

# 3M™ Novec™ 7000 Engineered Fluid

## 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.

## 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
- Medical Lab
  - Histobath working fluid

## 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

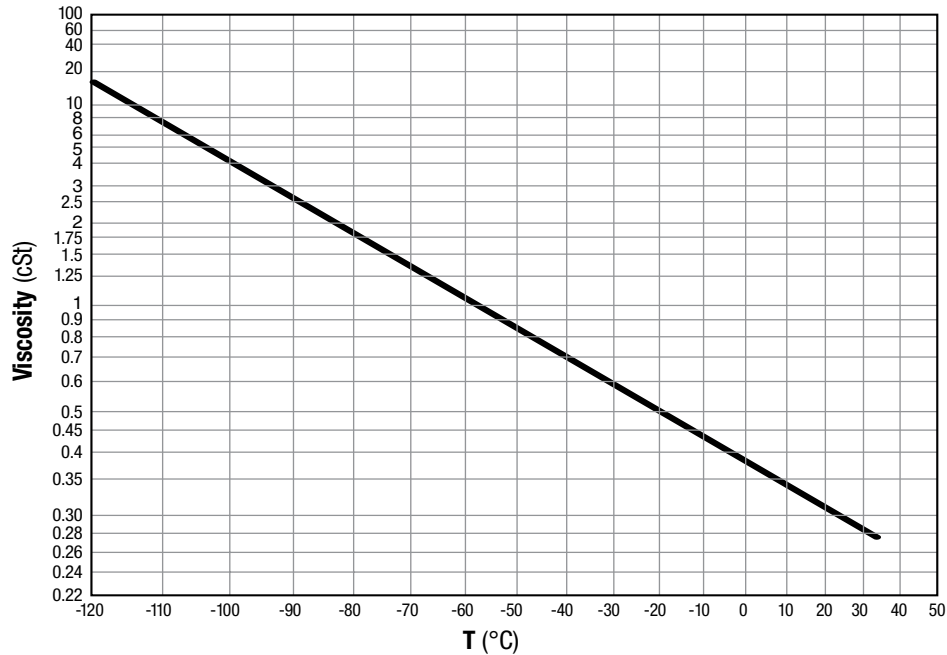
Ingredients	Novec™ 7000 Engineered Fluid
1-methoxyheptafluoropropane (C <sub>3</sub> F <sub>7</sub> OCH <sub>3</sub> )	99.5% by weight
Appearance	Clear, colorless
Non-volatile residue (NVR)	25.0 ppm maximum

## 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 <sup>3</sup> )	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 <sup>-1</sup>
Critical Density (kg/m <sup>3</sup> )	553
Critical Pressure (MPa)	2.48
Critical Temperature (°C)	165°C
Dielectric Constant	7.4
Dielectric Strength (kV)	~40
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 <sup>-1</sup> ·K <sup>-1</sup> )	1300
Surface Tension (dynes/cm)	12.4
Thermal Conductivity (W·m <sup>-1</sup> ·K <sup>-1</sup> )	0.075
Vapor Pressure (kPa)	64.6
Volume Resistivity (ohm-cm)	108

