

Vertrel™ X-DF

Drying Agent

Removes Water and Contaminants; Rapid, Spot-Free Drying;
Low Energy Consumption

Technical Information

Introduction

Water removal from processed parts is a major manufacturing step in the finishing of glass, ceramic, plastic, and metal components and assemblies. There are a variety of methods to accomplish this task. Some of the more common methods include evaporative, centrifugal, media absorbent, solvent absorption, and solvent displacement drying. Solvent displacement drying is a common and widely accepted method of water removal prior to plating, coating, and other surface treatments of plastics, metals, mirrors, lenses, crystals, and ceramics. The method is particularly useful when reflective and refractive properties must be maintained.

The Vertrel™ X-DF displacement drying system offers one-step, low-energy, spot-free drying that is efficient, safe to use, and environmentally responsible. Vertrel™ X-DF consists of Vertrel™ MCA (an azeotrope of HFC 43-10 and trans-1,2-dichloroethylene) and a surfactant. It is non-flammable, has zero ozone depletion potential (ODP), and very low global warming potential (GWP). The physical properties of Vertrel™ X-DF are shown in **Table 1**.

Table 1. Physical Properties

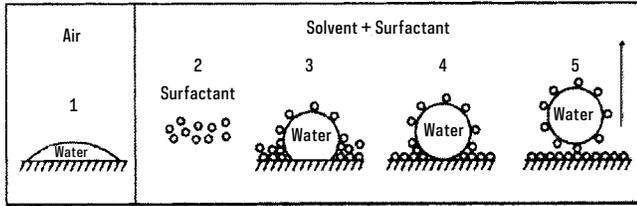
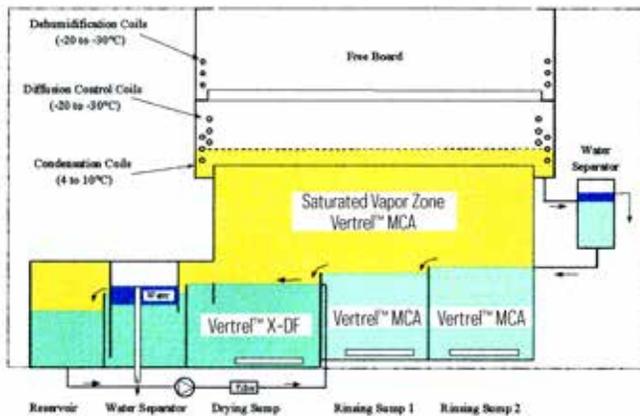
Property	Vertrel™ X-DF
Composition	
Vertrel™ MCA, wt%	99.9
Surfactant, wt%	0.1
Boiling Point, °C (°F)	39 (102.2)
Liquid Density at 25 °C (77 °F), kg/L	1.41
Surface Tension, N/m	0.0152
Flash Point	None
Flammability (UEL, LEL)	None

Vertrel™ Displacement Drying

The Vertrel™ displacement drying system operates on the displacement principle. The process uses the high density and low surface tension (wetting ability) of Vertrel™ MCA fluid and a hydrophobic surfactant additive that promotes water separation, while ensuring the spot-free drying of electrically non-conductive parts, such as glass lenses and mirrors. Used in a 2- or 3-sump cascading process similar to a vapor degreaser, the Vertrel™ displacement drying system can effectively remove large or small quantities of water from metal, glass, or plastic parts and assemblies.

Water, along with dissolved contaminants, adheres to surfaces in droplet form. When a wetted part is immersed in Vertrel™ X-DF, the higher density, lower surface tension and unique properties of the surfactant additive allow the Vertrel™ X-DF to penetrate underneath the water droplet. Buoyancy forces will help lift the agglomerated droplets away from the surface of the part, and the water will rise to the surface of the heavier, hydrophobic Vertrel™ X-DF drying fluid. **Figure 1** illustrates this sequence.

