

Hot-Oil Process Systems:

Preventive & Diagnostic Maintenance

The condition of fluids can reveal important details about the health of the process itself, and that of the components of the system—and their interoperation.

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HEAT TRANSFER FLUIDS

THERMAL FLUIDS

THE LIFE BLOOD OF THE SYSTEM

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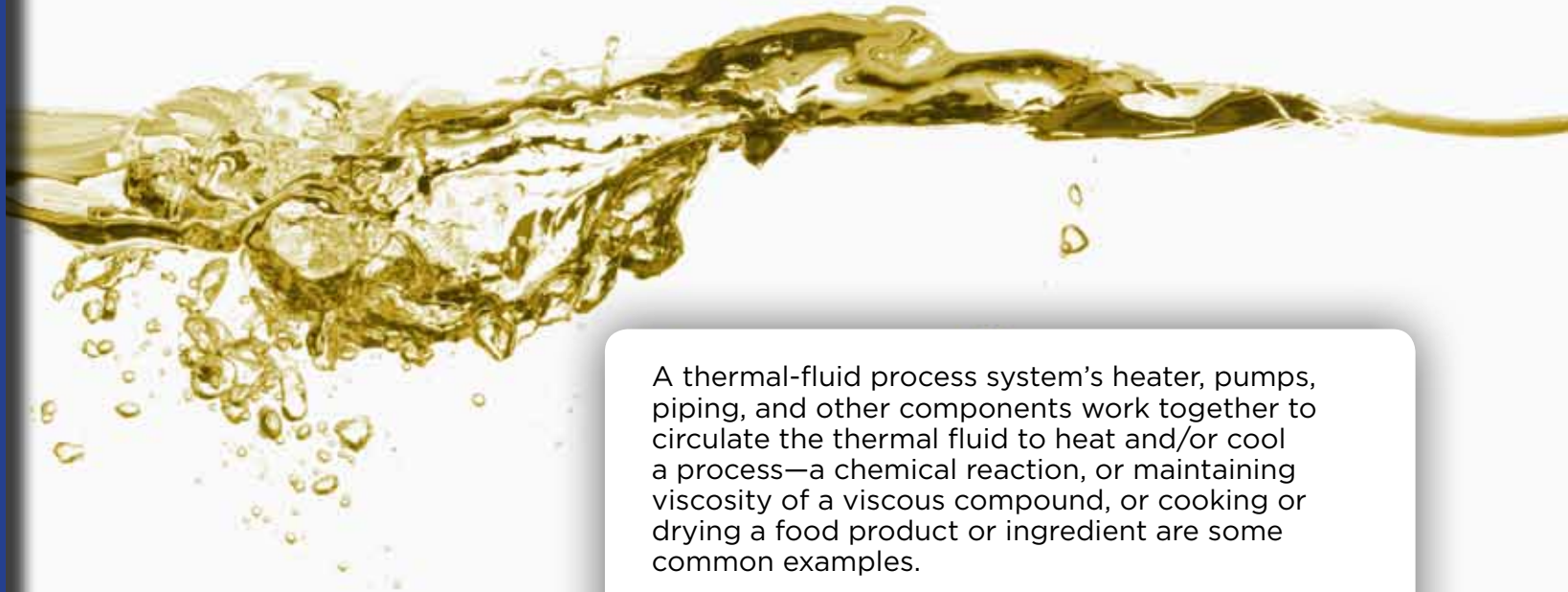
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A thermal-fluid process system's heater, pumps, piping, and other components work together to circulate the thermal fluid to heat and/or cool a process—a chemical reaction, or maintaining viscosity of a viscous compound, or cooking or drying a food product or ingredient are some common examples.

So the fluid, whether petroleum-based, or a synthetic aromatic liquid, is literally and functionally at the center of the system. As such, it is vital to the performance of the system, and like that other vital fluid we call blood, its condition can tell us important details about the health of the process itself, and that of the components of the system—and their interoperation.

FLUID ANALYSIS

A PREVENTIVE MAINTENANCE TOOL

An effective preventive maintenance program should always include regularly scheduled analysis of heat transfer fluids. There are two steps to the thermal-fluid analysis process. The first is observational, the second is analytical.

Trained technicians will open up the jar and manually observe a thermal fluid sample to record viscosity, consistency, water contamination, metal contamination, and possible acidity, particle formation, and presence of sludge.

These subjective observations can tell much about the fluid. Often, suspicions of contamination arise during this step, and can be confirmed by the subsequent lab tests. Appearance and odor can indicate contamination, as well as possible cracking due to overheating, and increased acidity due to oxidation.

If metal contamination is observed (using a small magnet), metallic wear in the system is the first suspect; this is most often due to

pump problems, but also sometimes originates elsewhere in the system.

