

3M™ Novec™ 7500 Engineered Fluid

Introduction

3M™ Novec™ 7500 Engineered Fluid is a nonflammable fluid with very low global warming potential for use in heat transfer applications. Novec 7500 fluid shares many of the inertness and dielectric properties of perfluorocarbons (PFCs) and perfluoropolyethers (PFPEs), and is a viable option for replacing them in a wide array of applications.

A unique heat transfer fluid with favorable environmental properties

Semiconductor

This Novec fluid can be used in cooling of ion implanters, dry etchers and CVD machines in semiconductor and flat panel display manufacturing facilities.

Test Equipment

The fluid may be used to cool semiconductor thermal shock and test equipment.

Electronic Cooling

Because Novec 7500 fluid is compatible with most electronic components, it can be used in direct contact single- and two-phase cooling of supercomputers and sensitive military electronics, and to cool high voltage transformers and power electronics.

Industrial/Pharmaceutical

Novec 7500 fluid can also be used as an alternative to commonly used fluids in pharmaceutical and chemical manufacturing processes, such as freeze drying and reactor cooling.

The primary advantage of Novec 7500 fluid over a comparable PFC or PFPE, however, is reduced Global Warming Potential (GWP). Novec 7500 fluid has been developed as a low-GWP alternative to perfluorocarbon and perfluoropolyether heat transfer liquids.

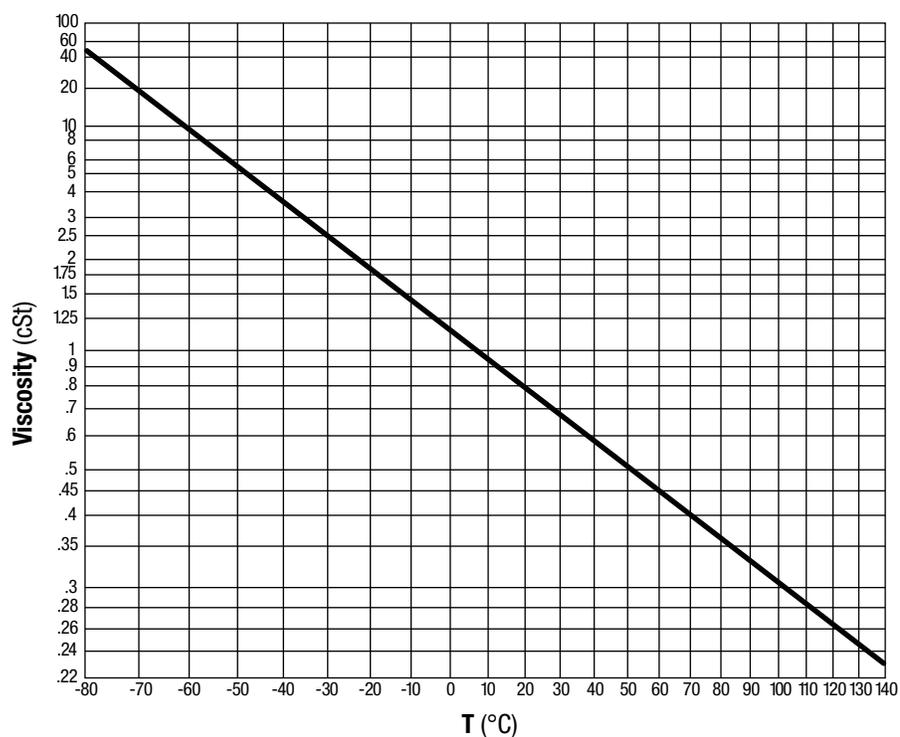
Novec 7500 fluid is non-ozone-depleting and has been exempted from the U.S. EPA definition of a volatile organic compound (VOC) because it does not contribute to the formation of photochemical smog.

Typical Physical Properties

Not for specification purposes. All values @ 25°C unless otherwise specified.

