3M Novec™ 7100 Engineered Fluid

Product Information

Introduction

3M™ Novec™ 7100 Engineered Fluid, methoxy-nonafluorobutane ($C_4F_9OCH_3$), is a clear, colorless and low-odor fluid intended to replace ozone-depleting substances (ODSs) and compounds with high global warming potential (GWP) in many applications. Its physical properties are compared with several other ODS replacement fluid candidates in Table 1.

This proprietary fluid has zero ozone depletion potential and other favorable environmental properties (see Table 2). It has one of the best toxicological profiles of CFC replacement materials, with a time-weighted average exposure guideline of 750 ppm (eight hour average).

The high boiling point and low surface tension of Novec 7100 fluid make it ideal for use in vapor degreasing applications as a neat (pure), azeotropic component or co-solvent parts cleaner. In addition, its chemical and thermal stability, non-flammability and low toxicity make it useful for many other industrial and specialty solvent applications (see below).

Typical Applications

- Cleaning and rinsing agent
  - Heavy-duty cleaning (co-solvent) – heavy oils, greases, fluxes
  - Medium-duty cleaning (azeotrope)– oils, greases, waxes
  - Light-duty cleaning (neat)– particulates, fluorolubes, light oils, fluoropolymers
- Lubricant carrier
  - Fluorocarbons
  - Hydrocarbons
  - Silicones
- Spot-free water drying agent (with surfactants added)
- Specialty solvents, dispersion media, reaction media
- Spray contact cleaner
- CFC, HCFC, HFC and PFC replacement
- Dielectric test media
- Heat transfer
  - See "3M™ Novec™ 7100 Engineered Fluid for Heat Transfer" Application Information

Material Description

Ingredients	Novec 7100
Methoxy-nonafluorobutane[1]	99.5% minimum
Appearance	Clear, colorless
Non-volatile residue (NVR)	2.0 ppm maximum

[1] Novec 7100 fluid ($C_4F_9OCH_3$) consists of two inseparable isomers with essentially identical properties. These are $(CF_3)_2CFCF_2OCH_3$ (CAS No. 163702-08-7) and $CF_3CF_2CF_2CF_2OCH_3$ (CAS No. 163702-07-6).

Typical Physical Properties – Table 1

Data compiled from published information

Not for specification purposes

Properties	Novec 7100	CFC-113	HCFC-141b	HCFC-225 ca/cb[1]	HFC-4310mee
Formula	$C_4F_9OCH_3$	$C_2Cl_3F_3$	$C_2Cl_2H_3F$	$C_3Cl_2HF_5$	$C_5H_2F_{10}$
Molecular Wt.	250	187	117	203	252
Boiling Pt °C	61	48	32	54	54
Freeze Pt °C	-135	-35	-103	-131	-80
Liquid Density[1]	1.52	1.56	1.23	1.55	1.58
Surface Tension[2]	13.6	17.3	19.3	16.2	14.1
Solubility of Solvent in Water[3]	12	170	210	330	140
Solubility of Water in Solvent[3]	95	110	420	310	490
Vapor Pressure[5]	202	334	569	290	226

[1] g/ml @ 25°C [2] dynes/cm @ 25°C [3] ppm by weight
[4] Vol % by ASTM E681-94 @ 100°C [5] mm Hg @ 25°C

Environmental and Safety Properties and Exposure Guidelines – Table 2

Data compiled from published information

Not for specification purposes

Properties	Novec 7100	CFC-113	HCFC-141b	HCFC-225 ca/cb[1]	HFC-4310mee
Ozone Depletion Potential[2]–ODP	0.00	0.80	0.10	0.03	0.00
Global Warming Potential[3]–GWP	320	6000	700	180/620	1700
Atmospheric Lifetime–ALT (yrs)	4.1	85	9.2	2.1/6.2	17.1
Flashpoint	None	None	None	None	None
Flammability Range in Air	None	None	7.6-17.7[4]	None	None
Exposure Guidelines, ppm (8 hr. time-weighted average)	750	1000	500	50	200
Exposure Ceiling (ppm)	None	None	None	None	400
Acute Toxicity (4 hr. LC_{50} [Rat])	>100,000	55,000	62,000	37,000	11,000

