THERMINOL® 3

Heat Transfer Fluid by **Solutia**

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THERMINOL® HEAT TRANSFER FLUID FILTRATION: HOW AND WHY

Indirect heating of processes by organic thermal liquid fluids, such as Therminol® heat transfer fluids, offer highly reliable operation, and the heat transfer systems are generally treated as low-maintenance utilities. Occasionally the Therminol heat transfer fluid can become contaminated, resulting in the formation of sludge particles, or other sources of dirt can infiltrate the system. This contamination can cause operational problems. The solid particulates can cause circulation pump shaft seal leakage problems, valve stem wear, plugging of flow passages and sometimes fouling of heat exchange surfaces. After contamination, the 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. Filtration also may help protect the system from solids problems by installation before start up.

What Is the Dirt?

It can be a variety of materials, such as construction site debris left in the system, millscale that dislodges from the system piping during operation and reaction products of the 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, metal oxides. Some heat transfer fluids, when operated slightly over their maximum use temperature limit, will form insoluble solids naturally.

What Filters Are Used?

For in-system filtration, experience shows that glass fiber-wound filter cartridges are generally the most satisfactory, 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 have the temperature capability but are difficult to clean and are usually expensive. Earth filtration is not effective at high temperatures and should be backed up by a mechanical filtration.

The glass fiber-wound element size is generally 2.5 in. (6.4 cm) 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 of 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 which 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 the 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 below 750°F (400°C) operation. The major manufacturers of glass-wound filter elements are in the attached listing with the major distributors outside of the USA. In many countries, there are local manufacturers of these filter elements.

If the decision is 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 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 and 40 psi (1.4 to 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 liter/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 (.07 to .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 to 40 psi (1.8 to 2.1 kg/cm^2). If there is a possibility of back flow 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 be 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 TIB 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, larger than one 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 in 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 one-micron nominal particle removal rating of a glass string-wound filter usually can be determined through the following formula:

$$\mathbf{N = 0.00025\ (V)\ (IS)}$$

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

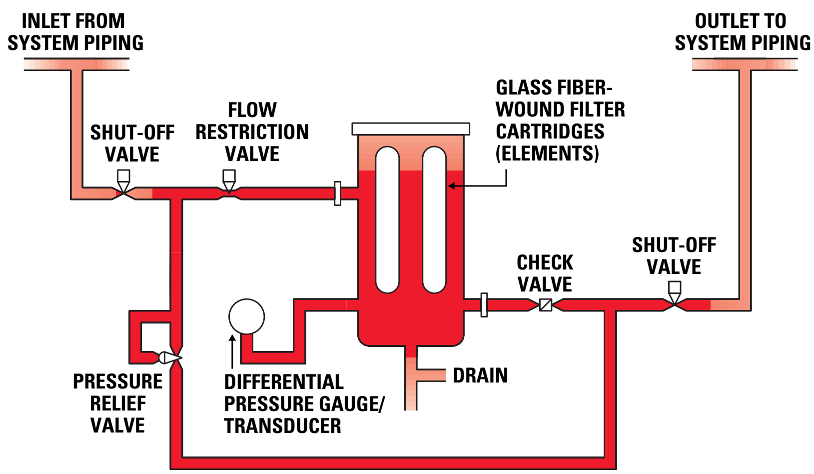
V = heat transfer system volume (liters)

IS = insoluble solids (mg/100 ml)

While one-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 to 100 micron elements and working down to 1 to 10 micron element levels. The filter element changeout 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 level in the heat transfer system, the best clean-up method is disposal of the heat transfer fluid and total system cleaning (see TIB No. 1). After the clean-up, a 5-micron filtration should be kept in the system permanently as a continuous clean-up and a diagnostic element to help detect any future contamination, should it occur.

Figure 1

Filter in Side Stream Operation



Notes:

- The side stream filtration should be less than 1% of the primary system flow rate and should not exceed 5 GPM (18 liter/min) per 10 in. (25 cm) 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 to 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.

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