3M Novec™ 7000 Engineered Fluid

Product Information

Introduction

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

Typical Applications

- 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

Benefits

- Low GWP (370, 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
- Nonflammable
- Non-corrosive
- Good thermal stability
- Useful at extreme low temperatures
  - Viscosity is less than 20 cSt at -120°C

Material Description

Ingredients	Novec 7000
Methoxy-nonafluorobutane[1]	99.5% minimum
Appearance	Clear, colorless
Non-volatile residue (NVR)	1.0 ppm maximum

Typical Physical Properties

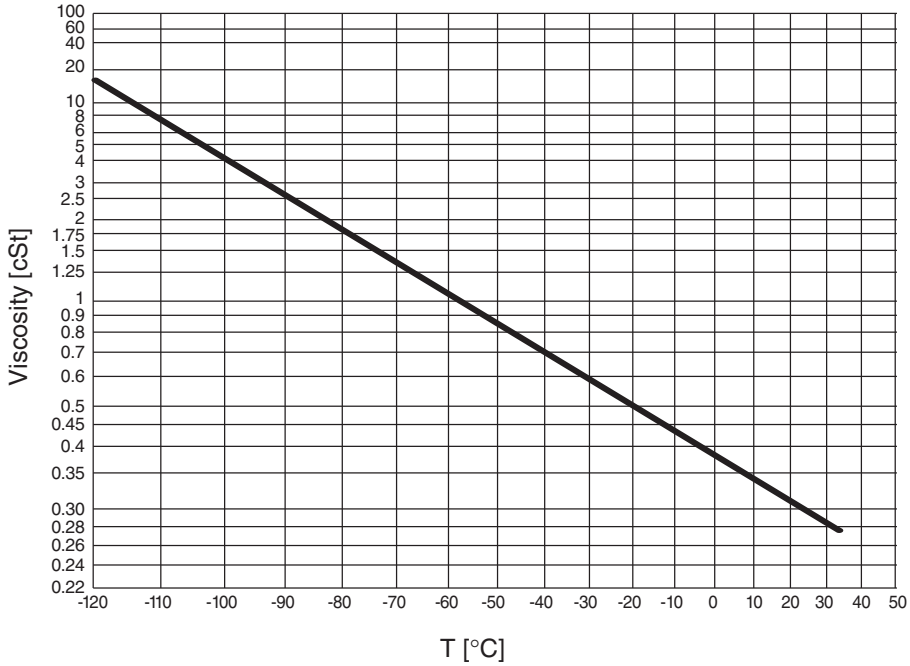
Not for specification purposes

All properties at 25°C (77°F) and 1 atm unless otherwise noted

Properties	Novec 7000
Molecular Weight	200 g/mol
Flash Point	None
Freeze Point	-122.5°C (-189°F)
Boiling Point @ 1 atmosphere	34°C (93°F)
Liquid Density	1400 kg/m^3
Kinematic Viscosity	0.32 cSt
Kinematic Viscosity @ -80°C	2.0 cSt
Kinematic Viscosity @ -120°C	17 cSt
Coefficient of Expansion	0.00219 K^{-1}
Critical Density	553 kg/m^3
Critical Pressure	2.48 MPa
Critical Temperature	165°C (329°F)
Dielectric Constant	7.4
Dielectric Strength	~40 kV
Latent Heat of Vaporization	142 kJ/kg (33.9 cal/g)
Solubility of water in fluid	~60 ppmw
Solubility of air in fluid	~35 vol %
Specific Heat	1300 $J \cdot kg^{-1} \cdot K^{-1}$ (0.31 $cal \cdot g^{-1} \cdot K^{-1}$)
Surface Tension	12.4 dynes/cm
Thermal Conductivity	0.075 $W \cdot m^{-1} \cdot K^{-1}$
Vapor Pressure	64.6 kPa (484 mm Hg)
Volume Resistivity	10^8 ohm-cm

Chart 1

Novec 7000 Kinematic Viscosity



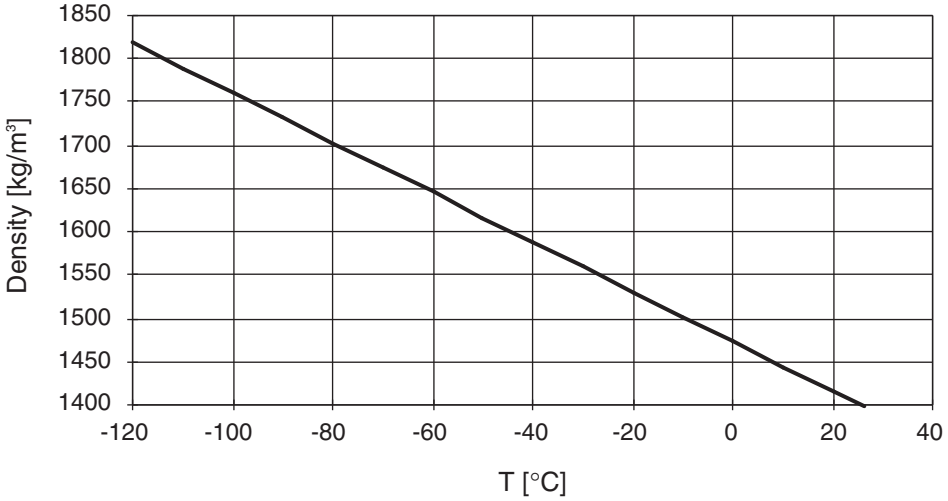
Typical Physical Properties (continued)