The water flows from the surface of the drying sump over a weir, into a gravity water separator, and is rejected from the dryer through the water drain. The parts are then removed from the drying fluid and passed through one or more cascading baths of Vertrel™ MCA to dissolve and remove residual surfactant from the surface. Upon removal, the parts are dry and spot-free. Displacement drying systems are commercially available and operate much the same as vapor degreasing equipment, except that water separation and removal capabilities are greatly enhanced.

Figure 1. Fluorocarbon Displacement Drying**Figure 2.** Displacement Drying System
**Principle Scheme of Vertrel™ Drying Equipment
(including Chemours Triple Guard™ System)**

Displacement Drying Advantages

Spot-Free Drying

Evaporative or hot air drying generally will deposit a residue of any non-volatile material that was suspended or dissolved in the water. Centrifugal drying is usually effective only in removing gross amounts of water from free draining parts. A slight water film usually remains, which must be removed by other means. Media-absorbent drying transfers moisture from the parts to a porous medium, such as sawdust or corncobs, which then must be disposed of or dried through evaporation. The parts must then be further processed to remove residue deposited by the absorbent media.

Displacement drying depends on the use of a relatively high specific gravity drying fluid to encourage rapid displacement of water along with its water-soluble contaminants. At the low operating temperature (39 °C [102 °F]) of this system, virtually no water evaporates from the wet parts; therefore, water-soluble salts cannot be deposited on their surfaces. This permits water to float to the surface of the solvent, where it is continuously swept away by the equipment

(enabling dried parts to be removed without passing through a layer of contaminated water). This combination of favorable factors (low temperature boiling action, non-miscibility with water, high specific gravity) is the major reason for the dry, spot-free condition of parts emerging from the Vertrel™ X-DF displacement drying system.

Low Energy Consumption

Evaporative or hot air drying employs heat to remove water by changing it from a liquid to a vapor. This method requires large amounts of energy to operate, because approximately 0.6 kWh are required to evaporate each kilogram of water. The Vertrel™ displacement drying system operates at a low operating temperature (39 °C [102 °F]) and consumes significantly less energy.

Other Advantages

The new Vertrel™ displacement drying system offers the following advantages:

- Removes water in pH ranges between 5 and 9.
- Removes hard water.
- Is easily rinsed, because of lower drying agent concentrations.
- Drying agent has limited water solubility and no vapor pressure; so, it will remain in the boil sump.
- Reduces cycle time by elimination of air drying step.

Other Solvent Drying

There are two ways in which solvents can remove water from surfaces: (1) by displacing it through preferential wetting of the parts' surfaces and subsequent separation of the water from a more dense, water-insoluble solvent, such as Vertrel™ X-DF and Vertrel™ X-DA (especially designed for plastic parts) or (2) by dissolving the water—as with polar solvents, such as alcohol or acetone. Vertrel™ X-P10 is such a blend. It consists of Vertrel™ XF (non-soluble in water) and isopropyl alcohol, has no flash point, and is designed for absorption drying. For further information, see Vertrel™ X-P10 product bulletin.

Anti-Static Additive

As opposed to Vertrel™ X-DA (see information sheet of the product), the use of an anti-static additive in the drying fluid in combination with the surfactant is not necessary when using Vertrel™ X-DF.

Drying Procedures

Following is a brief suggested procedure for drying:

