eastman technical specialist to learn more and get expert guidance.

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