3M™ NOVEC™ ENGINEERED FLUIDS

PRODUCT OVERVIEW

BOEING

BOEING DISTRIBUTION SERVICES INC.

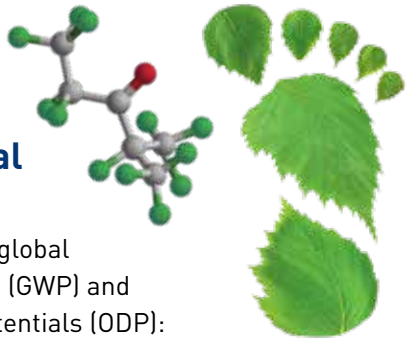
3M™ NOVEC™ ENGINEERED FLUIDS

Safe Reliable Sustainable Chemistries

Boeing Distribution Services Inc. has partnered with 3M to offer you 3M™ Novec™ Engineered Fluids, a new generation of products developed as a replacement for conventional solvents, heat transfer media, insolation media, electronic coating and precision cleaning. They offer a safe, sustainable alternative to many regulated solvents used across multiple applications and are compatible with a wide range of metals, plastics and elastomers.

Due to their excellent compatibility with particularly sensitive plastics such as polycarbonate and PMMA, these products are suitable for cleaning assemblies consisting of many composite materials.

3M™ Novec™ Engineered Fluids are clear, colourless and low-odor fluids based either on hydrofluoroether, fluoroketone, fluorofuran or fluoronitrile chemistry.



Low Environmental Impact

Comparison of the global warming potentials (GWP) and ozone depletion potentials (ODP):

Novec	ODP	GWP	Atmospheric lifetime
649	0	1	5 days
774	0	< 1	4 days
4710	0	2090	30 years
5110	0	< 1	16 days
7000	0	420	4.9 years
7100	0	297	3.8 years
7200	0	57	0.8 years
7300	0	310	3.8 years
7500	0	100	2.2 years
7700	0	420	5.9 years

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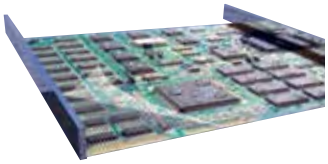
Applications

- Electronics cooling
  - Thermal syphon
  - Dual-stage pump systems
  - High-voltage transformers
  - Immersion cooling
    - > Server cooling
    - > Cooling of high-performance electronics
- Fire Extinguishing
  - Protection of any electronic device against fire
  - Miniature fire extinguishing systems for any electronic hardware
- Solvents for fluoro-based polymers
  - Fluoro-based lubricants
- Measuring and testing
  - Reliable testing of electrical/electronic components
  - Temperature shock testing

- Electronics processing
  - Precision cleaning of PCBs
  - Cleaning of electronic/ mechanical parts or assemblies
  - PCB coating (anti-condensation coating)
- Electro wet-cleaning
  - Applicable for any power electronic units
  - Enables cleaning under current
- SF_6 Gas replacement agent
  - Medium-voltage switchgears
  - High-voltage switchgears
- ORC equipment



Properties

- Electrically non-conductive
- Boiling points from -4.7 °C to 167 °C
- Low surface tension
- Non-flammable and non-explosive
- Zero ozone depletion potential
- Low global warming potential
- Excellent dielectric properties

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3M™ NOVEC™ ENGINEERED FLUIDS

Product Overview/Selection Criteria

Key Properties	Novec Insulating Gas	Novec Engineered Fluids							
Selection Criteria	**4710**	**5110**	**7000**	**649**	**7100**	**7200**	**7300**	**7500**	**7700**
Boiling Point, °C	-4.7	26.9	34	49	61	76	98	128	167
Pour Point, °C	-118	-93	-126	-108	-135	-138	-38	-110	-50
Molecular Weight	195	266	200	316	250	264	350	414	528
Vapour Pressure, Pa	$252.3x10^3$	$94.3x10^3$	$64.6x10^3$	$40.4x10^3$	$26.8x10^3$	$15.7x10^3$	$6.0x10^3$	$2.1x10^3$	$1.41x10^3$
Specific Weight, kg/m^3	8.11 (gas) 1335 (fluid)	1547	1400	1602	1510	1420	1660	1610	1797
Coefficient of Expansion, 1/K	0.002	0.002	0.002	0.002	0.002	0.002	0.001	0.001	0.001
Kinematic Viscosity, mm^2/s (cSt)	0.21	0.30	0.32	0.39	0.38	0.41	0.71	0.77	2.5
Absolute Viscosity, mPa*s (cP)	0.28	0.46	0.45	0.63	0.58	0.58	1.17	1.24	0.87
Specific Heat, kJ/kg K	---	1.322	1.300	1.103	1.180	1.220	1.140	1.128	1.130
Heat of Vapourisation at B.P., J/g	126	109	142	88	112	119	101.7	88.5	83.4
Dielectric Strength, kV, 0.1" gap	27.4 (gas at 100 kPa)	40	40	48	40	40	26.7	35	35
Dielectric Constant, 1 kHz	---	---	7.4	1.84	7.4	7.3	6.14	5.8	6.7
Volume Resistivity, Ω*cm)	---	---	$1x10^8$	$9.9x10^{11}$	$1x10^8$	$1x10^8$	$1.8x10^{11}$	$2.2x10^8$	$5x10^{11}$
Global Warming Potential, 100 years	2090	< 1	420	1	297	57	310	100	420
Ozone Depletion Potential	0	0	0	0	0	0	0	0	0
Temperature Resistance, °C	700*	600*	150	300	150	150	150	150	290

*Thermal stability in the gas phase
All values determined at 25 °C unless otherwise specified. Technical data should not be used for specification purposes.

Contact Boeing Distribution Services for help with all of your engineered fluid needs, or go to **BoeingDistribution.com**

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