DuPont™ Vertrel® XF Select

Specialty Fluid

Introduction

Vertrel® XF Select is a proprietary hydrofluorocarbon fluid with "zero" ozone depletion and a low global warming potential ideally suited for critical cleaning, rinsing, carrier fluid, and other high-value specialty applications. It can replace current hydrochlorofluorocarbon (HCFC) and perfluorocarbon (PFC) fluids in most applications.

Vertrel® XF Select 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 1–2**. 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 Select ideal for a broad range of applications.

Table 1
Physical Properties

Property[a]	Vertrel® XF Select
Molecular Weight	252
Boiling Point, °C (°F)	55 (130)
Vapor Pressure, mm Hg (psia)	226 (4.4)
Freezing Point, °C (°F)	–80 (–112)
Liquid Density, g/cc (lb/gal)	1.58 (13.2)
Surface Tension, dyn/cm	14.1
Viscosity, cPs	0.67
Solubility in Water, ppm	140
Solubility of Water, ppm	490
Critical Temperature, °C (°F)	181 (357)
Critical Pressure, psia (atm)	331.9 (22.6)
Critical Volume, cc/mol	433
Heat of Vaporization (at boiling point), cal/g (Btu/lb)	31.0 (55.7)
Specific Heat, cal/g°C (Btu/lb°F)	0.27 (0.27)
Dielectric Constant	7-10
Breakdown Voltage, kV	
Liquid	14-28
Vapor	10-12
Volume Resistivity, ohm-cm	
Liquid	10^9-10^{11}
Flash Point	
Closed Cup[b]	None
Open Cup[c]	None
Flammable Range in Air	None

[a] At 25°C (77°F) except where indicated.

[b] Pensky-Martens Closed Cup Tester (ASTM D 93)

[c] Tag Open Cup Tester (ASTM D 1310)

Typical Applications

- Cleaning and rinsing agent
- Particulate remover
- Lubricant carrier
- Solvent and dispersion media
- Replacement for many HCFC, PFC, and CFC-113 applications

Table 2
Density and Vapor Pressure Change with Temperature

Temperature, °C (°F)	Density, g/cc (lb/g)	Vapor Pressure, mmHg (psia)
–20 (–4)	1.70 (14.2)	16 (0.3)
–10 (14)	1.68 (14.0)	36 (0.7)
0 (32)	1.66 (13.8)	62 (1.2)
10 (50)	1.62 (13.5)	109 (2.1)
20 (68)	1.60 (13.3)	176 (3.4)
30 (86)	1.57 (13.1)	284 (5.5)
40 (104)	1.55 (12.9)	434 (8.4)
50 (122)	1.51 (12.6)	641 (12.4)
60 (140)	1.49 (12.4)	921 (17.8)
70 (158)	1.46 (12.2)	1288 (24.9)
80 (176)	1.43 (11.9)	1753 (33.9)
90 (194)	1.40 (11.7)	2343 (45.3)
100 (212)	1.38 (11.5)	3072 (59.4)
110 (230)	1.34 (11.2)	3961 (76.6)
120 (248)	1.32 (11.0)	5032 (97.3)
130 (266)	1.30 (10.8)	6309 (122.0)

Flush Cleaning

Vertrel® XF Select 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 Select, with its lower viscosity and higher density, results in a thinner boundary layer, which enhances cleaning. Common aqueous cleaning fluids, mixtures of water and detergent, have higher viscosities and lower densities compared to Vertrel® XF Select, making these fluids less efficient.

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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. DuPont offers a series of proprietary azeotrope and blend compositions which exploit this property (see **Table 3**). See the specific product bulletins or contact your DuPont representative for details.

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

Table 3
Alchol Blends 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® X-P10	Isopropanol	54 (129)

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 equipment.

Solvency

Unlike the PFCs, Vertrel® XF Select 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 Select 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 the PFCs, Vertrel® XF Select has high solubility for Krytox® and "Fomblin" fluorocarbon lubricants and can be used either as an application carrier fluid or to remove them.

Plastic and Elastomer Compatibility

A large variety of plastics and elastomers can be safely exposed to Vertrel® XF Select. **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 DuPont 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[a]	
Acrylic	Cellulosic

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

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
	Viton® B
Incompatible[a]	
None Tested	

[a] 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 Select 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*
- Aluminum
- Stainless Steel
- Copper*
- Brass*

*Slight discoloration with water present

Vertrel® XF Select 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 Select has low toxicity. Vertrel® XF Select is a slight skin and eye irritant and has low acute inhalation toxicity. **Table 6** shows the applicable exposure limits for Vertrel® XF Select.

Table 6
Exposure Limits

Component	Limit, ppm		Type
Vertrel® XF Select	AEL[a]	200 400	8- and 12-hr TWA Ceiling[b]

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

[b] A 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 Select 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 Select is a pure component material, and is easily recoverable by off-line or 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 Select to ensure proper classification for waste disposal.

Storage/Handling

Vertrel® XF Select 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 Select.

Drum pumps are recommended to dispense Vertrel® XF Select from its container. Refer to the Material Safety Data Sheet for specific handling precautions and instructions.

Environmental Legislation

Vertrel® XF Select has "zero" ozone depletion potential and a low global warming potential (**Table 7)**. Vertrel® XF Select is used as an alternative to CFC-113, methylchloroform, hydrochlorofluorocarbons (HCFCs), and perfluorocarbons (PFCs) in many critical cleaning, drying, carrier fluid, and other high-value specialty uses where reliability is paramount.

Vertrel® XF Select 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 EPA. Vertrel® XF Select is also VOC compliant under the California South Coast Air Quality Management District (SCAQMD) regulations, which require VOC content less than 50 g/L of solvent.

Vertrel® XF Select is listed in most country chemical inventories, such as TSCA in the U.S., ELINICS in Europe, Chemical Substances Control Law (MITI/MHW) in Japan, DSL (notified) in Canada, NICNAS in Australia, and TCCL in Korea.

Vertrel® XF Select is not a hazardous air pollutant (HAP), and therefore not subject to NESHAP regulation. Spent Vertrel® XF Select is not a RCRA characteristic or listed waste. However, addition of contaminants could change that status. Vertrel® XF Select 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.

Table 7
Environmental Properties

Property	Vertrel® XF Select
Formula	$C_5H_2F_{10}$
Class	Hydrofluorocarbon (HFC)
Atmospheric Lifetime, yr	17.1
Ozone-Depletion Potential (ODP)	0
Global Warming Potential (GWP/100 yr ITH)	1300
Volatile Organic Compounds (VOC, g/L)	Exempt

Packaging and Availability

Vertrel® XF Select 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**. Vertrel® XF Select is listed in the TSCA Inventory.

Table 8
Vertrel® XF Select Specifications

Fluoropentanes, wt%	99.9 min.
Nonvolatile Residue, ppm wt	1.0 max.
Moisture, ppm wt	40 max.
Acidity, mg KOH/g	0.01 max.
Appearance	Clear, Colorless
Dioctylphthalate, ppb wt	20 max.
Organic Silicones, FTIR absorbance units @ 1050 cm-1	0.01 max.

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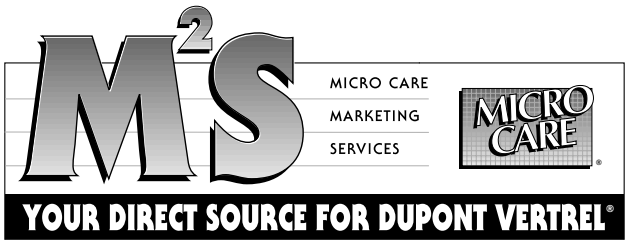

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