

Appendix E
Heating Fluid Description



Paratherm NF[®]

HEAT
TRANSFER
FLUID

Non-Fouling, Completely Non-Toxic

U PAREVE

ENGINEERING BULLETIN NF 104

Precise, Uniform Temperature Control™ in Closed-Loop Heat Transfer Systems

The Paratherm NF[®] heat transfer fluid is highly efficient, thermally stable and cost-effective. Completely non-toxic, it is exceptionally safe to use and is easy to dispose. Used fluid can be safely combined with spent lubricating oils and recycled locally (EPA, citation 57FR21524). The NF fluid is specified in a broad variety of applications, world wide. It is tough and durable with a proven record of success under demanding conditions, yet is easy and safe to handle.

Fluid Fouling

Unlike conventional heat transfer fluids, the Paratherm NF will not cause hard carbon formation on heated surfaces. Conventional heat transfer fluids, when severely overheated, will produce sooty carbon at the film layer. Much of this carbon immediately adheres to the heated surface and bakes on, forming a crust. As layer-upon-layer builds up, heat transfer – and in many cases flow – is impaired. Although nearly impossible to remove without scraping, sandblasting or using chlorinated solvents, the carbon *can* ultimately break loose, and large chunks of it can circulate through the system impeding flows and fouling components. Where fouling is extreme, heater tubing and electrical elements will stress and prematurely fail.

Under similar extreme overheat conditions, the NF fluid evolves small carbon granules. These granules remain in suspension and are easily filtered out.

Environmental Safety

The Paratherm NF has passed Bioassay. Rainbow trout, fresh water shrimp and Gulf shrimp were exposed to *water-accommodated fractions* of the NF fluid. No organisms died, and there were no ill effects. In the event of a release, you can use the same simple clean-up procedures employed for light lubricating oils. Once gathered, the NF fluid can be combined with spent lube oils and sent to the local oil recycler. There it can be converted into another useful material, preserving natural resources. The crystal-clear Paratherm NF contains no chlorinated hydrocarbons, aromatics, heavy metals, or sulfur or nitrogen compounds.

Fluid Toxicity

The Paratherm NF fluid is *completely* non-toxic. It is certified by the FDA and USDA, by Canadian Agriculture and Health & Welfare and by New Zealand MAF for use with food and pharmaceuticals. It also carries the USDA's H-1 incidental food contact rating and is certified kosher by the *Orthodox Union* (O-U), the world's premier kosher certifying agency. Do not breathe vapor mists of any fluid (see the Material Safety Data Sheet for further information on these, and other conditions).

Typical Properties*

Physical Properties

Feedstock		NF/USP Hydrotreated hydrocarbon base
Appearance		Transparent, Colorless, Bright
Taste & Odor		None
Maximum Recommended Film Temperature		650°F (343°C)
Minimal Optimal Temperature		120°F (49°C)
Flash Point (coc)	ASTM D-92	345°F (174°C)
Flash Point (pmcc)	ASTM D-93	335°F (168°C)
Fire Point (coc)	ASTM D-92	385°F (196°C)
Autoignition	ASTM D-2155	690°F (366°C)
	ASTM E659-78	691°F (367°C)
Atmospheric Boiling Point, 10% Fraction	ASTM D-1160	650°F (343°C)
Vapor Pressure, psia @ 600°F		4.720
Coefficient of Thermal Expansion**		0.000304/°F 0.000547/°C
Average Molecular Weight	ASTM D-2502	350
Density, lb/gal @ 75°F (24°C)	ASTM D-1298	7.25
Pour Point (Crystal Point)	ASTM D-97	-45°F (-43°C)
Pumpability: Centrifugal @ 2,000 centipoise		-13°F (-25°C)
Heat of Vaporization (Calculated)		90.72 BTU/lb

Electrical and Optical Properties: Available On Request

* These are typical laboratory values, and are not guaranteed for all samples.

** Note: Normal practice is to size the expansion tank so that it is 1/4 to 1/3 full when the system is cold, and 2/3 to 3/4 full when the system is at the maximum normal operating temperature.

