UCON

heat transfer fluid 500

Heat Transfer Fluid 500

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Introduction

UCON™ Heat Transfer Fluid 500 (HTF 500) is a polyalkylene glycol-based fluid specially formulated for high-temperature, liquid-phase heat transfer in systems requiring bulk fluid temperatures up to 500°F (260°C).

UCON HTF 500 has been used successfully in many high-temperature applications and is recommended by heating equipment manufacturers.

Applications

- Chemical processing equipment
- Laminating and calendering rolls
- Dies and molds in the rubber and plastics industries
- Drying rolls and ovens
- Die-cast zinc and aluminum alloys

(For open bath systems, use UCON Heat Transfer Fluid 50-HB-260-Y3.)

Special Features and Benefits

Long, Trouble-Free Service Life

Features oxidative and thermal stability in vented systems at continuous temperatures up to 500°F (260°C).

High Heat Transfer Efficiency

UCON HTF 500 shows less tendency to form coke, lacquers, and resinous deposits than petroleum-based products when used with properly designed, manufactured, and maintained equipment. As a result, the probability of line plugging through deposit buildup is reduced. High heat transfer efficiency is maintained throughout the life of the fluid. (Proper system maintenance is critical for this and all heat transfer fluids.)

Easy to Use with Conventional Equipment

Having a wide liquid range, UCON HTF 500 operates safely and efficiently with properly designed gas-fired, oil-fired, or electrical heat sources. No expensive pressurized equipment is needed at high temperatures. No secondary heating equipment is needed at low temperatures.

Excellent Materials Compatibility

UCON HTF 500 is compatible with carbon steel, aluminum, copper, and other common metals.

Water Soluble

UCON HTF 500 is water-washable with cold or hot water. No expensive solvents and solvent recovery systems are required for cleanup.

High Flash and Fire Points

UCON HTF 500 has a higher flash point at 575°F (302°C), Cleveland Open Cup, and fire point at 600°F (316°C), Cleveland Open Cup, than petroleum fluids and most other synthetic fluids.

Typical Physical Properties

Effective Operating Temperature Range: 0 to 500°F (-18 to 260°C)

Viscosity at 100°F (38°C), cSt (SUS)	62 (288)
Specific Gravity 68/68° F (20/20° C)	1.038
Coefficient of Expansion	
at 68° to 500°F	4.4 x 10^{-4} per °F
at 20° to 250°C	7.9 x 10^{-4} per °C
Pour Point (ASTM D 97), °F (°C)	-55 (-48)
Boiling Point	None—nonvolatile liquid
Flash Point, °F (°C)	
Cleveland Open Cup (ASTM D 92)	575 (302)
Pensky-Martens Closed Cup (ASTM D 93)	425 (218)
Fire Point (ASTM D 92), °F (°C)	600 (316)
Spontaneous Ignition Temperature, °F (°C)	750 (400)
Viscosity Index (ASTM D 2270)	200
Water Solubility	Nearly complete below 100°F (38°C) Dispersible above 100°F (38°C)
Dielectric Constant (25°C, 1000 cps)	7
Specific Volume, ft^3/lb (cm^3/g)	0.015 (0.936)
Enthalpy, Btu/lb (J/g)	100°F - 0.46; 400°F - 0.59 (38°C - 1.07; 204°C - 1.37)
Specific Heat, cal/gm °C	0.44745 + 0.00052812(T) (T = Temperature in °C)
Particulates	Substantially free
Appearance[1]	Transparent red to brown liquid

[1]Darkening with use is normal and does not indicate loss of good fluid quality.

Additional Properties

Extrapolated Vapor Pressure at 500°F	<0.1/mm Hg
Volumetric Expansion	5% per 100°F (5% per 56°C) above room temperature
Approximate Standard Heat of Combustion, Btu/lb (kJ/g)	Net 11,800 (27.5) Gross 12,700 (29.6)

