

Vertrel™ XF

Specialty Fluid

Technical Information

Introduction

Vertrel™ XF is a proprietary hydrofluorocarbon (HFC) fluid ideally suited for use in vapor degreasing equipment for cleaning, rinsing, and drying. It can replace current hydrochlorofluorocarbon (HCFC) and perfluorocarbon (PFC) fluids in most applications.

Vertrel™ XF is HFC 43-10mee or 2,3-dihydrodecafluoropentane; empirical formula $C_5H_2F_{10}$. It is a clear, colorless liquid with the properties shown in **Tables 1** and **2**.

Unique physical properties include a high density, low viscosity, and low surface tension. This combined with nonflammability, chemical and thermal stability, low toxicity, and ease of recovery by distillation make Vertrel™ XF ideal for a broad range of applications. Solvency is selective, but can be enhanced by use of appropriate azeotropes and blends with alcohols, hydrocarbons, esters, etc. (see **Table 3**).

Typical Applications

- Cleaning and rinsing agent
- Drying fluid
- Particulate remover
- Fluorocarbon lubricant carrier
- Solvent and dispersion media
- Heat transfer media
- Dielectric fluid
- Replacement for many HCFC, PFC, and CFC-113 applications

Flush Cleaning

Vertrel™ XF is ideally suited for cleaning fine particulate matter (submicron range) from metal and nonmetal parts. Removal of particle contamination requires a solvent that can minimize the thickness of the laminar boundary layer where particles are bonded to the substrate. If the boundary layer thickness is less than the particle diameter, momentum from the flowing solvent can efficiently dislodge the particles and carry them away. Vertrel™ XF, with its lower viscosity and higher density, results in a thinner boundary layer that enhances cleaning. Common aqueous cleaning fluids, mixtures of water and detergent, have higher viscosities and lower densities compared to Vertrel™ XF, making these fluids less efficient.

The electronic attraction between particle and surface can be overcome further by increasing the polarity of the fluid through the addition of small amounts of alcohols. Chemours offers a series of proprietary azeotrope and blend compositions that exploit this property (see **Table 3**).

Table 1. Physical Properties

Property ^a	Vertrel™ XF
Molecular Weight	252
Boiling Point, °C (°F)	55 (130)
Surface Tension, N/m (dyn/cm)	0.0141 (14.1)
Liquid Density, kg/L (lb/gal)	1.58 (13.2)
Freezing Point, °C (°F)	-80 (-112)
Solubility in Water, ppm	140
Solubility of Water, ppm	490
Critical Temperature, °C (°F)	181 (357)
Critical Pressure, kPa (atm) (psia)	2,288 (22.6) (331.9)
Critical Volume, L/mol (cc/mol)	0.433 (433)
Heat of Vaporization (at boiling point), cal/g (kJ/kg)	31.0 (129.7)
Specific Heat at 20°C, kJ/kg·°C	1.13
Vapor Pressure, kPa (atm) (psia)	30.1 (0.297) (4.37)
Viscosity, cP	0.67

^aAt 25°C (77°F), except where indicated.

^bPensky-Martens Closed Cup Tester (ASTM D93)

^cTag Open Cup Tester (ASTM D1310)

Another common cleaning technique is the addition of ultrasonics to the solvent. High frequency, ultrasonic waves produce tiny bubbles that form and collapse (cavitate) as the wave passes. Cavitation energy increases with decreasing viscosity, another advantage of Vertrel™ XF, improving its ability to mechanically dislodge particle contamination.

Vapor Degreasing Process

Use of modern vapor containment technology is recommended for both batch and in-line equipment. These systems have higher freeboard and a secondary set of low-temperature (-29°C [-20°F]) condenser coils to greatly reduce vapor losses from boiling solvent degreasing, defluxing, rinsing, and drying equipment.

Neat Vertrel™ XF can be used for rinsing, drying, and some cleaning applications, but use with other components, such as azeotropes or simple blends, can provide improved solvency and soil removal. Vertrel™ XF forms azeotropes or constant boiling mixtures with many similar boiling range components. Five nonflammable proprietary azeotrope compositions have been developed that are useful for general, as well as precision, cleaning and defluxing. See specific product bulletins for details.