Vapor Pressure

The NF fluid has an extraordinarily low vapor pressure – less than 1/3 of an atmosphere at its maximum operating temperature of 600°F. This and the fluid's exceptionally low pressure drop permit the designer considerable latitude in the choice of lower-cost equipment.

Efficiency

The lower a heat transfer fluid's viscosity, the less energy will be required to pump it through the system. Paratherm NF's viscosity is among the lowest of available high temperature heat transfer fluids. This means that less horsepower is needed for a given duty, and that a smaller pump and motor can be specified. And lower power consumption continues to produce savings year after year.

Water in the System

The NF fluid is manufactured from natural feedstocks and offers the same superb metal-coating and lubricating properties as the finest natural oils. However, any water allowed to stand in piping, components or especially expansion tanks of thermal oil systems can cause severe corrosion. Because the Paratherm NF is immiscible with water (and is also slightly less dense), any water can be easily drained from the system's low points, or the component's drain valves. Crack the low-point valve and allow fluid to drain into a beaker or clear water glass. If you see a phase separation (one liquid

"floating" on top of the other), continue to drain until no separation is observed.

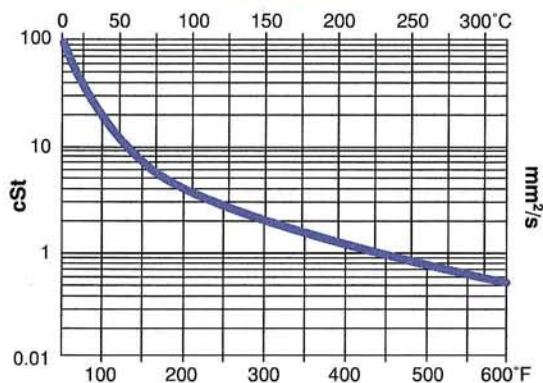
Storing Your Fluid

Containers of heat transfer fluid should be kept in non-hazardous dry areas only. Until ready for use, the container's tamper-evident safety seals *must* remain intact. Liquids should not be allowed to pool on the tops of steel drums. In the afternoon and evening when temperatures decrease, the heat transfer fluid will cool and contract slightly. A partial vacuum is created in the drum, and, if the bung's O-ring seal is not perfect, liquid standing on the top of the drum can be drawn through, contaminating the fluid. If drums must be temporarily stored outside, store them on their sides.

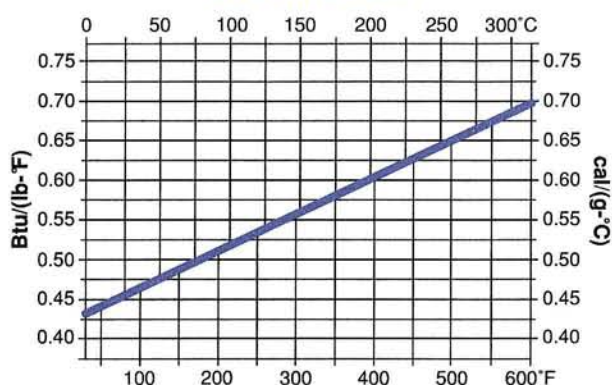
Pre-Cleaning the System

For optimal performance of both your system and its heat transfer fluid, we strongly suggest that piping, valves and other components be thoroughly cleaned before installation. Mill scale, weld spatter and slag, quench oils, protective lacquer and varnish coatings, and dust and dirt can act to degrade the fluid, and can damage pumps and valves. And lodging in restrictions, these contaminants can easily create the same low flow conditions that cause premature failure of systems and fluid.