Figure 1 • Effect of Temperature on Viscosity of UCON Heat Transfer Fluid 500

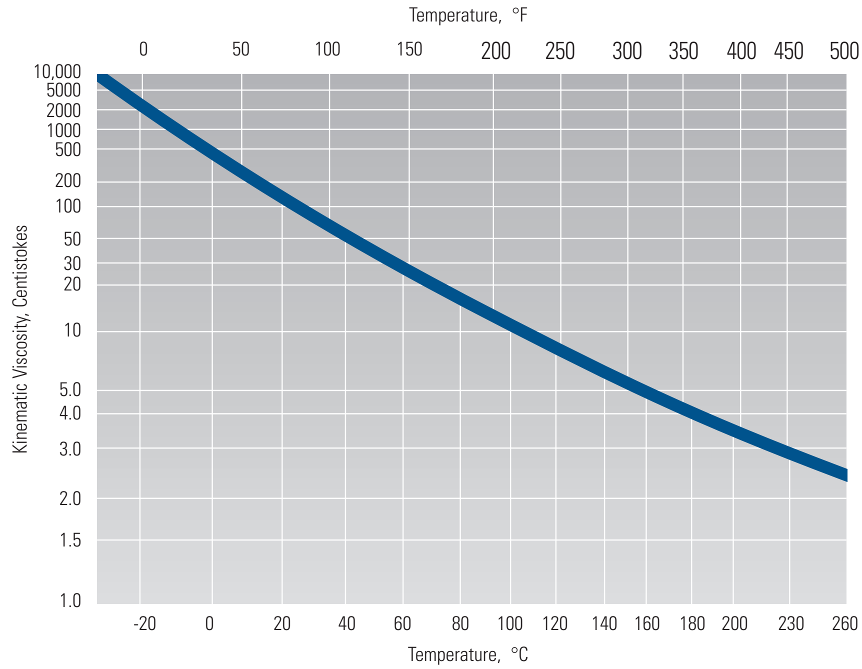


Figure 2 • Effect of Temperature on Density of UCON Heat Transfer Fluid 500

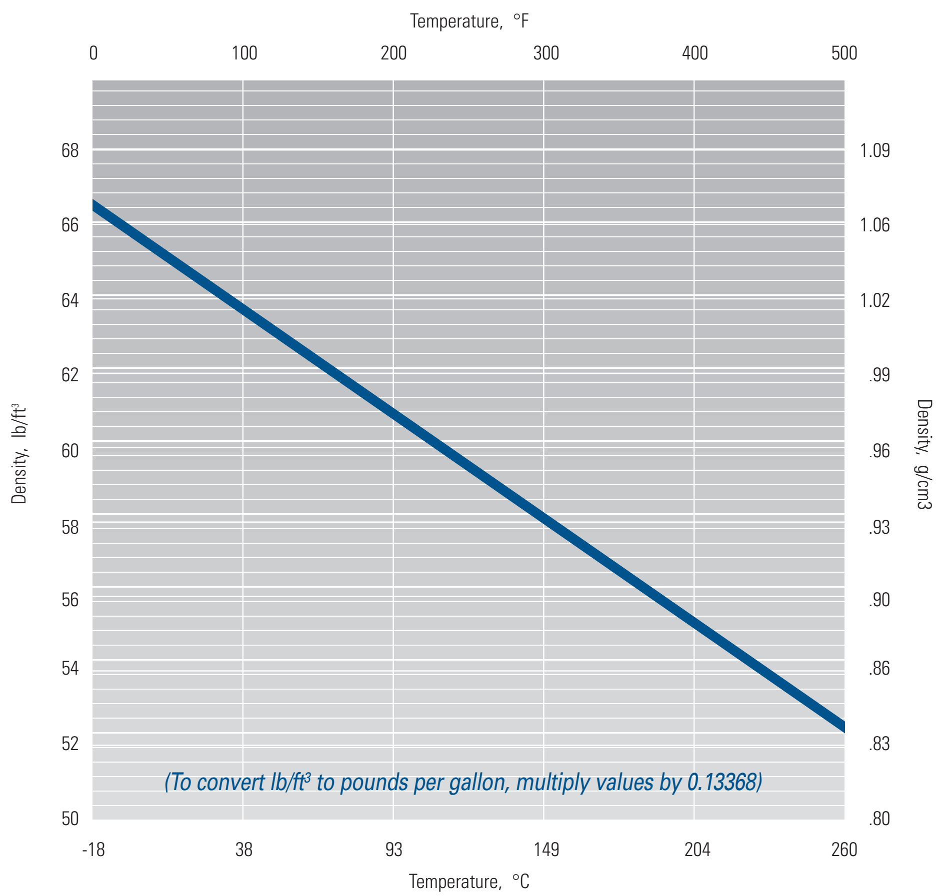


Figure 3 • Effect of Temperature on Specific Heat of UCON Heat Transfer Fluid 500

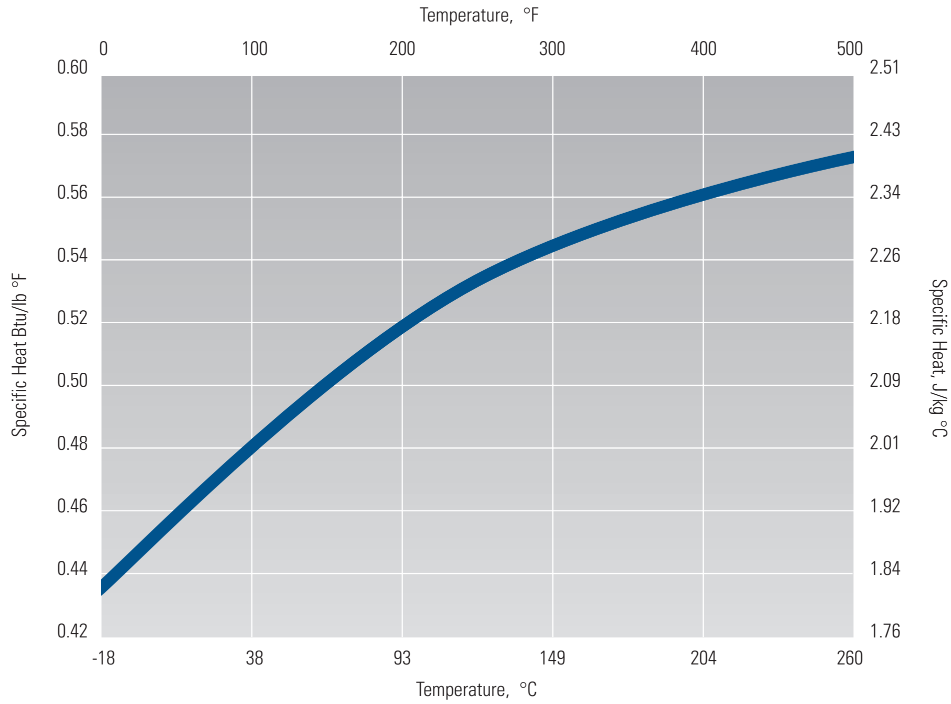
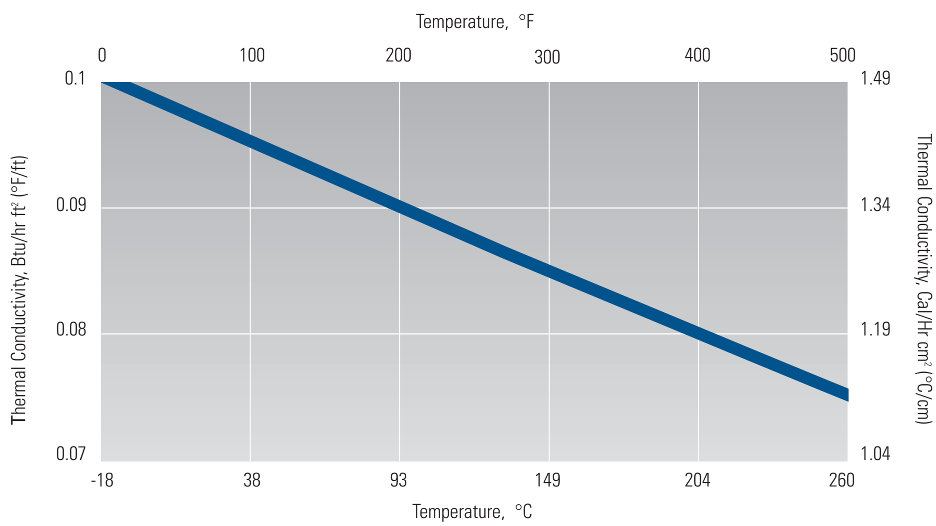


