

DuPont™ Vertrel® X-Si

SPECIALTY FLUID

Technical Information

Silicone Deposition, Removal and Swelling

Introduction

DuPont™ Vertrel® X-Si is a proprietary blend of DuPont™ Vertrel® XF hydrofluorocarbon (2,3-dihydrodecafluoropentane) and hexamethyldisiloxane. It is ideally suited for use in medical applications as a solvent for cleaning or depositing silicone oil-based lubricants. It is also used as a swelling media for silicone rubber tubing.

DuPont™ Vertrel® X-Si has zero ozone-depletion potential and low global warming potential, and is exempted as a volatile organic compound (VOC). DuPont™ Vertrel® X-Si is accepted by the U.S. Environmental Protection Agency under the Significant New Alternatives Policy (SNAP) program, as a substitute for ozone-depleting substances. It is an alternative to environmentally regulated fluids such as CFC-113, 1,1,1-trichloroethane (1,1,1-TCA or methylchloroform), HCFC-141b, and hexane, a VOC. DuPont™ Vertrel® X-Si can replace high global warming potential materials like perfluorocarbon (PFC) fluids in similar applications in the medical field.

Physical properties of DuPont™ Vertrel® X-Si are shown in **Table 1**.

Process of Use

For most applications using DuPont™ Vertrel® X-Si, parts are immersed in the solvent at room temperature. DuPont™ Vertrel® X-Si evaporates quickly, thus it is recommended that the vapor-to-air interface area be minimized and/or the solvent be cooled to promote efficient and effective use. Due to flammability characteristics, this product should be used in appropriately rated areas and equipment. If there is a need to use the solvent at higher temperatures, a flammable-rated, single sump vapor degreaser can be used. DuPont™ Vertrel® X-Si is not an azeotrope, and should *not* be used in a two-sump vapor degreaser as components of the blend may separate.

Table 1
Physical Properties

Property ^a	DuPont™ Vertrel® X-Si
Molecular Weight	203
Boiling Point, °C	57
°F	134
Liquid Density, kg/l	1.05
Vapor Pressure, atm	0.178
Surface Tension, N/m	0.014
Freezing Point, °C	<-50
°F	<-80
Heat of Vaporization	
at Boiling Point, kJ/kg	159.0
Heat Capacity, kJ/kg·°C	N/A
Viscosity, cPs	0.60
Flash Point	
Closed Cup, °C	<-18 ^b
Open Cup, °C	<0 ^c
Vapor Flammability In Air	
Lower Limit, vol%	5
Upper Limit, vol%	^d

^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)

^d Unable to determine Upper Limit due to condensation

Solubility and Swelling

Laboratory test data for solubility of common silicone fluids in DuPont™ Vertrel® X-Si are shown in **Table 2**.



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Table 2
Solubility of Typical Silicone Fluids in
DuPont™ Vertrel® X-Si at Room Temperature
(% Oil Loading in Solvent)

Oil	DuPont™ Vertrel® X-Si	CFC-113	Hexane
DC-200*	14	19	25
DC-360*	21	24	46
DC-550*	33	39	58
DC-1107*	45	51	65
NuSil Med 4159	28	29	31

*As manufactured by Dow Corning.

Data was also collected to measure swelling of polysilicone tubing. The data shown in **Table 3** compares change in width and weight of polysilicone tubing in various solvents with DuPont™ Vertrel® X-Si.

Table 3
Swelling of Polysilicone Tubing

Test	DuPont™ Vertrel® X-Si	CFC- 113	Hexane
At Room Temperature			
% Change in Width	15	16	23
% Change in Weight	60	133	83
At Boiling Point*			
% Change in Width	20	20	24
% Change in Weight	64	144	63

*47°C (117°F) for CFC-113; 54°C (129°F) for DuPont™ Vertrel® KCD-X-Si; 68°C (154°F) for Hexane

Note that DuPont™ Vertrel® X-Si has similar swelling capability compared with hexane and CFC-113. However, DuPont™ Vertrel® X-Si is superior in performance because it results in a much smaller weight gain of the polysilicone tubing due to solvent absorption. This is very desirable from the viewpoint of solvent consumption as well as a faster recovery of the polysilicone tubing to its original state.

Plastic and Elastomer Compatibility

DuPont™ Vertrel® X-Si is compatible with most polymeric materials commonly used in the medical application and has excellent compatibility with polycarbonate and polyurethane materials.

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.

Test data for plastics and elastomers compatibility are summarized in **Tables 4** and **5**. These tests simulate effects for exposures of parts in a cleaning cycle. Long-term compatibility data simulating exposure of equipment construction materials is available from DuPont upon request.