If water contamination is observed, an interview with the system engineer might reveal possible exchanger breaches, or other system problems that could have introduced moisture to the circuit.

When the preliminary observations are complete, the sample is sent to the laboratory to be tested for TAN (Total Acid Number,) kinematic viscosity, and distillation range.

On the laboratory end, changes in the distillation curve can indicate overheating problems, as can viscosity changes. New-fluid baseline values for these parameters are compared with those of the used sample from the working system. Interviewing the system operators can then help further pinpoint whether there are fluid velocity problems, flow restrictions, expansion tank configurations, or other system characteristics that may be causing overheating. >>



In a similar manner, the symptom most characteristic of fluid oxidation is increased acidity, so when the total acid number of the fluid has exceeded the envelope considered optimum for this particular fluid, detailed interviews with the customer can help determine how their system is malfunctioning, or underfunctioning, to cause air to contact the hot fluid and oxidize it.

Oxidation problems often involve the expansion tank, and may include how it is piped, what size it is relative to the total system volume, its location, its level, or its temperature-- or a combination of these factors. But there are other circumstances that can cause oxidation in a given system, and discussion of fluid analysis results with the operator can often reveal these trouble spots.

Early discovery of such fluid problems, which really are symptoms of system problems, has helped preserve systems and fluid, maintaining them longer than when analysis is not performed. But even more important, early detection resulting from fluid analysis has prevented problems such as; loss of production; long downtimes for repairs; poor end-product quality; fire risk due to degraded fluid; premature pump replacement due to cavitation, poor adjustment, or seal and bearing wear; design flaws that cause shortened fluid and system life; expansion tank damage due to acidic sludge buildup, and many more.

ADDITIONAL RESOURCES

SPECIAL REPORT

Heat Transfer Fluids Do's, Don'ts and Best Practices

This special report includes:

- How to Easily Track the Performance of Your Heat Transfer System
- Heat Transfer Fluid Tips
- Fluid Properties Explained

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WHEN AND HOW TO ANALYZE YOUR HEAT TRANSFER FLUID

Sooner or later in the life of any thermal fluid system, the question of when to test the thermal fluid arises. In some cases, the issue comes up when the system performance begins to falter or when it just flat out won't run. At that point, the issue of "when" or "if ever" the fluid has been tested is not as important as figuring out what went wrong. Helping to pinpoint the cause of the failure is the hidden benefit of fluid monitoring since many equipment and/or operational problems that can lead to catastrophic fluid failure will show up in the test results. So before you find yourself attempting to predict when the system will be back on line, here are some tips on when to test the thermal fluid:

- During the first year of operation for brand new systems—any major failures in the equipment design or layout that can affect the fluid will show up in the test results.

- A week or so after a fluid change—even if you don't change brands, there will have been enough change in the old fluid properties so that any residue will show up in the test results of the new charge.
- Annually—scheduling an annual preventive-maintenance item takes the guess work out of "when" and more important, keeps a current report on file for your insurance company.

How to test the fluid is another issue. Lube oil tests (which include dissolved metals and particles) are cheap but are not designed to identify changes in the properties required for high temperature operation. Outside labs may be able to run the correct tests but can't properly interpret the results. The most effective test results are provided by the thermal fluid supplier. They have the experience with the fluid to interpret the test results and provide recommendations for improvements.

ADDITIONAL RESOURCES

SPECIAL REPORT

Heat Transfer Fluids Troubleshooting

Click on the following:

[Oxidation in Heat Transfer Fluids](#)

[Maximizing Fluid Life I: **Understand Film Temperature**](#)

[Maximize Fluid Life II: **Minimize Oxidation**](#)

[Maximize Fluid Life III: **Prevent Contamination**](#)