Figure 4 • Effect of Temperature on Thermal Conductivity of UCON Heat Transfer Fluid 500



Recommended Parameters

Operating Temperatures

Proper equipment design, manufacture, and maintenance, and a maximum bulk fluid temperature of 500°F (260°C) are the keys to long fluid life and trouble-free operation of UCON HTF 500. Higher temperatures will accelerate degradation. Decomposition vapors or fumes can be highly irritating to the eyes, nose, and throat. Read the current Material Safety Data Sheet on this product before using. UCON HTF 500 may exothermically decompose with evolution of volatiles at temperatures in excess of 550°F (288°C). Inadequate design generally causes excessive heating element failure. This phenomenon is very localized around the heat source and may not be detected by bulk solution temperature sensors. Heating element life is a function of surface temperatures and linear fluid flow rate. Higher densities require higher fluid flow rates. Consult the heater manufacturer for recommended operating conditions.

Flow Rates

The suggested flow rates at various watt densities shown in Figure 5 for electric heaters and Figure 6 for fired heaters are calculated results based solely on theoretical principles and design formulas. These graphs can be used as guidelines when other practical data are not available. Results will vary with different heaters. Refer to the heater manufacturer for design data or guidelines for specific equipment.

Pump Speed

Higher speeds may result in pump cavitation—this is especially true with centrifugal pumps operating at a fluid temperature of 400-500°F (204-260°C) due to volatile contaminants, and for fluid shear rates, depending on equipment design. Care should be used to assure all lines are of proper size for design flow.

Heater Shut-off

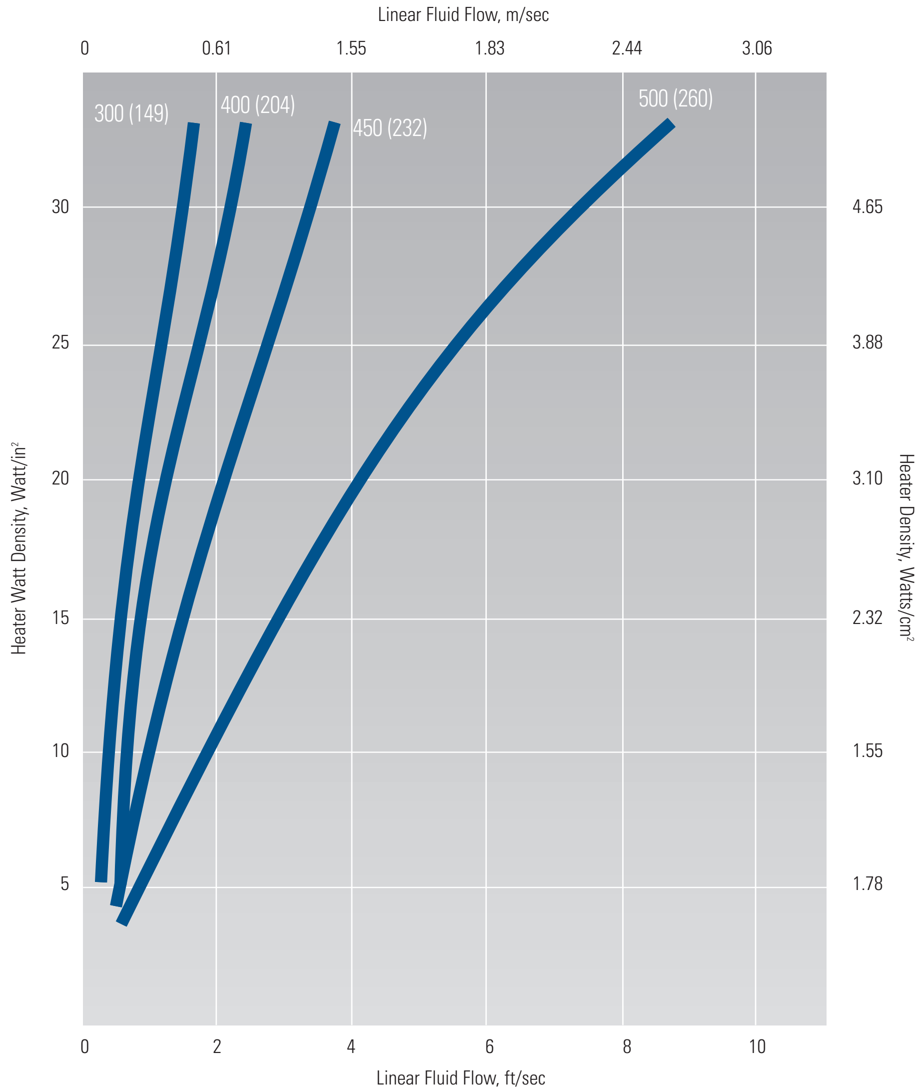
For electric and gas-fired heaters, a safety switch is recommended to automatically shut off the heating source in the event of loss of fluid flow, or if flow drops below design rates. This will help prevent fluid overheating and surface element fouling. A safety switch is not required for steam heated systems.

