



Novec™ Engineered Fluid HFE-7100 for Heat Transfer



A New Engineered Fluid with Unique Heat Transfer Properties

3M™ Novec™ Engineered Fluid HFE-7100 is a clear, colorless, nonflammable and low-odor dielectric fluid with low toxicity and favorable environmental properties. It is ideal for use in a variety of heat transfer applications.

Semiconductor

Novec fluid HFE-7100 is the first of a new generation of low-GWP (Global Warming Potential) dielectric fluids with many of the properties of perfluorinated liquids. These properties permit its use in many traditional PFC applications such as thermal management in dry etchers, ion implanters and thermal shock test equipment.

Industrial/Pharmaceutical

This Novec fluid is an excellent alternative to methylene chloride, trichloroethylene, d-limonene, silicone oils, chlorofluorocarbons and hydrocarbons. The low temperature properties are ideal for applications in freeze drying, reaction control, manufacturing and general process control.

Electronic Cooling

HFE-7100 fluid is compatible with most electronic components. It is being used for direct contact cooling of computers, transformers and fuel cells.

Food Refrigeration

The unique low temperature properties of HFE-7100 fluid make it ideal for use in secondary refrigeration systems. Low viscosity translates into high heat transfer coefficients and low pumping power requirements. Glide matching with this Novec fluid increases heat transfer efficiency and reduces frost formation.

Material Description

Ingredients	Composition of HFE-7100
Appearance	Clear, colorless
Methoxy-nonafluorobutane ¹	99.5% minimum
Non-volatile residue (NVR)	1.0 ppm maximum

¹ HFE-7100 fluid (C₄F₉OCH₃) consists of two inseparable isomers with essentially identical properties. These are (CF₃)₂CF₂CF₂OCH₃ (CAS No. 163702-08-7) and CF₃CF₂CF₂CF₂OCH₃ (CAS No. 163702-07-6).

3M™ Novec™ Engineered Fluid HFE-7100 Physical Properties

Not for specification purposes

All values determined at 77°F (25°C) unless otherwise specified

Properties	HFE-7100
Molecular Weight, g/mol	250.0
Flash Point	None
Freeze Point, °C	-135
Boiling Point, °C	61
Critical Temperature, °C	195.3
Critical Pressure, MPa	2.23
Critical Density, kg/m ³ (estimated)	555
Heat of Vaporization @ B.P., kJ/kg	111.6
Surface Tension, dynes/cm	13.6
Solubility of Water in Fluid, ppm by weight	95
Solubility of Air in Fluid, volume air @ 1 atm per volume fluid	53%
Typical Dielectric Strength (0.1 in. gap), kV (RMS) ¹	28
Dielectric Constant, 100 Hz – 10 MHz	7.39
Volume resistivity, ohm-cm	3.29x10 ⁹

¹ The dielectric strength of virgin HFE-7100 fluid is specified as 20 kV minimum. As dielectric properties can be degraded by the presence of dissolved plasticizer, particulate or water, when dielectric properties are critical, careful attention should be paid to material compatibility and moisture content.

Chart 1

HFE-7100 Kinematic Viscosity

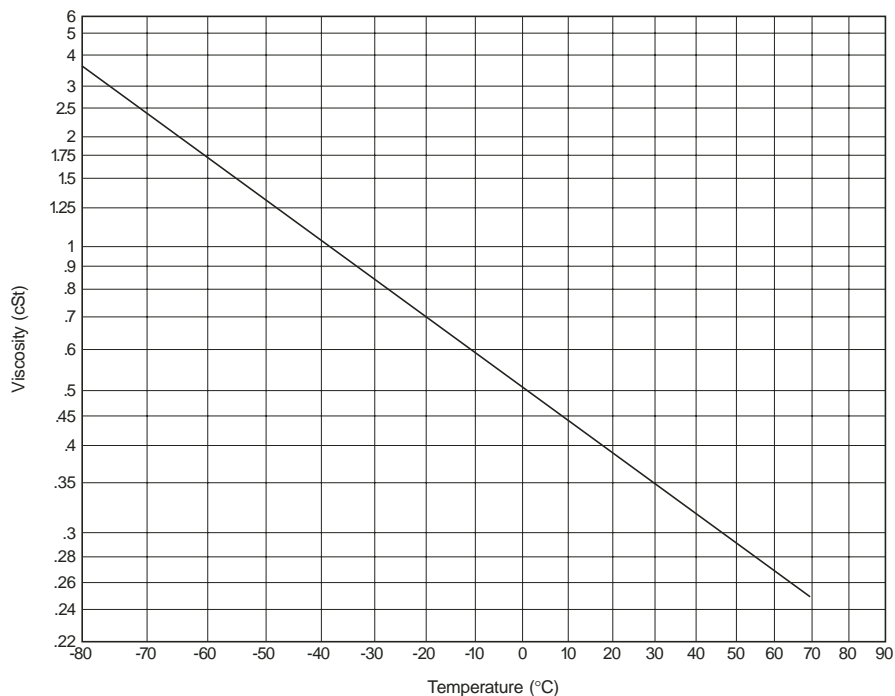
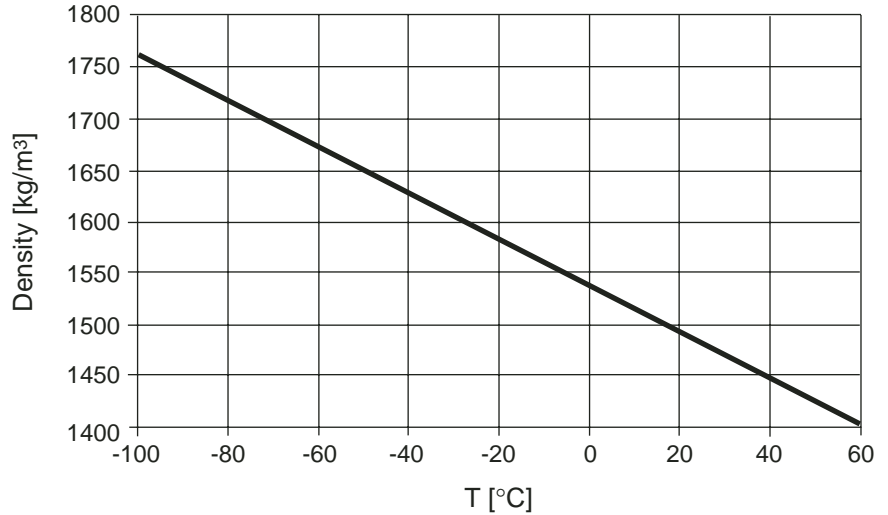