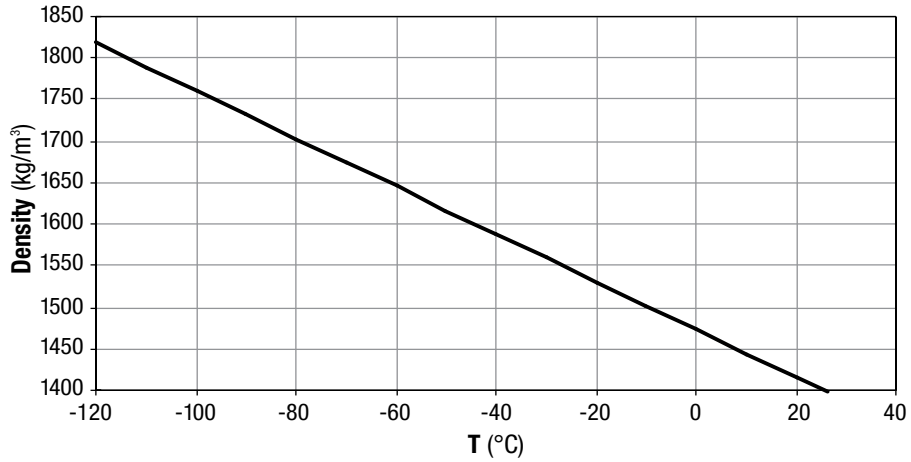
Novec 7000 Kinematic Viscosity



## Typical Physical Properties (continued)

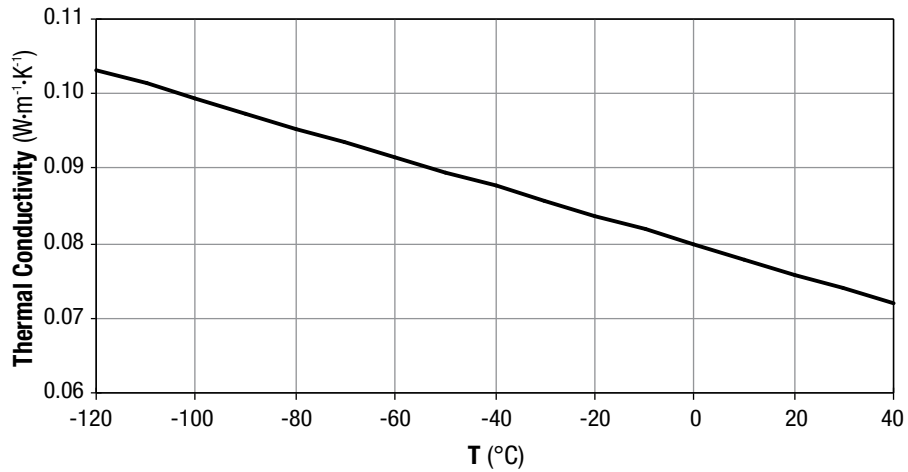
Not for specification purposes. All values @ 25°C unless otherwise specified.

### Novec 7000 Liquid Density



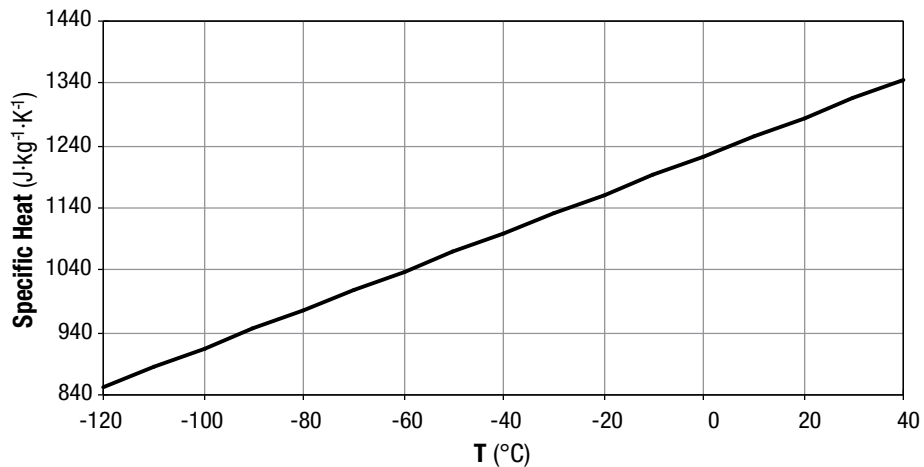
$$\text{Liquid Density [kg/m}^3\text{]} = 1472.6 - 2.880 \cdot T(^{\circ}\text{C})$$

### Novec 7000 Thermal Conductivity



$$\text{Thermal Conductivity [W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}\text{]} = 0.0798 - 0.000196 \cdot T(^{\circ}\text{C})$$

### Novec 7000 Liquid Specific Heat



$$\text{Liquid Specific Heat [J} \cdot \text{kg}^{-1} \cdot \text{K}^{-1}\text{]} = 1223.2 + 3.0803 \cdot T(^{\circ}\text{C})$$