Venting

A continuous vent is essential to minimize the possibility of system pressurization and/or pump cavitation and loss of flow. The vent is typically located at the top of the expansion tank. For the vent to be effective, the fluid in the expansion tank must be 200°F (94°C) or greater. For vent lines four feet or longer, install a trap to prevent any condensate from returning to the expansion tank. The vent line should be inspected at each startup to be sure that no plugging has occurred. The vent tube should be insulated.

If the expansion tank is below 200°F (94°C), locate the vent at a point closer to the main circulation loop where the fluid is hot, or install a small slip stream from a pressurized section of the heating loop to the expansion tank as shown in Figure 7. A valve is useful to regulate slip stream flow. UCON HTF is subject to thermal expansion. If not properly vented, pressure buildup and/or fluid overflow may occur.

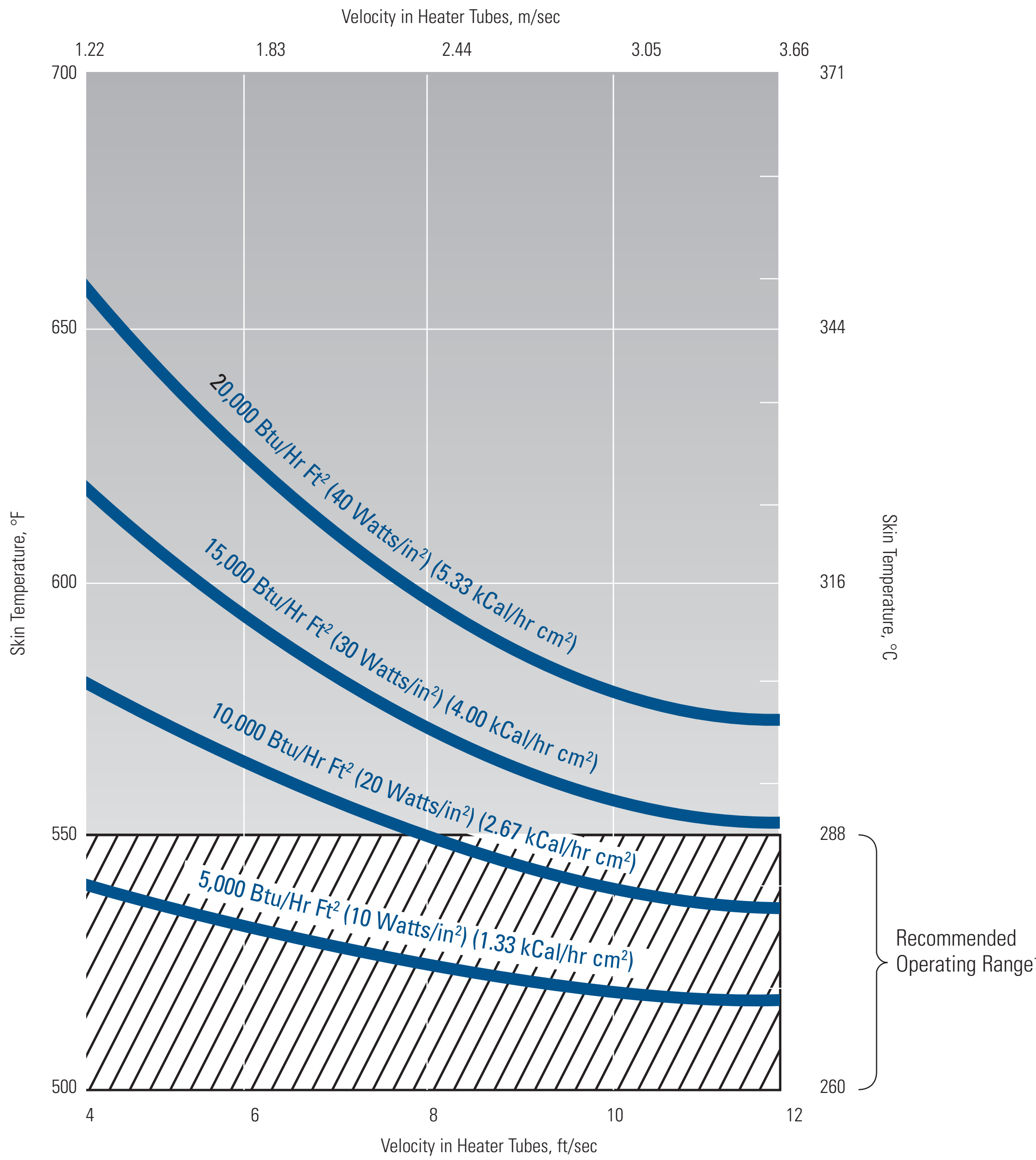
Figure 5 • Suggested Electric Heater Watt Densities and Linear Flow Rates Past Heater Elements



Fluid Bulk Temperature [°F (°C)] Listed on Each Curve

Note: Design Basis to Limit Fluid Skin Temperature to 550°F (287°C) Maximum

Figure 6 • Suggested Heater Flux Densities and Fluid Flow Rate for Fired Heaters



* Operating outside of recommended range may result in fluid overheating, deposit building inside heater tubes, premature tube failure, and plugging of tubes.

