3M™ Novec™ 7000 Engineered Fluid

Introduction

3M™ Novec™ 7000 Engineered Fluid, 1-methoxyheptafluoropropane, is a non-flammable, low global warming potential (GWP) heat transfer fluid capable of reaching -120°C. It is also useful as a direct expansion refrigerant.

Applications

For information on other applications, contact your 3M representative or 3M authorized distributor.

- Semiconductor
  - Ion implanters
  - Dry etchers
  - CVD/PVD tools
  - Electronic Automated Test Equipment (ATE)
- Industrial/Pharmaceutical
  - Chemical reactors
  - Freeze dryers
  - VOC capture
- Fuel cells
- Electronic Cooling
  - Supercomputers
  - Sensitive military electronics
  - High voltage transformers
- Electronics
  - Reliability testing
  - Temperature calibration
- Autocascade refrigeration
  - HCFC-123 replacement
- Medical Lab
  - Histobath working fluid

Benefits

- Low GWP (530, 100-year ITH)
- Excellent dielectric properties
  - In event of leakage or other failure, will not damage electronic equipment
- Zero ozone depletion potential (ODP)
- Good materials compatibility
- Low toxicity
- Non-flammable
- Non-corrosive
- Good thermal stability
- Useful at extreme low temperatures
  - Viscosity is less than 20 cSt at -120°C

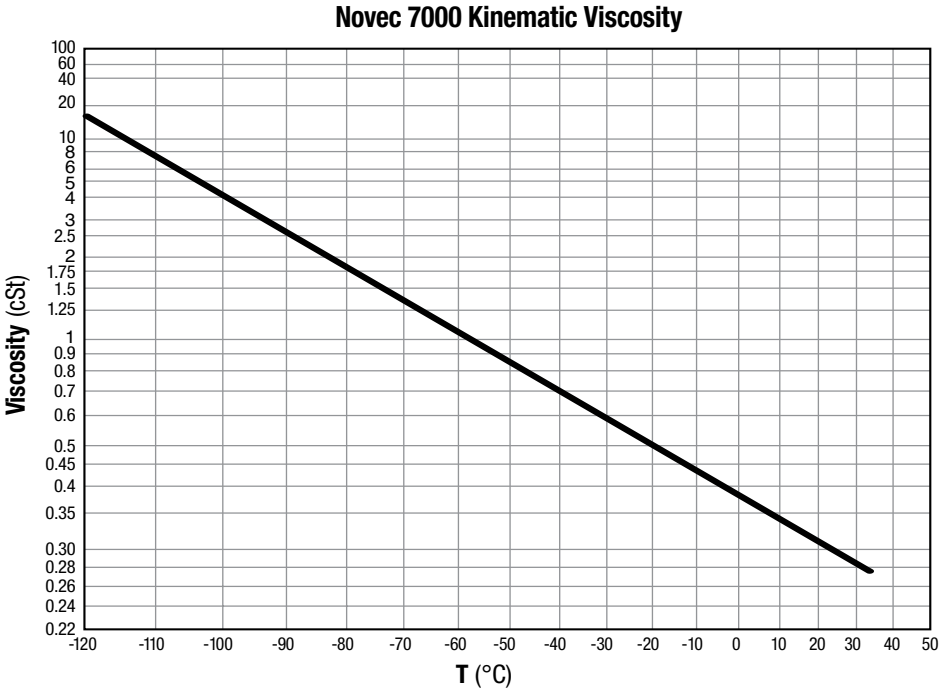
Material Description

Ingredients	Novec™ 7000 Engineered Fluid
1-methoxyheptafluoropropane ($C_3F_7OCH_3$)	99.5% by weight
Appearance	Clear, colorless
Non-volatile residue (NVR)	25.0 ppm maximum

