

Data Center Liquid Cooling Applications with 3M™ Novec™ Engineered Fluids

3M™ Novec™ Engineered Fluids are designed to balance performance with favorable environmental and worker safety properties. They are available for a wide variety of applications, including heat transfer, cleaning, testing, and lubricant deposition. These fluids are not classified as flammable and are non-oil-based, low in toxicity, non-corrosive and have good material compatibility and thermal stability. Novec fluids also have low global warming potential (GWP) and zero ozone depletion potential (ODP). For single-phase or two-phase data center liquid cooling (direct-to-chip and immersion cooling) applications, 3M recommends the use of the fluids listed below. It should be noted that these hydrofluoroether-based (HFE) Novec fluids have high dielectric constants that may lead to insertion losses in high-frequency applications due to exposed circuit traces. These fluids have been used successfully in cryptocurrency mining applications and may potentially be used in other data center applications if modifications are made to the IT hardware to enable operation in an HFE-based Novec fluid. Please consult 3M Technical Service for use of Novec fluids for immersion cooling.

Properties	Unit	3M™ Novec™ Engineered Fluids					
		Recommended products for two-phase liquid cooling applications			Recommended products for single-phase liquid cooling applications		
		7000	7100	7200	7300	7500	7700
Boiling Point	°C	34	61	76	98	128	167
Pour Point	°C	-122	-135	-138	-38	-100	-50
Molecular Weight	g/mol	200	250	264	350	414	528
Critical Temperature	°C	165	195	210	243	261	290
Critical Pressure	MPa	2.48	2.23	2.01	1.88	1.55	1.41
Vapor Pressure	kPa	65	27	16	5.9	2.1	<0.1
Heat of Vaporization	kJ/kg	142	112	119	102	89	83
Liquid Density	kg/m ³	1400	1510	1420	1660	1614	1797
Coefficient of Expansion	K ⁻¹	0.0022	0.0018	0.0016	0.0013	0.0013	0.0011
Kinematic Viscosity	cSt	0.32	0.38	0.41	0.71	0.77	2.52
Absolute Viscosity	cP	0.45	0.58	0.58	1.18	1.24	4.54
Specific Heat	J/kg-K	1300	1183	1220	1140	1128	1040
Surface Tension	mN/m	12.4	13.6	13.6	15.0	16.2	18.0
Solubility of Water in Fluid	ppm by weight	~60	95	92	67	45	14
Solubility of Fluid in Water	ppm or ppb by weight	<5 ppm	12 ppm	<5 ppm	<295 ppb	<4 ppb	<1 ppb
Dielectric Strength Range, 0.1" Gap	kV	>25	>25	>25	>25	>25	>25
Dielectric Constant @ 1 kHz	-	7.4	7.4	7.3	6.1	5.8	6.7
Volume Resistivity	Ohm-cm	10 ⁸	10 ⁸	10 ⁸	10 ¹¹	10 ⁸	10 ¹¹
Global Warming Potential ¹	GWP	530	297	57	310	100	436
Flash Point ²	°C	None	None	None ³	None	None	None