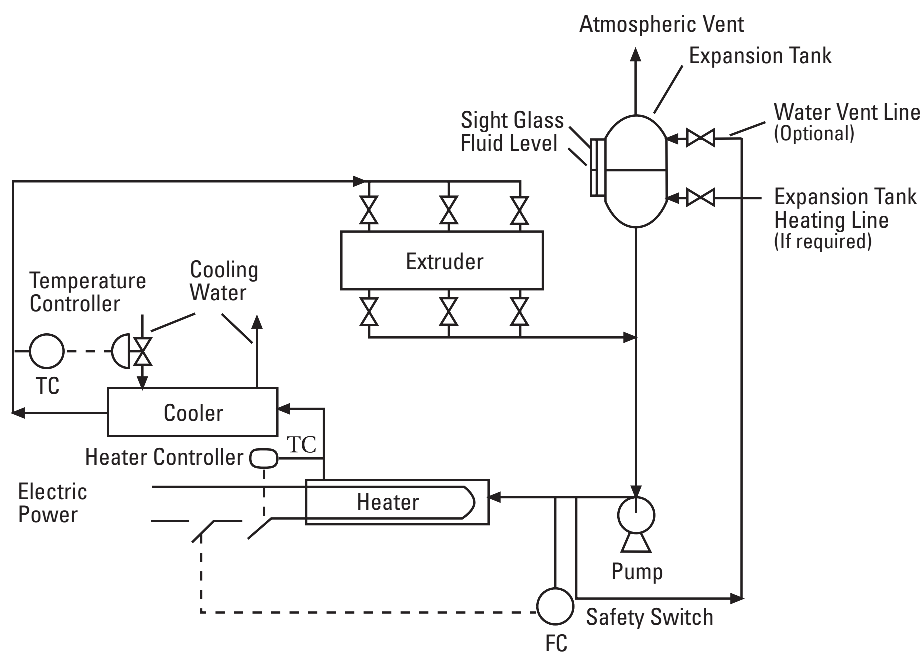
Recommended Parameters (continued)

Water Vent Line

UCON HTF 500 is hygroscopic and can absorb 1.5 to 2.5 percent water at room temperature. Water absorption is most likely during weekend or longer shutdowns in humid areas. Absorbed water may cause transient pump cavitation and increased pressure in a system not properly vented during startup until process temperatures drive off water. This process is expedited via a water vent line (shown in Figure 7), which is recommended when chronic water contamination exists. See "Troubleshooting" section for further explanation.

Continuing to operate a system containing large amounts of either entrained air or water can result in hazardous pumping conditions and limited fluid life. It is very important that both water and air be reduced continuously to ensure proper functioning of equipment and fluid. See "Troubleshooting" section for further explanation.

Figure 7 • Ideal Process Heating System Using UCON Heat Transfer Fluid 500



Materials of Construction

UCON HTF 500 is noncorrosive and compatible with most common metals, including all steels, iron, aluminum, copper, and copper alloys. However, stainless, cadmium-plated, or galvanized steels are preferred for sections of the system, such as vent lines and the expansion tank, which are in constant contact with UCON HTF 500 vapors, especially when operating temperatures are above 400°F (204°C). Vent lines should be insulated to prevent condensation in the line.

Piping

Manifold piping systems are frequently used to supply heat in a given plant area to a variety of units, such as space heating radiators. The following recommendations cover the best selection of piping components when designing a system, although additional consideration must be given to selection of materials of construction if corrosive products are being processed by direct contact with the piping.

Standard schedule 40 black steel piping is recommended. Flanges can be 150-lb class, raised face, welding neck or slip-on. All-welded systems are superior, but threaded joints can be used for small piping. Avoid pipe dope as some types are dissolved by UCON HTF 500 and/or do not withstand high temperature. Standard malleable 150-lb fittings are suitable for threaded fittings. Brass valves, 200-lb class, are suitable.

Seals

At 500°F (260°C), the operating temperature limit for UCON HTF 500, Teflon, graphite, and metal seals are suitable. At lower temperatures, natural and synthetic (Viton, Buna S, Butyl, and silicone) rubbers can be used. Nitrile-type synthetic rubbers, e.g., Buna N, are not recommended. Check with manufacturers for the temperature limits of these materials.

System Preparation

WARNING:

Proper system preparation and maintenance are critical to the safe operation of all heat transfer systems. Improper preparation or inadequate maintenance can result in system pressurization and/or system failures. In that event, there is a substantial likelihood of a release of hot fluid that could cause serious personal injury and/or property damage.

New Systems

If the system contains a strainer or other filtering device, no special startup procedure is required other than initial frequent strainer monitoring (and cleaning, if needed) until all loose particles are removed from the system.

If the system has no filtering device, charge the system with the minimum amount of UCON HTF 500 for circulation, circulate it for 15 minutes, drain the fluid and charge with fresh UCON HTF 500.