## Novec 7000 Vapor Pressure

$$\ln(P[\text{Pa}]) = -3548.6/T[\text{K}] + 22.978$$

$$-30^{\circ}\text{C} < T < T_c$$

## 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 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 Engineered Fluid
Acute Lethal Concentration (ppmv)	>30,000
8 hr Exposure Guideline (ppmv)	75
Skin Irritation	Negative <sup>1</sup>
Mutagenicity	Negative <sup>1</sup>
Ecotoxicity (water solubility < 2.5 ppb)	Very low aquatic toxicity
Acute Oral Toxicity	LD50 > 2000 mg/kg <sup>1</sup>
28-day Inhalation	NOAEL=1000 ppm

<sup>1</sup> 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 <sup>1</sup> (ODP)	0.0
Global Warming Potential <sup>2</sup> (GWP)	370
Atmospheric Lifetime (years)	4.9
Flash Point	None

<sup>1</sup> CFC-11 = 1.0

<sup>2</sup> 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:

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<sup>2</sup> 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<sup>2</sup>.

## 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. A pre-negotiated handling agreement between users and our authorized 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.

For additional information on the 3M Used Fluid Return Program, contact your local 3M representative or call 3M Customer Service at 800.810.8513.

### Resources

3M™ Novec™ Engineered Fluids are supported by global sales, technical and customer service resources, with 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 or for the name of a local authorized distributor, call 3M Electronics Markets Materials Division: **800 810 8513**.

### The 3M™ Novec™ Brand Family

The Novec brand is the hallmark for a variety of patented 3M products. Although each has its own unique formula and performance properties, all Novec products are designed in common to address the need for safe, effective, sustainable solutions in industry-specific applications. These include precision and electronics cleaning, heat transfer, fire protection, lubricant deposition and several specialty chemical applications.

3M™ Novec™ Engineered Fluids • 3M™ Novec™ Aerosol Cleaners • 3M™ Novec™ 1230 Fire Protection Fluid • 3M™ Novec™ Electronic Coatings • 3M™ Novec™ Electronic Surfactants

United States	China	Europe	Japan	Korea	Singapore	Taiwan
3M Electronics Markets Materials Division 800 810 8513	3M China Ltd. 86 21 6275 3535	3M Belgium N.V. 32 3 250 7521	Sumitomo 3M Limited 813 3709 8250	3M Korea Limited 82 2 3771 4114	3M Singapore Pte. Ltd. 65 64508888	3M Taiwan Limited 886 2 2704 9011

**Product Use:** All statements, technical information and recommendations contained in this document are based on tests or experience that 3M believes are reliable. However, many factors beyond 3M's control can affect the use and performance of a 3M product in a particular application, including conditions under which the product is used and the time and environmental conditions in which the product is expected to perform. Since these factors are uniquely within the user's knowledge and control, it is essential that the user evaluate the 3M product to determine whether it is fit for a particular purpose and suitable for the user's method of application.

**Warranty and Limited Remedy:** Unless stated otherwise in 3M's product literature, packaging inserts or product packaging for individual products, 3M warrants that each 3M product meets the applicable specifications at the time 3M ships the product. Individual products may have additional or different warranties as stated on product literature, package inserts or product packages. 3M MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY IMPLIED WARRANTY ARISING OUT OF A COURSE OF DEALING, CUSTOM OR USAGE OF TRADE. User is responsible for determining whether the 3M product is fit for a particular purpose and suitable for user's application. If the 3M product is defective within the warranty period, your exclusive remedy and 3M's and seller's sole obligation will be, at 3M's option, to replace the product or refund the purchase price.

**Limitation Of Liability:** Except where prohibited b.incidental, or consequential regardless of the legal theory asserted, including warranty, contract, negligence or strict liability.



### Electronics Markets Materials Division

3M Center, Building 224-3N-11  
St. Paul, MN 55144-1000  
www.3M.com/novec  
1-800-810-8513

Please recycle. Printed in USA.  
Issued: 6/10 © 3M 2010.  
All rights reserved. 7327HB  
98-0212-2499-7

3M and Novec are trademarks of 3M Company.  
Used under license by 3M subsidiaries and affiliates.