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

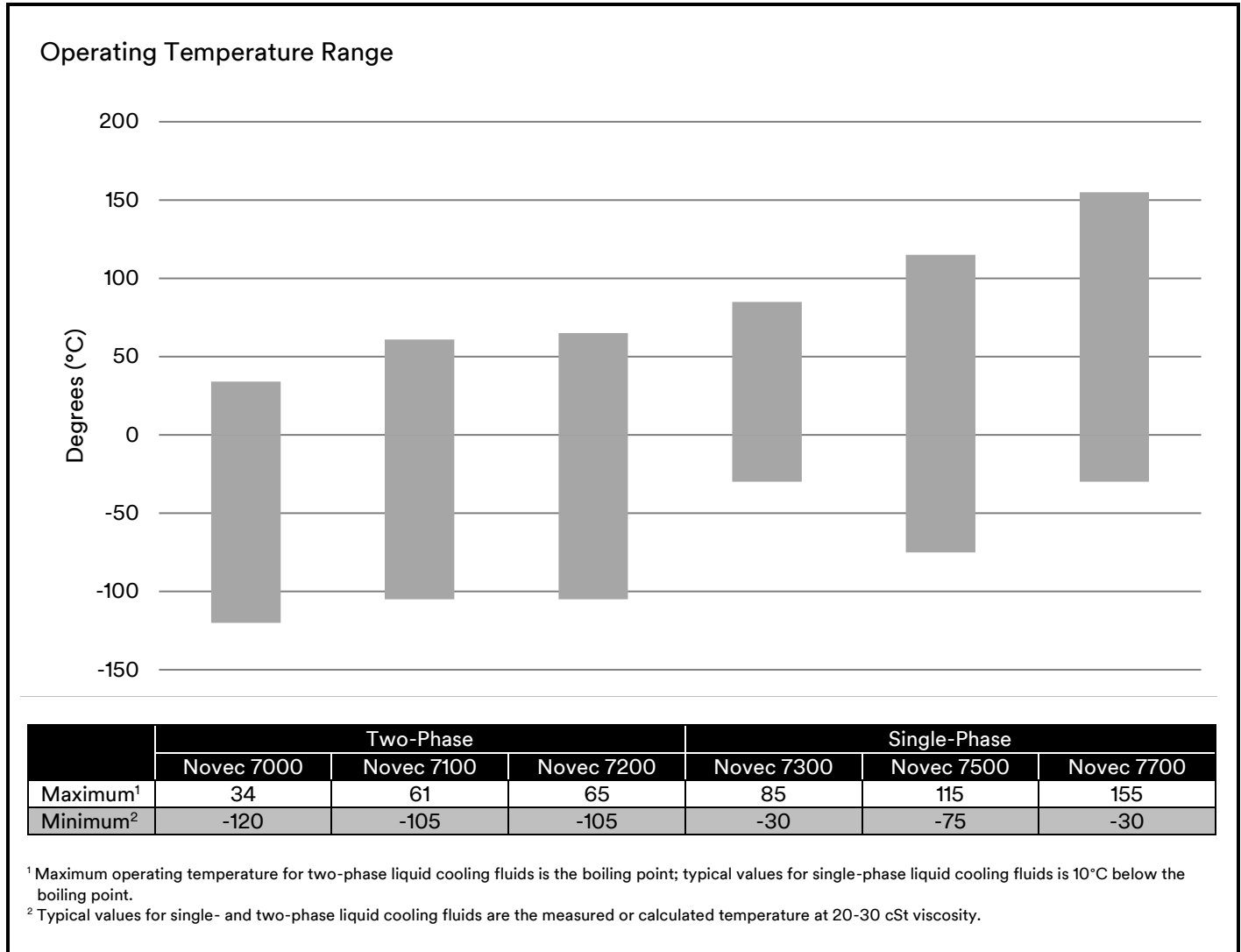
¹GWP-100 year ITH, CO₂ = 1.0, per IPCC 2013, with the exception of Novec 7100 fluid, which notes IPCC 2007.

²Per closed cup flash point test method.

³Does not display a closed cup flash point but does display upper and lower flammability limits. See SDS for details.

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Recommended Operating Temperature Range



To learn more about how 3M fluids can help enable your data center liquid cooling applications, visit 3M.com/immersioncooling.

To learn more about 3M™ Novec™ Engineered Fluids visit 3M.com/Novec.

Safety Data Sheet: Consult Safety Data Sheet before use.

Regulatory: For regulatory information about this product, contact your 3M representative.

Product Use: Many factors beyond 3M's control and uniquely within user's knowledge and control can affect the use and performance of a 3M product in a particular application. Given the variety of factors that can affect the use and performance of a 3M product, user is solely responsible for evaluating the 3M product and determining whether it is fit for a particular purpose and suitable for user's method of application.

IMPORTANT NOTICE: The technical information, recommendations and other statements contained in this document are based upon tests or experience that 3M believes are reliable, but the accuracy or completeness of such information is not guaranteed. Contact your local 3M representative or visit 3M.com/Novec for more information.

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