Chart 2

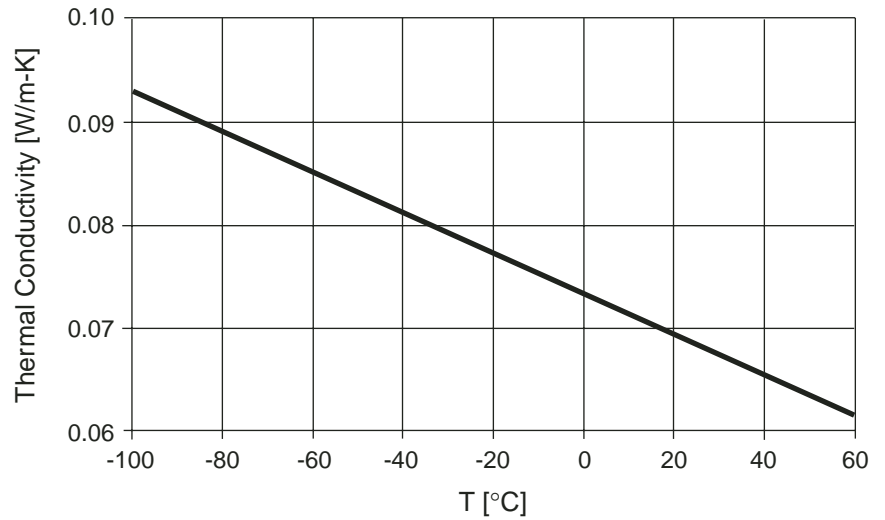
HFE-7100 Liquid Density



Liquid Density [kg/m³] = -2.2690*T [°C] + 1538.3

Chart 3

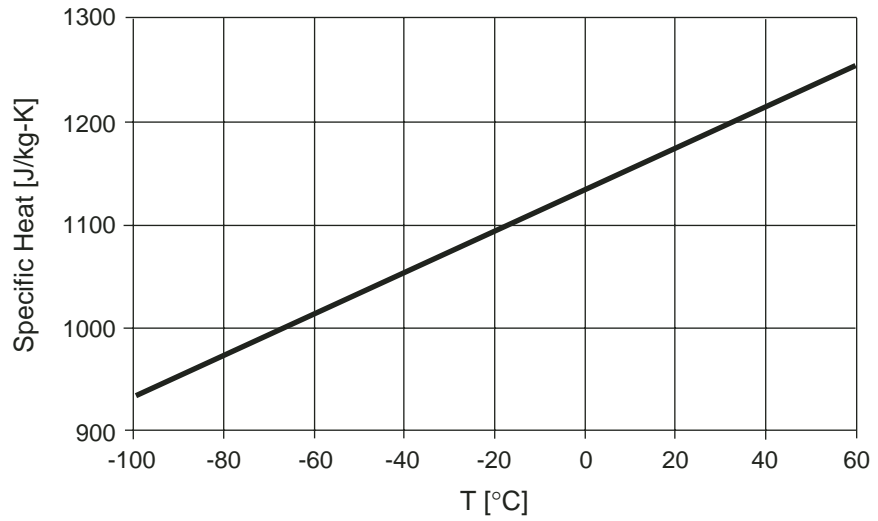
HFE-7100 Thermal Conductivity



Thermal Conductivity [W/m-K] = -0.00019548*T [°C] + 0.073714

Chart 4

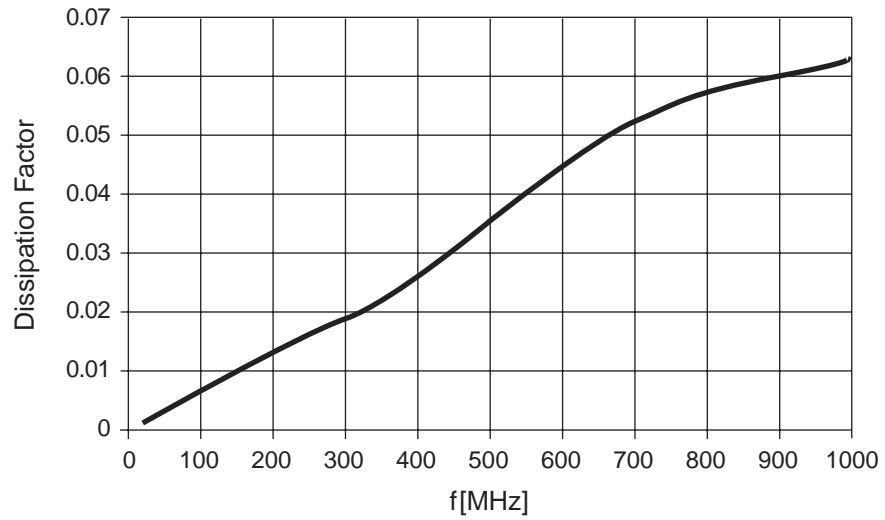
HFE-7100 Liquid Specific Heat



$$\text{Liquid Specific Heat (J/kg-°C)} = 2.00 \cdot T(\text{°C}) + 1133$$

Chart 5

HFE-7100 Electrical Dissipation Factor



HFE-7100 Vapor Pressure

$$\ln(P[\text{Pa}]) = (-3641.9/T[\text{K}]) + 22.415$$

-10°C < T < T_c

3M™ Novec™ Engineered Fluid HFE-7100 Toxicity Profile

The toxicological testing completed on Novec fluid HFE-7100 shows the overall toxicity is low. The material is practically non-irritating to the eyes, minimally irritating to the skin, and is not a mutagen or cardiac sensitizer. It is rated “practically non-toxic” through inhalation. A 90-day inhalation study has helped establish a recommended exposure guideline of 750 ppm for an eight-hour average worker exposure per day. This exposure guideline was established by the American Industrial Hygiene Association.

Toxicological Test Results

Properties	HFE-7100
Acute lethal inhalation concentration	>100,000 ppm (4 hour)
Oral	Practically non-toxic (>5g/kg)
Eye irritation	Practically non-irritating
Skin irritation	Minimally irritating
Skin sensitization	Not a skin sensitizer
Developmental toxicity	Detailed results are available
Mutagenicity	Negative in the three assays conducted
Cardiac sensitization	No signs of sensitization at exposures up to 100,000 ppm
Ecotoxicity	Complete—very low aquatic toxicity
90-day inhalation	750 ppm exposure guideline Detailed results are available

Environmental Properties

Properties	HFE-7100
Ozone depletion potential ¹ —ODP	0.00
Global warming potential ² — GWP	320
Atmospheric lifetime—ALT (years)	4.1

¹ CFC-11 = 1.0

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

3M™ Novec™ Engineered Fluid HFE-7100 Safety and Handling

Novec fluid HFE-7100 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

Novec fluid HFE-7100 is compatible with most metals and hard polymers such as:

