3M

Product Information

Novec™ 612
Magnesium Protection Fluid

Introduction

3M™ Novec™ 612 Magnesium Protection Fluid, dodecafluoro-2-methylpentan-3-one, ($CF_3CF_2C(O)CF(CF_3)_2$), is a clear, colorless and low odor fluid, one in a line of 3M products designed as replacements for ozone depleting substances (ODSs) and compounds with high global warming potentials (GWPs) such as sulfur hexafluoride (SF_6) and hydrofluorocarbons (HFCs), such as HFC-134a.

Novec 612 fluid is an effective and efficient cover gas agent for the protection of reactive molten metals such as pure and alloyed magnesium in all types of casting as well as primary production and recycling processes.

Typical Applications

When mixed with a carrier gas such as dry carbon dioxide or nitrogen with 5-20% dry air, Novec 612 fluid is an effective cover gas over molten magnesium metal in refining, alloying and casting operations. Examples of such processes include:

- Open Casting
  - Ingot Casting
  - Direct Chill Ingot Casting
  - Sand Casting
- Recycling of Die Casting Scrap
- Die Casting Furnaces
  - Hot Chamber Holding and Melting Furnaces
  - Cold Chamber Holding and Melting Furnaces
- Alloying of Pure Magnesium

Material Specifications

Properties	Novec 612 Fluid
Dodecafluoro-2-methylpentan-3-one	99.0 mole %, minimum
Nonvolatile residues	0.05 g/100 ml

Cover Gas Performance

Novec 612 fluid has been shown to protect pure magnesium and its alloys at temperatures from 650 to 800°C in melt furnaces and during casting operations. The resulting protection is similar to SF_6, but with very low greenhouse gas emissions. Novec 612 fluid can be used safely, is nonflammable, and produces minimal emissions under recommended operating conditions. It is an attractive and sustainable replacement for SF_6, SO_2 or HFC-134a in molten magnesium operations.

3M™ Novec™ 612 Magnesium Protection Fluid Environmental Properties

Not for specification purposes

All data other than those for Novec 612 fluid were compiled from published sources

Properties	Novec 612 Fluid	SF_6	SO_2	HFC-134a
Ozone Depleting Potential (ODP)	0	0	0	0
Global Warming Potential–IPCC 2001[1]	1	22,200	1	1300
Atmospheric Lifetime (years)	0.014	3200	--	140

[1] IPCC Intergovernmental Panel on Climate Change Method 100 Year (ITH)

Physical Properties

Not for specification purposes

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

Typical Physical Properties	Novec 612 Fluid
Chemical Formula	$CF_3CF_2C(O)CF(CF_3)_2$
Molecular Weight	316.04
Boiling Point @ 1 atm	49.2°C (120.6°F)
Freezing Point	-108.0°C (-162.4°F)
Critical Temperature	168.7°C (335.6°F)
Critical Pressure	18.65 bar (270.44 psi)
Critical Volume	494.5 cc/mole (0.0251 ft^3/lbm)
Critical Density	639.1 kg/m^3 (39.91 lbm/ft^3)
Density, Sat. Liquid	1.60 g/ml (99.9 lbm/ft^3)
Density, Gas @ 1 atm	0.0136 g/ml (0.851 lbm/ft^3)
Specific Volume, Gas @ 1 atm	0.0733 m^3/kg (1.175 ft^3/lb)
Specific Heat, Liquid	1.103 kJ/kg°C (0.2634 BTU/lb°F)
Specific Heat, Vapor @1 atm	0.891 kJ/kg°C (0.2127 BTU/lb°F)
Heat of Vaporization @ boiling point	88.0 kJ/kg (37.9 BTU/lb)
Liquid Viscosity @ 25°C	0.39 centistokes
Solubility of Water in Novec 612 Fluid	<0.001 % by wt.
Vapor Pressure	0.404 bar (5.85 psig)
Relative Dielectric Strength, 1 atm (N_2=1.0)	2.3

Features

Novec 612 fluid's environmental profile, margin of safety in use, and cover gas performance make it a sustainable replacement for SF_6, SO_2 or HFC cover gas agents. Unlike the materials it will replace, it is a liquid at room temperature that can easily be evaporated into a carrier gas stream to form a functional cover gas.

An advantage of a liquid agent is that it can be shipped in conventional liquid containers such as drums or pails rather than in pressurized containers. This means that it can be shipped in bulk by airfreight if needed. Additionally, if a gas leak occurs, the liquid agent can be retained while the gas leak is repaired. With pressurized gases, the agent would be lost.

The liquid is pourable because it is low in viscosity and is easy to handle. It can also be easily pumped with hand, air, or electric powered pumps. Novec 612 fluid is compatible with a wide range of materials of construction and requires no special piping or handling systems. It is also very stable in storage.

Studies by third party laboratories (Massachusetts Institute of Technology) have shown that Novec 612 fluid has an estimated atmospheric lifetime similar to that of acetaldehyde (5 days) due to photolysis in sunlight.[1] Compounds with such short lifetimes do not pose a risk for climate change.

The potential for Novec 612 fluid to impact the radiative balance in the atmosphere (i.e., climate change) is limited by this very short atmospheric lifetime. [Using a measured IR cross-section and the method of Pinnock et.al., the instantaneous radiative forcing for Novec 612 fluid is calculated to be 0.50 Wm-2ppbV^{-1}.] This radiative forcing and a 5-day atmospheric lifetime result in a GWP value of about 1 [using the WMO 1999 method over a 100-year integration time horizon].

The photolysis of Novec 612 fluid is expected to rapidly produce fluorinated alkyl radicals similar to those produced by other fluorochemicals. Studies of the atmospheric chemistry of these radical species and their degradation products have concluded that they have no impact on stratospheric ozone. This combined with its very short atmospheric lifetime, leads to the conclusion that Novec 612 fluid has an ozone depletion of zero.[1]

Before using this product, please read the current product Material Safety Data Sheet (available online or through your 3M sales or technical service representative) and the precautions and directions for use on the product package. Follow all applicable precautions and directions for use.

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[1] N. Taniguchi, T.J. Wallington, M.D. Hurley, A.G. Guschin, L.T. Molina and M.J. Molina, *Atmospheric Chemistry of $C_2F_5C(O)CF(CF_3)_2$: Photolysis and Reaction with Cl Atoms, OH Radicals and Ozone.* **J Phys Chem A**, 2003, **107**, 2674 – 2679.

Toxicity Profile

3M carefully characterizes the toxicity of new materials early in the product development process. These early studies and the subsequent studies conducted by independent laboratories indicate that Novec 612 fluid is very low in both acute and repeat dose toxicity. The No Observed Adverse Effect Level (NOAEL) for all endpoints of acute toxicity is 10% (100,000 ppmV) based on a cardiac sensitization study and a 4-hour acute inhalation study.

The 8-hour time weighed average (TWA) exposure guideline for Novec 612 fluid is 150 ppmV. On this basis, foreseeable use under normal operating conditions results in a large margin of safety between anticipated exposure and the exposure guideline.

3M™ Novec™ 612 Magnesium Protection Fluid Resources

Novec 612 fluid is 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 Novec 612 fluid in the United Sates, or for the name of a local authorized distributor, call 3M Electronics Markets Materials Division:
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