Properties	3M™ Novec™ 7500 Engineered Fluid
Boiling Point @ 1 atm (°C)	128
Pour Point (°C)	-100
Molecular Weight	414
Liquid Density (kg/m ³)	1614
Coefficient of Expansion	0.00129 K ⁻¹
Latent Heat of Vaporization @ 1 atm. (kJ/kg)	88.5
Surface Tension (dynes/cm)	16.2
Viscosity (cSt)	0.77
Critical Temperature (°C)	261
Critical Pressure (Mpa)	1.55
Solubility of Fluid in Water	<3 ppm by weight
Dielectric Strength	35 kV, 0.1" gap
Volume Resistivity	2.2x10 ⁸ ohm-cm
Dielectric Constant	5.8
Flammability	Nonflammable

Novec 7500 Fluid Kinematic Viscosity



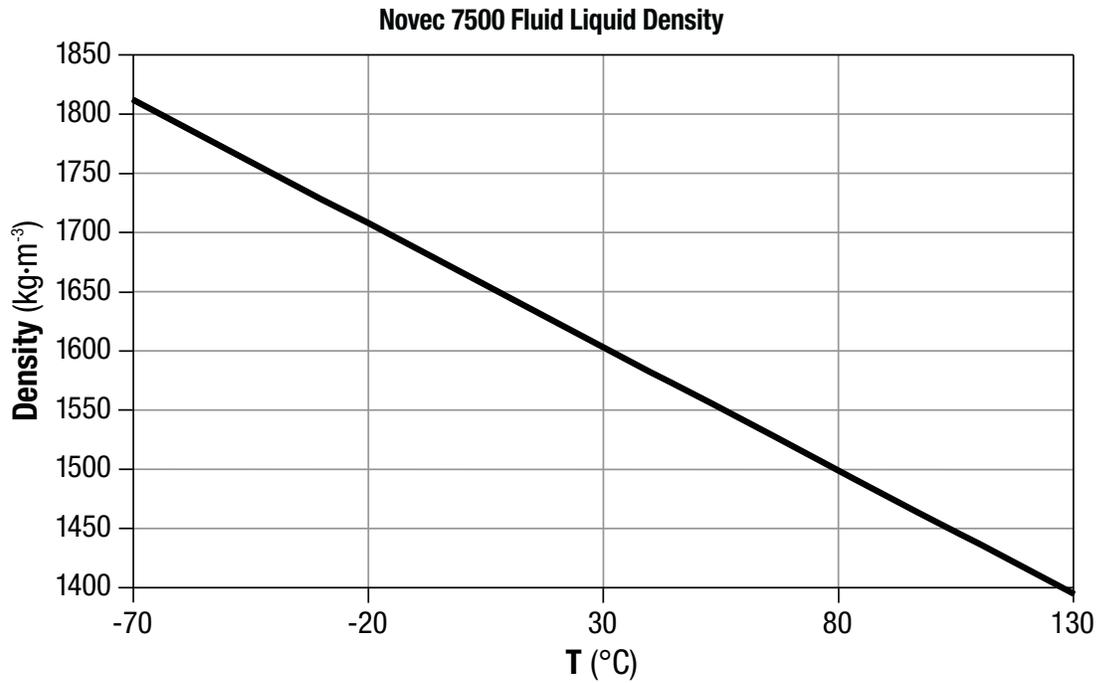
To determine the viscosity at a given temperature T in Kelvin, calculate