Typical Physical Properties

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

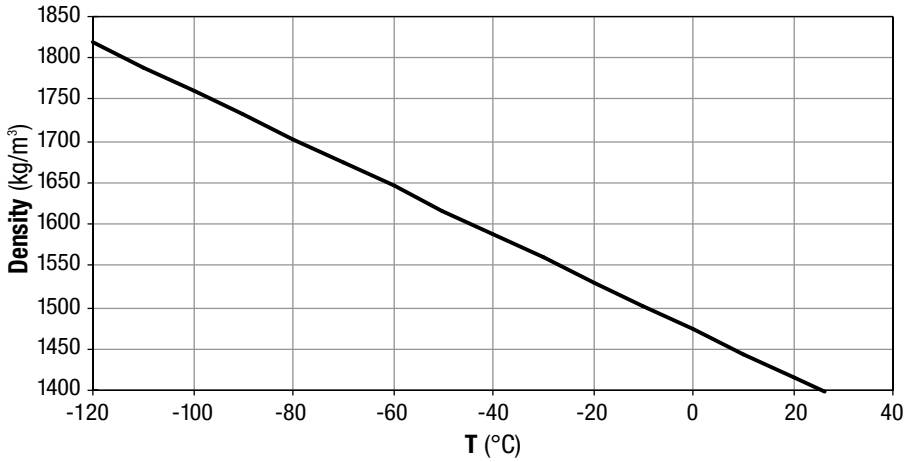
Properties	3M™ Novec™ 7000 Engineered Fluid
Molecular Weight (g/mol)	200
Boiling Point @ 1 atmosphere (°C)	34
Freeze Point (°C)	-122.5
Liquid Density (kg/m^3)	1400
Kinematic Viscosity (cSt)	0.32
Kinematic Viscosity @ -80°C (cSt)	2.0
Kinematic Viscosity @ -120°C (cSt)	17
Coefficient of Expansion	0.00219 K^{-1}
Critical Density (kg/m^3)	553
Critical Pressure (MPa)	2.48
Critical Temperature (°C)	165°C
Dielectric Constant	7.4
Dielectric Strength (kV)	~40
Flash Point	None
Latent Heat of Vaporization (kJ/kg)	142
Solubility of water in fluid (ppmw)	~60
Solubility of air in fluid (vol %)	~35
Specific Heat (J·kg^{-1}·K^{-1})	1300
Surface Tension (dynes/cm)	12.4
Thermal Conductivity (W·m^{-1}·K^{-1})	0.075
Vapor Pressure (kPa)	64.6
Volume Resistivity (ohm-cm)	108



Typical Physical Properties (continued)

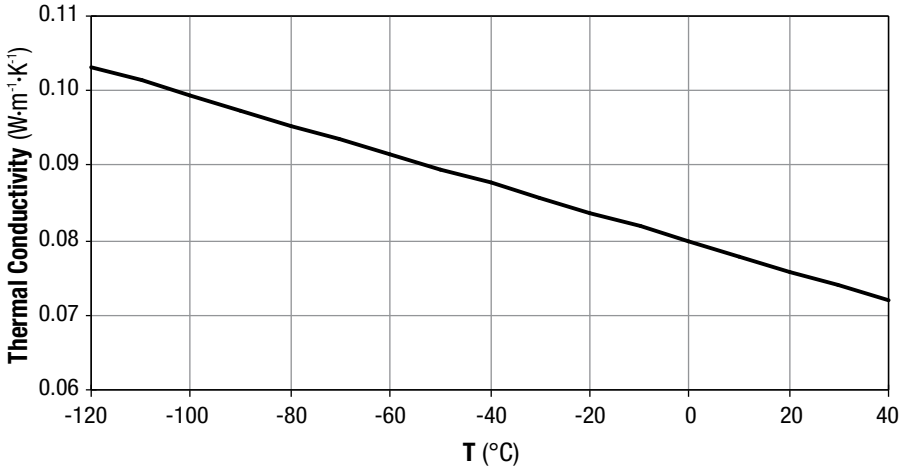
Not for specification purposes. All values @ 25°C unless otherwise specified.