Used Systems

Used systems, including the vent lines, must be thoroughly cleaned and free of carbonaceous material, sludge, and grit. A clogged system can result in overpressurization and system failure, including the hazards described previously. Always use appropriate protective equipment, follow approved safety precautions, refer to the appropriate MSDS before changing out a system, and dispose of all chemical products in accordance with applicable laws, rules and regulations. Recommended change-out procedure includes:

1. Drain the system as thoroughly as possible, preferably from the lowest points in the system. If necessary, joints and unions should be disassembled to permit draining from dead ends or difficult sections. If at all possible, the reservoir of the system should be physically cleaned by wiping with suitable cloths.

2. Flush the system with a suitable solvent. The flush should be circulated through the entire system at or slightly above room temperature for several hours to assist in removal of deposits, etc. Butyl CARBITOL™ Solvent has been found to be highly effective in removing deposits, varnishes, etc., from most petroleum-based hydrocarbon heat transfer fluids. Butyl CARBITOL Solvent is also effective in cleaning systems operating with UCON HTF 500. Steam cleaning is effective, as well. (Care should be exercised in handling Butyl CARBITOL Solvent. Refer to the Material Safety Data Sheet.)

   A minimum amount of solvent should be used and, if possible, circulated several times through the system or those portions of the system that are especially dirty. It is recommended that additional flushes be used to clean dirty systems rather than flushing with hot solvent to effect a higher degree of solubility.

3. More tenacious deposits (scale, carbon, etc.) may require more severe treatment: high-pressure steam to unplug lines, or the use of outside cleaning specialists.

4. Drain the flush from the system; follow with a minimum amount of UCON HTF 500, and drain.

5. Clean or replace filters, strainers, etc., and add fresh UCON HTF 500 to the system. Operate the system on low heat, circulating the fluid through the system for several hours. Check filters and strainers for any deposits. These may have to be changed frequently for a period following a system cleaning to ensure the removal of any deposits loosened during the cleaning procedures that were not removed at that time. Periodic fluid analysis is suggested to determine the appropriate change-out frequency for each application.

Fluid Appearance

UCON HTF 500 will vary slightly in color and will darken with use. These color characteristics are normal and do not indicate any loss of quality or performance.

Troubleshooting

Below are the most frequent problems encountered along with likely causes and corrective measures, which are described in the following section in greater detail. If more assistance is required, contact your local Dow representative.

Symptom	Causes	Corrective Measures
Loss of pressure, fluid flow or heating ability	• Pump cavitation due to water contamination	#1
	• Pump cavitation due to inadequate venting	#2
	• Pump cavitation due to excessive pump speed	#3
	• Pump cavitation due to excessive operating temperature	#4
Excessive fuming, smoking or "carbonized" deposits on heating surface or elsewhere in the system	• Loss of fluid flow	#2, 7
	• Inadequate fluid flow	#5, 7
	• Excessive heat flux	#6, 7
	• Excessive operating temperature	#4, 7
Pressure buildup	• Water contamination	#1
	• Inadequate venting	#2
	• Overheating	#8

Corrective Measures

1. Water Contamination

Identify water contamination source. Possible sources are:

- Cooler leaks caused by corrosive cooling water; cooling water treatment is suggested to prevent future leaks.
- Inadequately drained reprocessed rolls or other equipment that were pressure-tested with water.
- Absorption of water from air. UCON HTF 500 is hygroscopic and absorbs 1.5 to 2.5% water if exposed to air during system shutdown or storage.

In some instances, water can be removed from UCON HTF 500 by venting at a fluid temperature of 220-300°F (105-149°C). Use caution when venting: water vaporizing in the heating section can cause sudden fluid surges in the expansion tank. To minimize surges, maintain the lowest fluid temperature that produces a reasonable venting rate. As water content is reduced, higher fluid temperatures may be used to maintain venting.

If venting of water is not practical, drain system completely and replace with fresh UCON HTF 500.

For chronic water contamination, such as water absorption due to weekend shutdowns, a water vent line as shown in Figure 7 expedites venting of absorbed water. A high-velocity spray nozzle installed on the water vent line at the point of entry to the expansion tank will break the fluid into small droplets and promote vaporization of water. *The line valve should be opened only for water venting.* If open continuously, excessive degradation of UCON HTF 500 will occur due to excessive air exposure.

PVC (noncorroding) tubing should be used to carry volatile degradation by-products to the outside. A trap should be employed to prevent condensate from reentering the system.

Note: UCON HTF 500 is *not* for use in potable water systems.

2. Inadequate Venting

See "Venting" in the "Recommended Parameters" section. If pressure or fluid flow loss persists, replace with fresh UCON HTF 500 immediately, because chronic flow loss causes fluid overheating, heating surface fouling, and eventually the heating section may become plugged.

3. Excessive Pump Speed

See "Pump Speed" under "Recommended Parameters" for pump speeds.

4. Excessive Operating Temperature

The recommended maximum operating temperature for UCON HTF 500 is 500°F (260°C). Higher temperatures shorten fluid life.

5. Inadequate Fluid Flow

See "Recommended Parameters" and Figures 5 and 6 for recommended UCON HTF 500 fluid flow rates.

6. Excessive Heat Flux

Consult the heater manufacturer for recommendations.

7. "Carbonized" Deposits on Heating Surfaces

"Carbonized" Deposits on Heating Surface These must be removed because they will continue to cause overheating, even when design deficiencies are corrected. Scraping is generally required for deposit removal. If equipment disassembly is undesirable, try steam cleaning, or consult with a cleaning company or heating equipment vendor.

8. Pressure Buildup

Operating at bulk temperatures in excess of 550˚F (288˚C) can cause pressure buildup. The recommended maximum operating temperature for UCON HTF 500 is 500˚F (260˚C).