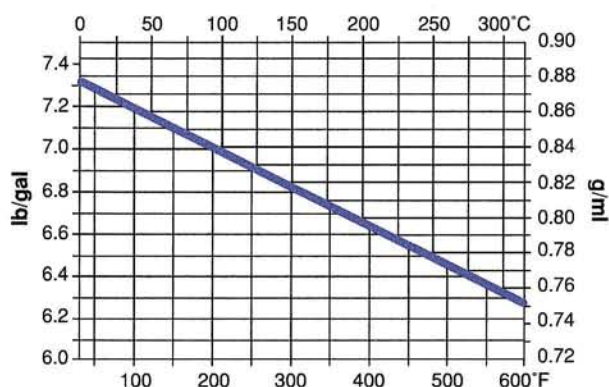
VISCOSITY



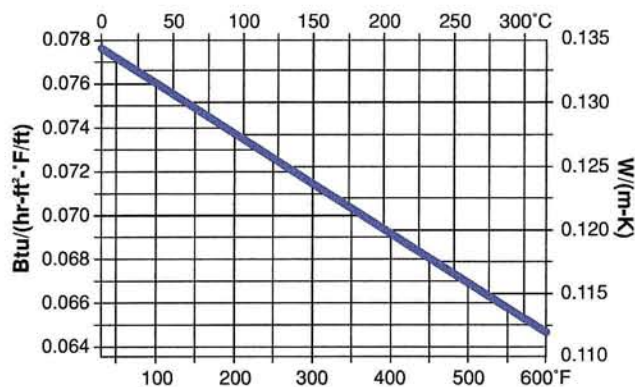
SPECIFIC HEAT



DENSITY



THERMAL CONDUCTIVITY



Inerting the System

Immediately after completing installation of the system, we suggest you purge with inert gas. Such purging can eliminate air and water vapor, and can substantially reduce corrosion. And while purging, you can leak test the system using simple soap-bubble detection methods. Finally, when you charge the system, any gas that becomes dissolved in the fluid will be inert, and fluid oxidation at start-up will be almost nil.

Charging the System

When charging the system, we suggest you fill from the bottom (a point near pump suction) using a small positive displacement pump — not the system pump. Charging from the system's low point can help reduce trapped air in the system, which will substantially reduce the entrainment of gas bubbles and resultant pump cavitation.

Fluid Disposal

Because Paratherm heat transfer fluids are produced from natural U.S. feedstocks, they are exceptionally safe to use. Easy to dispose, used Paratherm fluids can be safely combined with spent lubricating oils and recycled locally (EPA, citation

57FR21524). Paratherm strongly encourages recycling of used heat transfer fluid to conserve natural resources and to minimize the problem of liquid waste in landfills.

Fluid Analysis

Overheating, oxidation and contamination of your heat transfer fluid can significantly reduce its ability to perform. Product quality will suffer, and in severe cases considerable damage to your thermal oil system can result. Periodic analysis of your fluid can allow you to detect problems in the early stages and achieve substantial savings.

Quality Control

We thoroughly test each batch of heat transfer fluid to ensure absolute conformance to tight product specifications. Each shipment is traceable to its master batch, with test results archived at Paratherm.

Technical Assistance

Our technical expertise is available to you in the conceptual stage, during planning and design, and through system construction, start-up and operation. We want to work closely with you in the recommendation of proven thermal fluid systems, components, supplies and procedures.

We also advise on system cleaning and repair, should these become necessary. And if your application calls for fluids that we are unable to provide, Paratherm will assist you with the names and phone numbers of competitors' engineers that can help.

Additional Information

Paratherm has available technical data sheets covering a variety of thermal fluid and system topics including fire prevention, system performance tracking, recommended components, draining, flushing and charging and fluid analysis, among others. We'd be pleased to forward these to you upon request.



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Note: The information and recommendations in this literature are made in good faith and are believed to be correct as of the below date. You, the user or specifier, should independently determine the suitability and fitness of Paratherm heat transfer fluids for use in your specific application. We warrant that the fluids conform to the specifications in Paratherm literature. Because our assistance is furnished without charge, and because we have no control over the fluid's end use or the conditions under which it will be used, we make no other warranties—expressed or implied, including the warranties of merchantability or fitness for a particular use or purpose (recommendations in this bulletin are not intended nor should be construed as approval to infringe on any existing patent). The user's exclusive remedy, and Paratherm's sole liability is limited to refund of the purchase price or replacement of any product proven to be otherwise than as warranted. Paratherm Corporation will not be liable for incidental or consequential damages of any kind.