Table 2. Density and Vapor Pressure Change with Temperature

Temperature, °C (°F)	Density, kg/L	Vapor Pressure, atm
-20 (-4)	1.70	0.021
-10 (14)	1.68	0.047
0 (32)	1.66	0.082
10 (50)	1.62	0.143
20 (68)	1.60	0.232
30 (86)	1.57	0.374
40 (104)	1.55	0.571
50 (122)	1.51	0.843
60 (140)	1.49	1.212
70 (158)	1.46	1.695
80 (176)	1.43	2.306
90 (194)	1.40	3.083
100 (212)	1.38	4.042
110 (230)	1.34	5.211
120 (248)	1.32	6.621
130 (266)	1.30	8.301

Table 3. Azeotropes of Vertrel™ XF

Product	Vertrel™ XF With	Boiling Point, °C (°F)
Vertrel™ XM	Methanol	46 (115)
Vertrel™ XE	Ethanol	52 (126)
Vertrel™ XP	Isopropanol	52 (126)
Vertrel™ MCA	Trans-1,2-Dichloroethylene	39 (102)
Vertrel™ SMT	Trans-1,2-Dichloroethylene and Methanol	37 (99)

Solvency

Unlike PFCs, Vertrel™ XF is completely miscible with most esters, ketones, ethers, ether-alcohols, and the lower alcohols, such as methanol, ethanol, and isopropanol. The lower hydrocarbons, such as hexane and heptane, are also soluble. Neat Vertrel™ XF has limited solvency for many higher molecular weight materials, such as hydrocarbon oils, silicone oils, waxes, and greases; here combinations with the many readily miscible esters, alcohols, and lower hydrocarbons can enhance solubility and cleaning efficiency. Like CFC-113 and PFCs, Vertrel™ XF has high solubility for Krytox™ and “Fomblin” fluorocarbon lubricants and can be used either as an application carrier fluid or to clean the lubricants.

Plastic and Elastomer Compatibility

A large variety of plastics and elastomers can be safely exposed to Vertrel™ XF. **Tables 4** and **5** summarize test results on short-term exposures of unstressed plastics and elastomers, which simulate a typical cleaning cycle.

Long-term compatibility data simulating exposure of vapor degreaser construction materials is available from Chemours upon request.

Elastomer swelling and shrinking will, in most cases, revert to within a few percent of original size after air drying. Swell, shrinkage, and extractables are strongly affected by the compounding agents, plasticizers, and curing used in the manufacture of plastics and elastomers. Therefore, prior in-use testing is particularly important.

Table 4. Plastic Compatibility Immersion: 15 Minutes at Room Temperature

Compatible	
Polyethylene	ABS
Polypropylene	Acetal
Polystyrene	Epoxy
Polyester, PET, PBT	Ionomer
Polyphenylene Oxide, PPO	Liquid Crystal Polymer
Polyimide, PI, PEI, PAI	Phenolic
Polyetherketone, PEK	PVC, CPVC
Polyaryletherketone, PEEK	PTFE, ETFE
Polysulfone	
Polyarylsulfone	
Polyphenylene Sulfide, PPS	
Incompatible*	
Acrylic	Cellulosic

Table 5. Elastomer Compatibility Immersion: 15 Minutes at Room Temperature

Compatible	
Buna-N, NBR, Nitrile	Buna-S, SBR, GRS
Butyl Rubber, IIR	Chlorosulfonated PE
EPM, EPDM, Nordel®	Polysulfide
Natural Rubber, Isoprene	Neoprene
Urethane	Silicone
Incompatible*	
Viton™	

*Material composition varies depending upon compounding agents, plasticizers, processing, etc. Specific materials should be tested for compatibility with solvent.

Metals and Other Compatibility

Vertrel™ XF is fully compatible with the metals listed below after exposure for two weeks at 100°C (212°F) in sealed tubes with and without water contact.

- Zinc*
- Stainless Steel
- Brass*
- Aluminum
- Copper*

*Slight discoloration with water present

Vertrel™ XF is not compatible with strong bases; therefore, contact with highly basic process materials is not recommended.

Exposure Limits

Data from acute toxicity studies has demonstrated that Vertrel™ XF has low toxicity. Vertrel™ XF is a slight skin and eye irritant and has low acute inhalation toxicity. **Table 6** shows the applicable exposure limits for Vertrel™ XF.