Used Fluid Analysis

For optimal performance, the condition of UCON HTF 500 during use should be monitored periodically. Although the monitoring frequency is dependent on the system operating temperature and use, typically fluid analysis should be performed at least twice a year. To assist in troubleshooting for chemicals utilized in the following section, refer to applicable MSDS(s), and follow approved safety practices and recommended precautions. Records should be kept for the analytical results for each machine in use.

Five tests are particularly helpful in monitoring the condition of UCON HTF:

- Appearance
- Viscosity
- Ester Content
- Antioxidant Content
- Petroleum Oil Contamination

1. Appearance

Visual inspection of a sample of used lubricant can frequently provide useful information. In service, UCON HTF 500 will develop a characteristic deep mahogany color to transmitted light. Samples should be clear, however, and any turbidity or sediment is indicative of foreign contamination and/or inadequate filtration.

Close inspection of sediment, freed of fluid by washing with methanol, may provide clues to its origin. A low-power magnifying glass frequently provides better resolution than higher-power microscopes.

Insoluble debris, for example, could represent residual contamination introduced into the fluid system during installation. On the other hand, metallic particles could signify possible corrosion.

2. Viscosity

During operation the change in viscosity of UCON HTF 500 may reflect the degree of lubricant degradation and/or contamination. Viscosity values significantly below or above the initial range for UCON HTF 500 may be cause for re-charging with fresh fluid. The machine manufacturer should be consulted for guidance. Periodic viscosity measurements will establish a base-line from which significant changes will be apparent.

Determination of viscosity can be a routine measurement and the same methods used for petroleum products are applicable to UCON HTF 500. The principal method employed worldwide is the determination of kinematic values in centistokes (cSt), which is described in ASTM Method D 445/IP 71.

The standard temperature currently used for fluid evaluation is 40°C (104°F). The typical viscosity operating range for used fluid is 43-73 cSt at 40°C (104°F). The fluid should be replaced if the viscosity is outside of this range.

3. Ester Content

Ester content, expressed in milliequivalents per gram sample, follows the accumulation of ester-type degradation products dissolved in the lubricant. The upper limit of ester content may range from 0.3 to 0.5 meq/g depending on other analysis data. The procedure is as follows.

Determination of Ester Content in UCON HTF 500

Reagents Required:

(A) Potassium hydroxide in 80 percent methanol, approximately 0.2N. Dissolve 11.2 g. of potassium hydroxide in 200 ml of distilled water and dilute to one liter weight methanol.

(B) Standard hydrochloric acid of exactly known concentration near 0.1N.

(C) A pH meter or a pH indicator such as para-naphtholbenzein solution. Dissolve one gram of para-naphtholbenzein in 100 ml of isopropanol (99 percent grade).

Procedure:

Weigh, to the nearest 0.01 gram, 3 to 5 grams of the well-mixed fluid sample into a 250 ml Erlenmeyer flask. Pipet exactly 20 ml of 0.2N alcoholic potassium hydroxide into the flask, add a few clean glass beads and reflux the solution for 1.5 to 2 hours. Wash down the condenser with at least 50 ml of distilled water and titrate the contents of the Erlenmeyer flask with standard hydrochloric acid. Because the dark color of used UCON HTF 500 frequently precludes the use of colorometric indicator, the use of a pH meter is preferred (end point 8.5 pH units). With the indicator present (10 drops), a color change from blue to orange will develop.

Calculation:

$$\frac{(B - A) \times N}{\text{grams of sample}} = \text{milliequivalents of ester content per gram of lubricant sample}$$

where:

A = ml of hydrochloric acid required for sample

B = ml of hydrochloric acid required for blank

N = normality of the hydrochloric acid

4. Antioxidant Content

All fluids exposed to air at elevated temperatures are subjected to oxidative deterioration. Antioxidant additives are employed to stabilize UCON HTF 500, and the determination of residual antioxidant content provides a measure of fluid condition. A minimum antioxidant level of 10 percent of the original value is recommended for continued service.

Option 1: Colorimetric Method–Determination of Antioxidant Content

The method of analysis for the antioxidant in used UCON HTF 500 involves oxidation of the inhibitor with ferric ammonium sulfate in an aqueous solution containing 50 percent sulfuric acid. The intense blue color developed will detect as little as 0.1 mg of the antioxidant in the ferric sulfate reagent.

Reagents Required:

(A) 50 percent sulfuric acid. Add concentrated sulfuric acid (95 percent) slowly with stirring and cooling to an equal volume of water.

(B) Ferric ammonium sulfate in 50 percent sulfuric acid. For each liter of reagent, dissolve 1.38 g of ferric ammonium sulfate ($12H_2O$) in 500 ml of water. To this add slowly, with stirring and cooling, 500 ml of concentrated sulfuric acid.

Procedure:

Weigh one gram of the used fluid sample (weighed to a nearest 0.01 g) into a 50 ml volumetric flask and dilute to 50 ml with methanol. With a pipette, transfer 2.0 ml of the methanol solution to a 100 ml volumetric flask, add 20 ml of the ferric ammonium sulfate reagent and let stand at room temperature for approximately 1.5 hours. (Avoid letting this solution stand for more than 4 hours.) Dilute to 100 ml with 50 percent sulfuric acid and mix. Measure the optical density of this solution at 600 millimicrons, using distilled water for the zero setting. A Bausch and Lomb Spectronic 20 Colorimeter, or its equivalent, may be used.