1. Place parts in open-mesh holder and lower into drying sump containing Vertrel™ X-DF boiling at 39 °C (77 °F). Usually, a 1- to 3-minute immersion is sufficient, depending on the size, configuration, and other characteristics of the parts. Shake the holder up and down a few times to help dislodge any trapped water between parts. Also, make certain that parts with recesses or cups are oriented so released water can float up to the surface of the bath.
2. Remove parts from the Vertrel™ X-DF and hold over the drying sump to permit excess solvent to drain back into the sump. Lower into the Vertrel™ MCA sump for rinsing. Shake holder. If equipment with a second Vertrel™ MCA rinse sump is employed, repeat the rinsing step.
3. At the end of the rinse, hold parts in the vapor zone. After dripping stops, remove from the dryer; parts will be dry, spot-free, and ready for further processing.
4. Ultrasonics (in the drying and/or rinse sumps) can increase the efficiency of the drying process. A spray rinse of the parts with a spray lance or ring, while they are in the vapor zone, increases the efficiency of the final step. Spraying of parts should be done under the vapor blanket to minimize emissions.
5. The Vertrel™ displacement drying system depends on floating away the displaced water from wet parts. Drying cannot take place if water is trapped inside small cracks and crevices or if orientation traps water under cup-like cavities. These problems are often solved by shaking or rotating parts in the drying bath. The Vertrel™ displacement drying system is not recommended for fibrous or porous parts, as they present special problems in both water displacement and excessive solvent carryout.

Equipment

Consideration should be given to the purchase of new or retrofitting of existing vapor degreasing equipment to provide vapor containment technology that enables safe and economical use of Vertrel™ X-DF.

Fluids Required in the System

Two different fluids are required in the Vertrel™ displacement drying system:

- Vertrel™ X-DF—The drying agent used in the boiling sump. It consists of Vertrel™ MCA plus a surfactant additive to give the water-displacing action. It is used only for the initial charge of the drying sump and re-circulating tank system, as well as for make-up.
- Vertrel™ MCA—Fluid used to charge the rinse sumps. Its primary purpose is to rinse off residual drying agent left on parts coming from the boiling water removal sump. Thereafter, condensed Vertrel™ MCA vapor from the boiling sump will act to keep the fluid in the rinse sumps clean and at the proper level.

Both fluids are nonflammable and offer a drying system compatible with most plastics, elastomers, metals, and other materials of construction.

Because displaced water, with its water-soluble contaminants, automatically floats quickly out of the drying sump and down the drain, the Vertrel™ drying bath retains its effectiveness over long periods of use. Due to the limited water solubility (100 ppm water in Vertrel™ XF) of the surfactant, some surfactant loss can be expected. This can be compensated for by adding Vertrel™ X-DF when additional solvent is needed in the drying sump. Make-up solution for compensation of Vertrel™ X-DF losses should be made of one-third Vertrel™ X-DF and two-thirds Vertrel™ MCA and poured into the drying sump.

Compatibility

The compatibility of materials with Vertrel™ X-DF is virtually the same as with Vertrel™ MCA. Both products have a broad compatibility range (see technical bulletin of Vertrel™ MCA).

Metals and Other Compatibility

Vertrel™ X-DF 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™ X-DF 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™ X-DF has very low toxicity. Vertrel™ X-DF is a slight skin and eye irritant and has low acute inhalation toxicity.

Table 2 shows the applicable exposure limits for Vertrel™ X-DF. Acceptable Exposure Limits (AELs) are time weighted average (TWA) concentrations for a normal 8-12 hour workday and a 40 hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. Please refer to the Safety Data Sheet (SDS) for additional details.

Safety/Flammability/Storage

Vertrel™ X-DF is nonflammable and does not become flammable during boiling or evaporation. It is thermally stable to 300 °C (572 °F) and does not oxidize or degrade during storage. Refer to the SDS for specific handling precautions and instructions. Store in a clean, dry area. Drum pumps are recommended to dispense Vertrel™ drying agent from its container.

Packaging and Availability

Vertrel™ X-DF is currently available in 55-gal (208-L) drums with a net weight of 550 lb (249 kg) and in 5-gal (19-L) pails with a net weight of 50 lb (23 kg).

Table 2. Exposure Limits

Component	Limit, ppm		Type
Vertrel™ XF	AEL ^a	200 400	8- and 12-hr TWA Ceiling ^b
Trans-1,2-dichloroethylene		200	8-hr TWA

^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 the blend product as well.

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

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Replaces: K-16539
C-11031 (10/16)