- Stainless Steel
- Brass
- Copper
- Aluminum
- Polypropylene
- Polyethylene
- Nylon
- Polyacetyl
- PEEK
- PTFE (some swelling occurs)

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 HFE-7100 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

Novec fluid HFE-7100 has been accepted for commercial use by regulatory agencies in the United States, Canada, Japan, Korea, Australia, Europe (under the European List of Notified New Chemical Substances) the Philippines and China.

Novec fluid HFE-7100 has been approved without restrictions under the Significant New Alternatives Policy (SNAP) of the U.S. EPA. Novec fluid HFE-7100 has been excluded by the U.S. EPA from the definition of a volatile organic compound (VOC) on the basis that this compound has negligible contribution to tropospheric ozone formation.

Contact your local 3M representative regarding the regulatory status of Novec fluid HFE-7100 in other countries.

Used Fluid Return Program

3M offers a program for free pickup and return of used 3M Specialty Materials in the U.S. through Safety-Kleen Corporation. 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 Materials is required for participation in this free program.

Safety-Kleen Corporation 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 Corporation at this toll-free line: 1.888.932.2731.

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 Novec fluid HFE-7100 in the United States, call 3M Performance Materials Division, 800 810 8513.

For information on additional 3M fluids, visit our web site at:
www.3m.com/electronicmaterials

North America 3M Specialty Materials 800 810 8513 800 810 8514	Europe 3M Belgium N. V. 32 3 250 7521	Canada 3M Canada Company 800 364 3477	Japan Sumitomo 3M Limited 813 3709 8250	Korea 3M Korea Limited 82 2 3771 4114
Malaysia 3M Malaysia Sdn. Berhad 60 3 706 2888	Singapore 3M Singapore Pte. Ltd. 65 454 8611	Taiwan 3M Taiwan Limited 886 2 2704 9011	Other Areas 651 736 7123	

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Specialty Materials

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