Table 6. Exposure Limits

Component	Limit, ppm	Type
Vertrel™ XF AEL ^a	200 ^a 400 ^b	8- and 12-hr TWA ^a Ceiling ^b

^aAcceptable Exposure Limit (AEL) is an airborne inhalation exposure limit established by Chemours that specifies time-weighted average concentrations to which nearly all workers may be repeatedly exposed without adverse effects.

^bA ceiling limit is the concentration that should not be exceeded during any part of the working day. The ceiling limit for individual components applies to a blend product as well.

Safety/Flammability

Vertrel™ XF is nonflammable and does not become flammable during boiling or evaporation. It exhibits no closed or open cup flash point and is not classified as a flammable liquid by NFPA or DOT. It is thermally stable to 300 °C (572 °F) and does not oxidize or degrade during storage.

Recovery

Vertrel™ XF is a pure component material and is easily recoverable by off-line and in-line distillation equipment, such as a vapor degreaser or still. The presence of soil, however, may alter the characteristics of the material during the recovery operation. Recovery should be closely monitored to ensure operating levels are maintained. Users should test the spent Vertrel™ XF to ensure proper classification for waste disposal.

Storage/Handling

Vertrel™ XF is thermally stable and does not oxidize or degrade during storage. Store in a clean, dry area. Protect from freezing temperatures. Do not allow stored product to exceed 52 °C (125 °F) to prevent leakage or potential rupture of container from pressure and expansion.

Consideration should be given to retrofit of existing or purchase of new, vapor degreasing equipment to provide vapor containment technology that enables safe and economical use of Vertrel™ XF.

Drum pumps are recommended to dispense Vertrel™ XF from its container. Refer to the Safety Data Sheet (SDS) for specific handling precautions and instructions.

Environmental Legislation

Vertrel™ XF has zero ozone depletion potential and a low global warming potential (**Table 7**). Vertrel™ XF and its azeotropes and blends are used as alternatives to CFC-113, methylchloroform, HCFCs, and PFCs in many critical cleaning, drying, carrier fluid, and other high-value specialty uses where reliability is paramount.

Vertrel™ XF is accepted by the U.S. Environmental Protection Agency (EPA) under the Significant New Alternatives Policy (SNAP) program as a substitute for ozone-depleting substances. HFC 43-10mee or decafluoropentane is exempt from classification as a volatile organic compound (VOC) by the EPA. Vertrel™ XF is also VOC compliant under the California South Coast Air Quality Management District (SCAQMD) regulations that require VOC content less than 50 g/L of solvent.

Vertrel™ XF is listed in the TSCA inventory. It is subject to the Significant New Use Rule (SNUR) and should be used only in the indicated applications. See SDS Regulatory Section.

Vertrel™ XF is not a hazardous air pollutant (HAP), and, therefore, not subject to NESHAP regulation. Spent Vertrel™ XF is not an RCRA characteristic or listed waste. However, addition of contaminants could change that status. Vertrel™ XF is not included in the SARA Title III Section 313 list of toxic chemicals and is not subject to SARA Title III (EPCRA) reporting requirements.

Packaging and Availability

Vertrel™ XF is commercially available in 55-gal (208-L) drums with a net weight of 660 lb (299 kg) and in 5-gal (20-L) pails with a net weight of 60 lb (27 kg). One-gallon and smaller samples in glass containers are available on request. Customers are encouraged to secure samples now for compatibility and performance testing.

Specifications

Composition and specifications are shown in **Table 8**.

Table 7. Environmental Properties

Property	Vertrel™ XF
Formula	C ₅ H ₂ F ₁₀
Class	Hydrofluorocarbon (HFC)
Atmospheric Lifetime, yr	17.1
Ozone Depletion Potential (ODP)	0
Global Warming* Potential (GWP/100 yr ITH)	1650
Volatile Organic Compounds (VOC, g/L)	Exempt

*IPCC AR5 Fifth Assessment Report

Table 8. Vertrel™ XF Specifications

Property	Vertrel™ XF
Fluoropentanes, wt%	99.9 min.
Nonvolatile Residue, ppm wt	2.0 max.
Moisture, ppm wt	50 max.
Acidity, mg KOH/g	0.01 max.
Appearance	Clear, Colorless

For more information on Vertrel™, please visit vertrel.com or call (800) 235-7882.

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