Novec 7000 Liquid Density



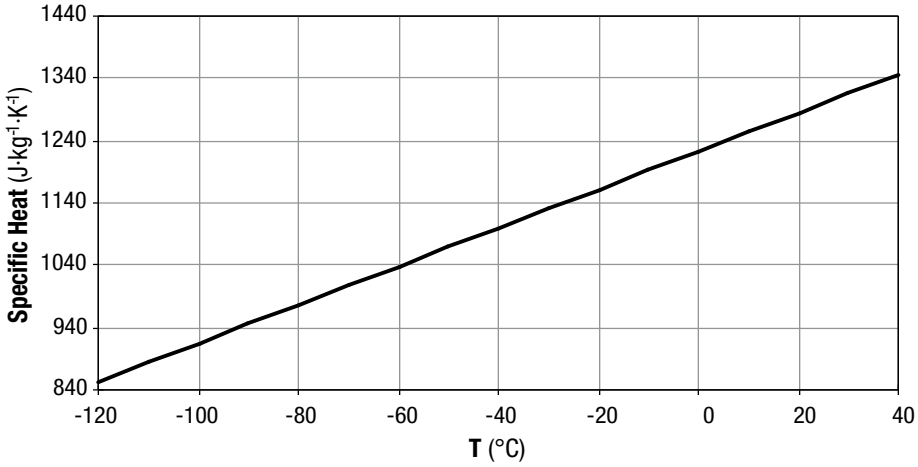
Liquid Density [kg/m^3] = 1472.6 - 2.880·T(°C)

Novec 7000 Thermal Conductivity



Thermal Conductivity [W·m^{-1}·K^{-1}] = 0.0798 - 0.000196·T(°C)

Novec 7000 Liquid Specific Heat



Liquid Specific Heat [J·kg^{-1}·K^{-1}] = 1223.2 + 3.0803·T (°C)

Novec 7000 Vapor Pressure

$$\ln(P[Pa]) = -3548.6/T[K] + 22.978$$
$$-30°C < T < T_c$$

Toxicity Profile

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

The toxicological testing completed on 3M™ Novec™ 7000 Engineered Fluid indicates low acute and sub-acute toxicity. A 28-day inhalation study conducted at 1000, 10,000 and 30,000 ppm helped establish an exposure guideline of 250 ppmv for an average 8 hour work day. The No Adverse Effect Level (NOAEL) in this study was 1000 ppm. This data suggests there is a large margin of safety for use of this fluid in relatively non-emissive heat transfer systems.

Toxicological Test Results

Properties	Novec™ 7000 Engineered Fluid
Acute Lethal Concentration (ppmv)	>30,000
8 hr Exposure Guideline (ppmv)	250
Skin Irritation	Negative[1]
Mutagenicity	Negative[1]
Ecotoxicity (water solubility < 2.5 ppb)	Very low aquatic toxicity
Acute Oral Toxicity	LD50 > 2000 mg/kg[1]
28-day Inhalation	NOAEL=1000 ppm

[1] A. Sekiya and S. Misaki, "*The potential of hydrofluoroethers to replace CFCs, HCFCs and PFCs*" J. of Fluorine Chemistry, 101, 2000, pp. 215-221.

Environmental Properties

Properties	Novec™ 7000 Engineered Fluid
Ozone Depletion Potential[1] (ODP)	0.0
Global Warming Potential[2] (GWP)	530
Atmospheric Lifetime (years)	4.9

[1] CFC-11 = 1.0
[2] GWP 100-year integrated time horizon (ITH). IPCC 2013.

Environmental, Health and Safety

Before using this product, please read the current product 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™ 7000 Engineered Fluid is non-flammable. The fluid is resistant to thermal breakdown and hydrolysis during storage and use. Recommended handling procedures are provided in the Safety Data Sheet, which is available from your local 3M representative upon request.

Materials Compatibility

Novec 7000 fluid is compatible with most metals and hard polymers such as:

Metals	Plastics
Stainless Steel	Polypropylene
Brass	Polyethylene
Copper	Nylon
Aluminum	Polyacetyl
	PEEK
	PTFE

Elastomeric materials should be limited to those compounds that contain the least amount of extractible plasticizer. 3M engineers can suggest appropriate compounds or assist with test procedures.

Heater Selection

The critical heat flux of Novec 7000 fluid is 18 W/cm^2 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 will be 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/cm^2.

Regulatory Status

Novec 7000 fluid is available for commercial sale in the United States, China, Malaysia, Singapore and Taiwan and is currently under review by regulatory agencies in Europe, Japan, the Philippines and Korea.

Contact your local 3M representative for an update on the regulatory status of Novec 7000 fluid.