$$Z = 10^{(10^{(11.843 - 5.0874 \cdot \log(T[K]))})}$$

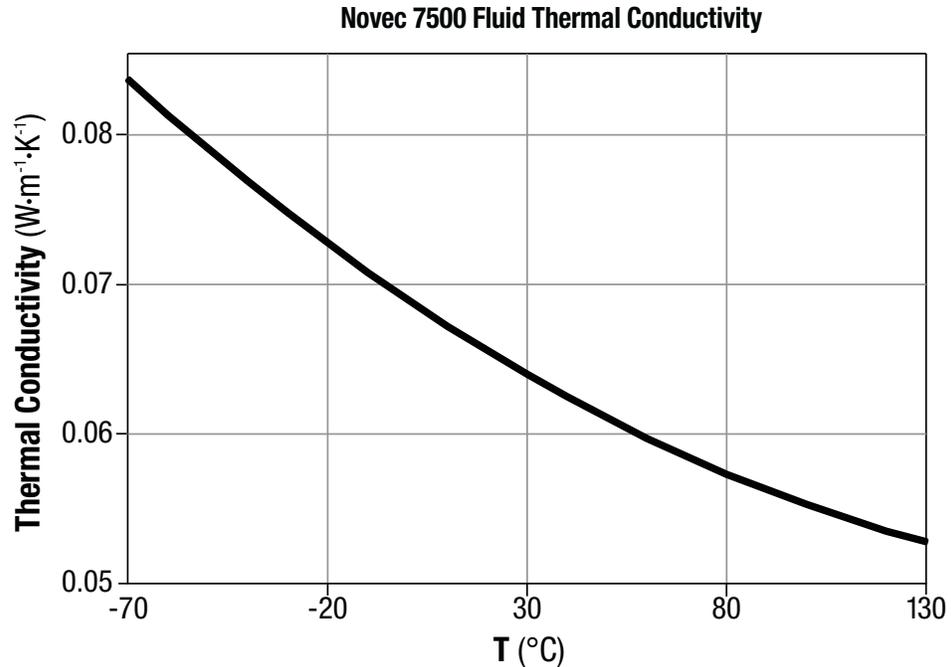
$$\text{Then, Viscosity [cSt]} = (Z - 0.7) - \exp(-0.7487 - 3.295(Z - 0.7) + 0.6119(Z - 0.7)^2 - 0.3193(Z - 0.7)^3)$$

Typical Physical Properties (continued)

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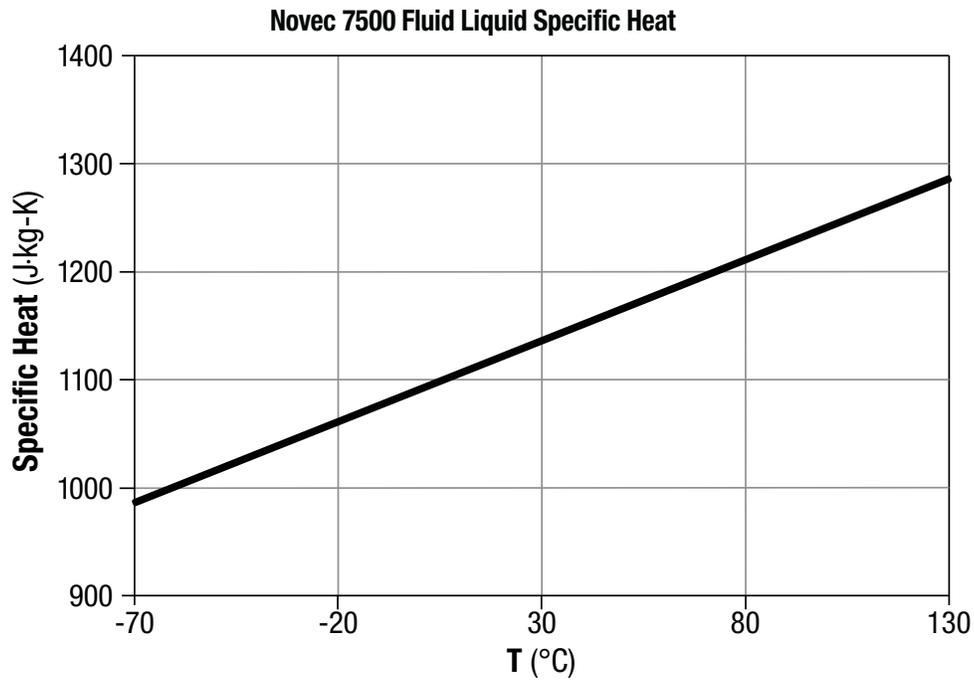
$$\text{Liquid Density [kg/m}^3\text{]} = -2.0845 \cdot T[\text{°C}] + 1665.8$$



$$\text{Thermal Conductivity [W/m-K]} = 0.069 - 1.798\text{E-}04 \cdot T[\text{°C}] + 4.24\text{E-}07 \cdot T[\text{°C}]^2$$