Metals and Other Compatibility

DuPont™ Vertrel® X-Si is very stable with most common metals such as aluminum, copper, zinc, carbon steel, and stainless steel.

Contact with highly basic process materials, pH 10 or above, is not recommended.

Table 4
Plastic Compatibility
Immersion: 15 Minutes at Room Temperature

Compatible	
Polyethylene	ABS
Polypropylene	Acetal
Polystyrene	Acrylic
Polyester, PET, PBT	Epoxy
Polyphenylene Oxide, PPO	Ionomer
Polyimide, PI, PEI, PAI	Liquid Crystal Polymer
Polyetherketone, PEK	Phenolic
Polyaryletherketone, PEEK	PVC, CPVC
Polysulfone	PTFE, ETFE
Polyarylsulfone	Cellulosic
Polyphenylene Sulfide, PPS	
Incompatible ^a	
None tested	

^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
Polyurethane	
Incompatible ^a	
Viton® B	Silicone

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

Exposure Limit

Data from acute toxicity studies has demonstrated that DuPont™ Vertrel® X-Si has low toxicity. DuPont™ Vertrel® X-Si is a slight skin and eye irritant and has low acute inhalation toxicity. **Table 6** shows the applicable exposure limits for the component materials of DuPont™ Vertrel® X-Si.

Table 6
Exposure Limits

Component	Limit, ppm	Type
DuPont™ Vertrel® XF	AEL ^a 200 400	8- and 12-hr TWA Ceiling ^b
Hexamethyldisiloxane	IHG ^c 200	8-hr TWA
DuPont™ Vertrel® X-Si	AEL ^{a, b} 200	Calculated ^d

^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 the blend product as well.

^c IHG are the Industrial Hygiene Guidelines.

^d Calculated in accordance with ACGIH formula for TLVs for mixtures.

Flammability

DuPont™ Vertrel® X-Si exhibits a closed cup flash point per the Pensky-Martens Closed Cup Tester (ASTM D 93) and is classified as a flammable liquid by NFPA or DOT. The product does exhibit vapor flammability limits in air, and has the potential to ignite and burn in an open vessel or in case of a spill, if an ignition source is present. Users should clear equipment of all vapors and liquids before performing any maintenance operations that could result in an ignition source.

Flash point data and limits of flammability in air provide the user with additional information that should be used as elements of a fire risk assessment and to determine guidelines for the safe handling of volatile chemicals. Users should assure compliance with NFPA standards and local fire codes.

Recovery

Recovery of DuPont™ Vertrel® X-Si is not recommended. The product is not an azeotrope, and composition of the recovered product cannot be assured.

If recovery is attempted, flammable rated areas and equipment should be used. The presence of soils may further change the characteristics of the material. Any recovery should be closely monitored to ensure operating levels are maintained. Users should test the spent DuPont™ Vertrel® X-Si to ensure proper classification for waste disposal.

Storage/Handling

DuPont™ Vertrel® X-Si is thermally stable and does not oxidize or degrade during storage. Store in a clean, dry area. Protect from freezing temperatures. If solvent is stored below –10°C (14°F), mix prior to use. Do not allow stored product to exceed 52°C (125°F) to prevent leakage or potential rupture of container from pressure and expansion.

DuPont™ Vertrel® X-Si is classified as a flammable liquid by DOT/NFPA. It does have flammable limits in air, and has the potential to ignite in an open vessel or in case of a spill, if an ignition source is present. A flammable-rated drum pump is recommended to dispense the product from its container.

Environmental Properties

DuPont™ Vertrel® specialty fluids have zero ozone-depletion potential and low global warming potential (**Table 7**). They are used as alternatives 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.

Table 7
Environmental Properties

Property	DuPont™ Vertrel® X-Si
Ozone-Depletion Potential (ODP)	0
Global Warming Potential (GWP/100 yr ITH)*	741
Volatile Organic Compounds (VOC, g/L)	Exempt

* IPCC Second Assessment Report (1995)

Packaging and Availability

DuPont™ Vertrel® X-Si is commercially available in 55-gal (208 L) drums with a net weight of 440 lb (200 kg). It is also available in 5-gal (19-L) pails with a net weight of 40 lb (18 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**. All components are listed in the TSCA Inventory.

Table 8
DuPont™ Vertrel® X-Si Specifications

DuPont™ Vertrel® XF, wt%	57.0 ±1.0
Hexamethyldisiloxane, wt%	43.0 ±1.0
Nonvolatile Residue, ppm wt	10 max.
Moisture, ppm wt	200 max.
Appearance	Clear, Colorless

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CAUTION: Do not use in medical applications involving permanent implantation in the human body or contact with internal body fluids or tissues. For other medical applications, see "DuPont Medical Caution Statement," H-50102.