Prepare a blank, using an equal aliquot of the methanol solution and diluting to 100 ml with 50 percent sulfuric acid. Do not add ferric ammonium sulfate reagent since this is a blank on the background color of the used fluid. Measure the optical density of the blank, using distilled water as zero setting.

The absorbancy per gram sample is determined by subtracting the absorbancy of the blank from the absorbancy of the sample and dividing this by the weight in grams of the sample.

The percent concentration of the antioxidant remaining in the used fluid is then read directly from the graph (Figure 8).

Calculation:

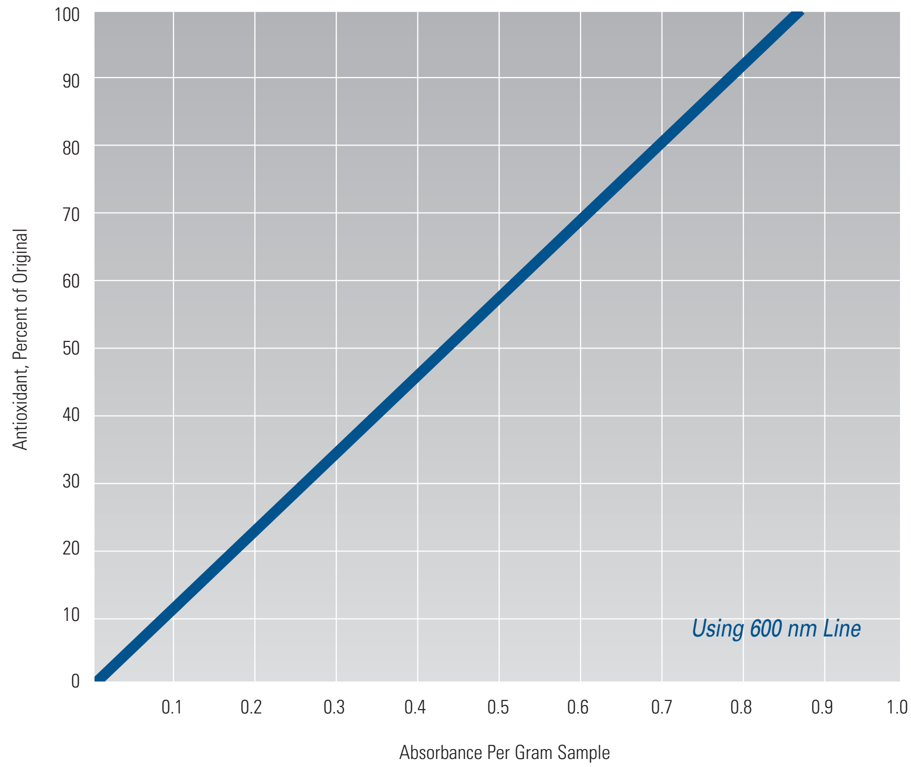
$$\frac{\text{Absorbancy sample} - \text{Absorbancy blank}}{\text{grams of sample}} = \text{Absorbancy per gram sample}$$

Option 2: Ultraviolet Spectroscopic Analysis

Alternatively, the antioxidant content of UCON HTF 500 may be readily determined by ultraviolet (uv) spectroscopic analysis conducted at a wavelength of 254 nm. Typically, a 2% sample of fluid diluted in methanol is used.

Used Fluid Analysis
(continued)

Figure 8 • Antioxidant Level as Measure of Absorbance



5. Petroleum Oil Contamination

Since UCON HTF 500 is not miscible with petroleum oils, and the density of a UCON fluid is greater, petroleum oil contamination can frequently be determined by the simple separation of two layers. A period of standing, during which the fluid is undisturbed, generally will effect the separation. However, if contamination by a petroleum oil is suspected but not apparent as a separation (because of the small amount of contamination, dark color of the sample, or emulsification), the oil may be separated by taking advantage of the fact that UCON HTF 500 is soluble in methanol while petroleum oils are not. Dilution of the sample with methanol also provides a measure of petroleum-derived sludges and residues that have been cleaned out of equipment (previously operated on petroleum oils) by the solvent action of UCON HTF 500.

Procedure:

Prepare a solvent mixture containing (by volume) 80 parts methanol and 20 parts distilled (or deionized) water. Mix thoroughly 20 ml of well-mixed used fluid sample with 80 ml solvent mixture. If this is carried out in a 100 ml graduated cylinder, separation into two layers will then provide an immediate measure of the hydrocarbon contamination. The indicated volume in the cylinder should be multiplied by five to give the percentage of petroleum oil present in the used fluid sample.

Pour Point, °F (°C)	-55 (-48)
Normal Boiling Point	None—nonvolatile liquid
Vapor Pressure, Reid Bomb, 100°F (38°C), psia	<1

Shipping Data

Weight per U.S. Gallon at 68°F (20°C), lb	8.65
Δ Pounds per Gallon	
50-68°F	0.00382 per °F
(10-20°C)	0.00687 per °C
Coefficient of Expansion	
at 68°F	0.00044 per °F
at 20°C	0.00079 per °C
at 131°F	0.00045 per °F
at 55°C	0.00082 per °C
Flash Point, °F (°C)	
Cleveland Open Cup (ASTM D 92)	575 (302)
Pensky-Martens Closed Cup (ASTM D 93)	425 (218)

Product Stewardship

Dow encourages its customers and potential users to review their applications from the standpoint of human health and environmental aspects. To help ensure that Dow products are not used in ways for which they are not intended or tested, Dow personnel will assist customers in dealing with environmental and product safety considerations. Dow literature, including Material Safety Data Sheets, should be consulted prior to use.

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