[1] HCFC-225 ca/cb ratio is 45/55 [2] CFC-11 = 1.0 [3] GWP–100 year Integration Time Horizon (ITH)
[4] Vol % by ASTM E681-94 @ 100°C

Regulatory Status

3M™ Novec™ 7100 Engineered Fluid has been accepted for commercial use by regulatory agencies in the United States, Europe, Canada, Australia, Japan, Korea and the Philippines. The components of Novec 7100 fluid have been nominated to China's draft chemical inventory.

Novec 7100 fluid has been approved under the Significant New Alternatives Policy (SNAP) of the U.S. EPA. In addition, Novec 7100 fluid has been excluded by the U.S. EPA from the definition of a VOC on the basis that this compound has negligible contribution to tropospheric ozone formation. The components of Novec 7100 fluid are not on any regulated lists.

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

Toxicity Profile

The toxicological testing completed on Novec 7100 fluid 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	Novec 7100
Acute lethal inhalation concentration	>100,000 ppm (4 hour)
Oral	Practically non-toxic (>5 g/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 testing	Complete–very low aquatic toxicity
90-day inhalation	750 ppm exposure guideline Detailed results are available

Vapor Pressure and Density

The variation of vapor pressure and density with temperature for 3M™ Novec™ 7100 Engineered Fluid can be calculated using the following formulas:

Vapor Pressure: $\ln P = 22.415 - 3641.9\,[1/(t+273)]$

Density: $D = 1.5383 - 0.002269t$

P = Vapor Pressure in Pascals
t = Temperature in °C
D = Density in g/ml

Materials Compatibility

Continuous Exposure

Novec 7100 fluid is compatible with most metals and hard polymers. Soft and elastomeric materials should be limited to compounds that contain the least amount of extractable plasticizer. 3M technical service engineers can suggest appropriate compounds and assist with material compatibility tests.

Non-Continuous Exposure

Short-term testing of Novec 7100 fluid demonstrates compatibility, after one hour exposure at boiling temperature, with a wide range of metals, plastics and elastomers, similar to the performance of perfluorinated liquids. Good short-term compatibility with particularly sensitive plastics such as polycarbonate and PMMA indicates utility in cleaning of assemblies containing many composite materials.

As with most fluorinated liquids, Novec 7100 fluid will absorb into fluorinated plastics and elastomers over longer exposures.

Short Term Exposure Compatibility

Metals	Plastics	Elastomers
Aluminum	Acrylic (PMMA)	Butyl Rubber
Copper	Polyethylene	Natural Rubber
Carbon Steel	Polypropylene	Nitrile Rubber
302 Stainless Steel	Polycarbonate	EPDM
Brass	Polyester	
Molybdenum	Epoxy	
Tantalum	PET	
Tungsten	Phenolic	
Cu/Be Alloy C172	ABS	
Mg Alloy AZ32B		

Exceptions: Some swelling of PTFE and Silicone Rubber. Some surface oxidation of copper during heat aging.

Safety and Handling

3M™ Novec™ 7100 Engineered Fluid is nonflammable and does not exhibit flammability characteristics under normal operating and storage conditions. This fluid is highly resistant to thermal breakdown and hydrolysis in storage and during use. Recommended handling procedures are provided in the pertinent Material Safety Data Sheet which is available from your local 3M representative upon request.

Environmental Policy

3M will continue to recognize and exercise its responsibility to prevent pollution at the source wherever and whenever possible; develop products that will have a minimal effect on the environment; conserve natural resources through the use of reclamation and other appropriate methods; assure that its facilities and products meet and sustain the regulations of all federal, state and local environmental agencies; assist, wherever possible, governmental agencies and other official organizations engaged in environmental activities.

Packaging and Availability

Novec 7100 fluid may be ordered in the following container sizes:

- 55-gallon drum; 30-gallon drum; 5-gallon pail; 1-gallon pail
- 4-ounce samples for limited or preliminary test work are available

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™ 7100 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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