Typical Physical Properties (continued)

Not for specification purposes. All values @ 25°C unless otherwise specified.



$$\text{Liquid Specific Heat [J/kg-K]} = 1.4982 \cdot T(^{\circ}\text{C}) + 1091$$

Toxicity Profile

Not for specification purposes. All values @ 25°C unless otherwise specified.

The toxicological testing completed on 3M™ Novec™ 7500 Engineered Fluid indicates very low overall toxicity. The material is minimally irritating to the skin and eyes and tested negative in two mutagenicity screens. In its intended applications a large margin of safety exists between anticipated exposure and the eight hour time weighted average exposure guideline of 100 ppm. In a 28-day oral toxicity study no adverse effects were observed at 1000 mg per kg body weight.

Toxicological Test Results

Properties	3M™ Novec™ 7500 Engineered Fluid
Oral LD50	>200 mg/kg
Acute lethal inhalation concentration	>10,000 ppm (6 hour)
Eye irritation	Minimally irritating
Skin irritation	Non-irritating
Dermal sensitization	Negative
Mutagenicity	Negative in the two assays conducted
Ecotoxicity	Very low aquatic toxicity
28-day oral toxicity	NOAEL 1000 mg/kg

Environmental Properties

Properties	3M™ Novec™ 7500 Engineered Fluid
Ozone Depletion Potential ¹ (ODP)	0.0
Global Warming Potential ² (GWP)	90
Atmospheric Lifetime (years)	2.2
Volatile Organic Compound (VOC)	No

¹ CFC-11 = 1.0

² GWP = pounds equivalent CO₂, 100-year integrated time horizon (ITH), IPCC 2001 method.

Environmental, Health and Safety

Before using this product, please read the current product Material Safety Data Sheet (available through your 3M sales or technical service representative) and the precautionary statement on the product package. Follow all applicable precautions and directions. 3M™ Novec™ 7500 Engineered Fluid is nonflammable and does not exhibit flammability characteristics under normal operation and storage conditions. The fluid is resistant to thermal breakdown and hydrolysis during storage and use. Recommended handling procedures are provided in the Material Safety Data Sheet, which is available from your local 3M representative upon request.

Materials Compatibility

In practice, Novec engineered fluids differ somewhat from PFCs and PFPEs in their ability to dissolve certain oils. This means that Novec 7500 fluid is more likely to extract plasticizers from elastomeric materials. For this reason, elastomeric O-ring and seal materials should be limited to those that contains a low amount of plasticizer. EPDM, EPR and butyl typically fall into this category. 3M engineers can suggest appropriate compounds or assist with test procedures.

Heater Selection

The critical heat flux of Novec 7500 fluid was found to be 18 W/cm² when boiling from a horizontal 0.5 mm diameter platinum wire in a quiescent pool of saturated fluid. The maximum heat flux obtainable in forced convection applications is significantly higher, but depends strongly upon the geometry and flow conditions. A safety interlock between the pump and heater is strongly recommended in applications with heat fluxes exceeding 15 W/cm².

Regulatory Status

The components of this product are in compliance with the chemical notification requirements of the United States (TSCA), Europe (ELINCS), Korea and the Philippines. Novec 7500 fluid is not acceptable for commercial sale in Japan. Certain restrictions apply. Contact the selling division for additional information.

Contact your local 3M representative regarding the regulatory status of Novec 7500 fluid in other countries.