Not for specification purposes

All properties at 25°C (77°F) and 1 atm unless otherwise noted

Chart 2

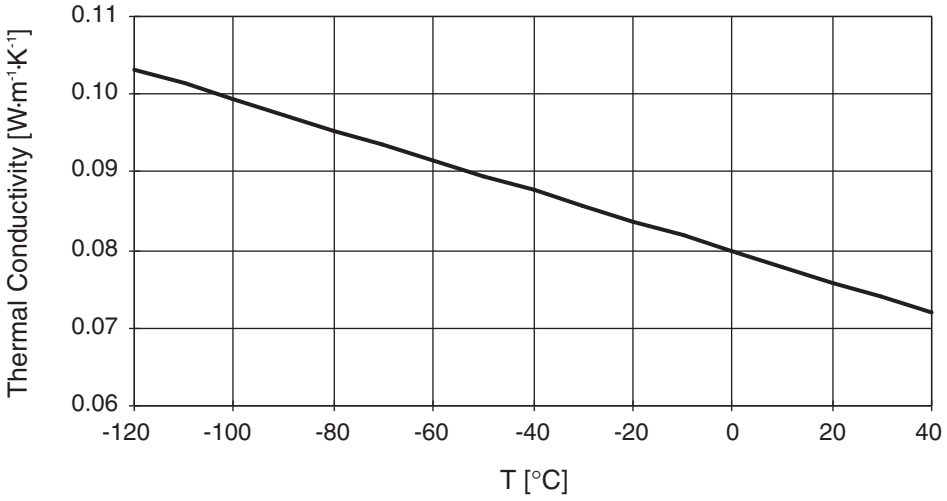
Novec 7000 Liquid Density



Liquid Density [kg/m³] = 1472.6 - 2.880·T[°C]

Chart 3

Novec 7000 Thermal Conductivity



Thermal Conductivity [W·m⁻¹·K⁻¹] = 0.0798 - 0.000196·T[°C]

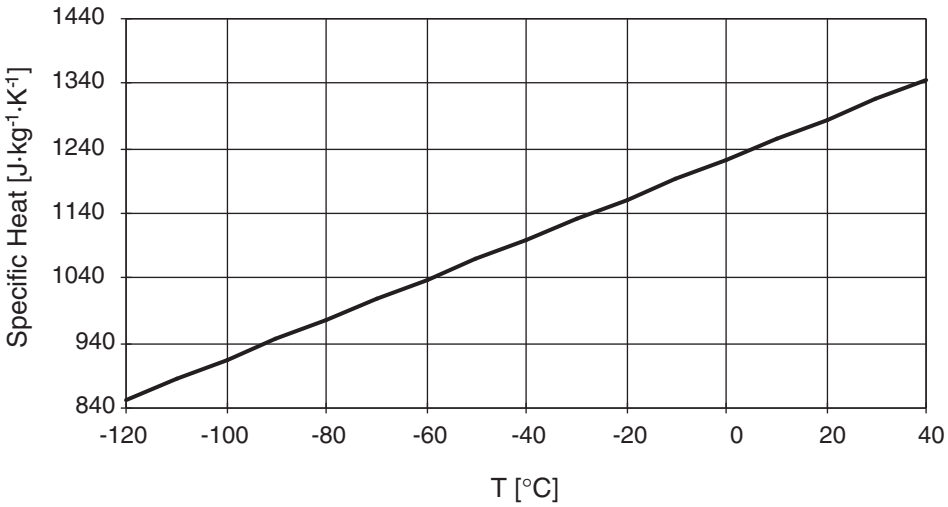
Typical Physical Properties (continued)

Not for specification purposes

All properties at 25°C (77°F) and 1 atm unless otherwise noted

Chart 4

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

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 75 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
Acute Lethal Concentration	>30,000 ppmv
8 hr Exposure Guideline	75 ppmv
Skin Irritation	Negative[1]
Mutagenicity	Negative[1]
Ecotoxicity (water solubility < 2.5 ppb)	Very low aquatic toxicity
Acute Oral Toxicity	LD_{50} > 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
Ozone Depletion Potential[1] (ODP)	0.0
Global Warming Potential[2] (GWP)	370
Atmospheric Lifetime (years)	4.9

[1] CFC-11 = 1.0

[2] GWP 100-year integrated time horizon (ITH)

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™ 7000 Engineered Fluid is nonflammable. 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

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

- Stainless Steel
- Brass
- Copper
- Aluminum
- Polypropylene
- Polyethylene
- Nylon
- 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/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 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/cm2.

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.

Recycle and Disposal Options

Used Fluid Return Program

3M offers a program for free* pickup and return of used 3M specialty fluids in the U.S. through Safety-Kleen Corp. A pre-negotiated handling agreement between users and this service provider offers users broad protection against future liability for used 3M product. The fluid return program is covered by independent third-party financial and environmental audits of treatment, storage and disposal facilities. Necessary documentation is provided. A minimum of 30 gallons of used 3M specialty fluid is required for participation in this free program.*

Safety-Kleen Corp. has a network of 156 branch service centers in the U.S. This large fleet will provide timely, economical fluid disposal service.

For additional information on the 3M Used Fluid Return Program, contact Safety-Kleen at this toll-free line: 1.888.932.2731. Contact your local 3M representative for fluid return programs outside the U.S.

* Must have a 30 or more gallon purchase to participate in the 3M paid program. Used product of 5-30 gallons can be returned through Safety-Kleen at the user's expense.

Resources

3M™ Novec™ Engineered Fluids are supported by global sales, technical and customer service resources, with fully-staffed technical service laboratories in the U.S., Europe, Japan, Latin America and Southeast Asia. Users benefit from 3M's broad technology base and continuing attention to product development, performance, safety and environmental issues.

For additional technical information on 3M™ Novec™ 7000 Engineered Fluid in the United States, call 3M Customer Service, **800 810 8513.**

For information on additional 3M fluids, coatings and other chemical products for the electronics industry, visit our web site at:

www.3M.com/electronics

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