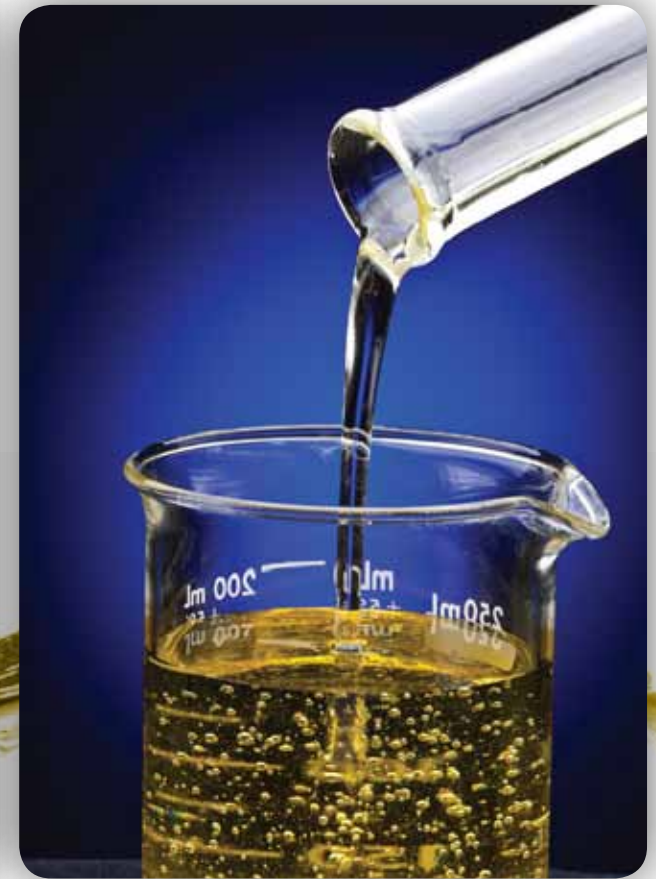
ANALYZING YOUR FLUID MORE BEST PRACTICES

Routine fluid analysis is a critical part of any preventive maintenance program. Not only do the results indicate what condition the fluid is in, they also provide an early warning of system or equipment problems that can eventually shut down the process.

How Often To Test the Fluid: Compared to other process heating systems such as direct fire, electric resistance or steam, thermal fluid systems require very little care or supervision for a number of years after start-up. But this “set it and forget it” feature can backfire if it results in surprises like reduced throughput or an unscheduled outage. At that point, it’s too late to test the fluid to see if it has “gone bad.” Thermal fluids very seldom “go bad” without help—95% of fluid degradation is caused by equipment malfunctions, poor design and/or operating errors. Most of these problems can be identified early on if the fluid is tested within the first 6 to 12 months after start-up and at most once a year after that. Early identification and correction of these problems can prevent surprises.

Taking the Sample: Samples should be taken directly into the sample container with the pump running and the fluid temperature at a minimum of 180°F (82°C). Samples taken cold or from a stagnant loop or from the expansion tank will not be representative of the entire fluid charge. If the system cannot be cooled below 270°F (135°C), install a two-foot length of metal tubing on the sample point to cool the sample; this will prevent the glass sample container from breaking. Some good locations to take the sample include the blow-down valve mounted on a Y-strainer or any low-point drain or pressure gauge tap near the pump or heater inlet. Purge the sample line with at least one full jar of fluid.

Inspection: Many fluid problems can be detected by appearance and smell. Fine black sediment in the bottom of the jar usually indicates solids are accumulating. Liquid contaminants (such as water or hydraulic fluid) can show up as a separate layer in the bottom of the sample. Contaminants that are soluble in the fluid (such as aromatic-based “synthetic” fluids) will affect the sample odor. >>



Laboratory Testing: Because thermal fluids operate in closed-loop systems (no continuous exposure to air), they require different tests and testing frequency than lubricating oils or hydraulic fluid which operate in open systems (continuous exposure to air). Thermal fluids usually only need to be tested once a year since there are no additive packages that need to be monitored and controlled or water contamination to worry about (water in a thermal-fluid system makes itself known pretty quickly). And since thermal-fluid pump clearances are not critical, metals analysis and particle counts are meaningless. In decreasing order of importance, the three tests that are run on the sample are as follows:

- **Acid Number (ASTM D-664)** measures the amount of acid present in the fluid which in turn is an indication of the amount of oxidation that has occurred. The higher the number the more oxidation has occurred.
- Because thermal fluids are blended from multiple components each with its own boiling point, the fluid will boil over a range of temperatures which is called the **Distillation Range (ASTM D-2887)**. The difference in temperature between the new fluid baseline and the test results are averaged and shown as

the “Low Boilers—% change” or “High Boilers—% change”. The higher the number, the more degradation has occurred.

- **Viscosity (ASTM D-445)** measures how easily the fluid flows. The data is compared to new fluid and the results are shown as a “% change” from new. A positive % indicates that the viscosity has increased (become thicker) while a negative % indicates that the fluid is thinner than new.

Analyzing the Results: Comparing the used fluid to new fluid is usually sufficient to determine whether the fluid has degraded enough to require change out. However, as noted above, 95% of fluid degradation is caused by external forces. Unless the equipment or process conditions that are causing accelerated degradation are corrected, fluid change out could become an annual routine. Properly analyzed and interpreted, the test results can provide the information necessary to identify and correct these undetected problems. Even more valuable are the trends that are evident when samples have been taken at routine intervals. Knowledge of the equipment is also necessary to properly interpret the results and identify the source of the degradation.



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