Teflon® FEP 140

fluoropolymer resin

Description

Teflon® FEP 140 fluoropolymer resin is a melt-processible fluoropolymer resin suitable for extrusion as a primary coating for heavy wire gauges (AWG #11 and larger) and for limited jacketing applications.

As shown in **Table 1**, this resin provides the electrical and mechanical properties needed for low-voltage applications. *Teflon*® FEP 140 has a lower flow rate than either *Teflon*® 3100 or *Teflon*® FEP 100. This low melt flow corresponds to a high molecular weight that provides significant stress crack resistance for thick-walled constructions. The low melt flow, however, significantly reduces the rate at which *Teflon*® FEP 140 can be extruded.

Like all *Teflon*® fluoropolymer resins, *Teflon*® FEP 140 offers an excellent combination of properties: chemical inertness, exceptional dielectric properties, heat resistance, toughness, flexibility, low coefficient of friction, nonstick characteristics, negligible moisture absorption, low flammability, performance at temperature extremes, and weather resistance.

Applications

Teflon® FEP 140 should be used as a primary insulation when thick walls or heavy wire gauges (AWG #11 and larger) are required. It should also be used as a primary coating in applications where *Teflon*® FEP 100 would not have sufficient stress crack resistance such as some heater cables.

Teflon® FEP 140 can be used as jacket material for data and telecommunications cables for use in air return plenums. It has similar stress crack resistance and faster processing speed, which makes it a better jacketing candidate for most applications. In applications such as heater or other industrial cables that involve frequent thermal cycling or extended periods at elevated temperatures, *Teflon*® FEP 140 performs better than *Teflon*® CJ92.

Safety Precautions

WARNING!

VAPORS CAN BE LIBERATED THAT MAY BE HAZARDOUS IF INHALED.

Before using *Teflon*® FEP 140, read the Material Safety Data Sheet and the detailed information in the "Guide to the Safe Handling of Fluoropolymer Resins, 2nd Edition," published by the Fluoropolymers Division of the Society of the Plastics Industry—available from DuPont.

Open and use containers only in well-ventilated areas using local exhaust ventilation (LEV). Vapors and fumes liberated during hot processing, or from smoking tobacco or cigarettes contaminated with *Teflon*® FEP 140, may cause flu-like symptoms (chills, fever, sore throat) that may not occur until several hours after exposure and that typically pass within about 36 to 48 hours. Vapors and fumes liberated during hot processing should be exhausted completely from the work area; contamination of tobacco with polymers should be avoided. Mixtures with some finely divided metals, such as magnesium or aluminum, can be flammable or explosive under some conditions.

Packaging

Teflon® FEP 140 is supplied as pellets and is available in 24.9-kg (55-lb) multilayer kraft bags with an integral polyethylene liner.

Freight Classification

For rail shipments, *Teflon*® FEP 140 is classified as "Plastic, Synthetic, OTL, NOIBN"; for truck shipments as "Plastic Materials, Granules"; and for express shipments as "Plastics, Synthetic."

Table 1
Typical Properties of *Teflon*® FEP 140 Fluoropolymer Resin

Property	ASTM Method	Unit	Value
Electrical			
Dielectric Constant	D1531		
100 kHz (10^5 Hz)		—	2.06
1 MHz (10^6 Hz)		—	2.05
Dissipation Factor	D1531		
100 kHz (10^5 Hz)		—	0.0003
1 MHz (10^6 Hz)		—	0.0006
Dielectric Strength	D149		
10-mil film		V/mil	2000
1/8-in sheet		V/mil	500
Mechanical			
Melt Flow Number	D2116	g/10 min	2.8
Specific Gravity	D762	—	2.14
Tensile Strength	D1708	MPa (psi)	31 (4,500)
Elongation	D1708	%	345
Thermal			
Melting Point	DTA-E168	°C (°F)	266 (511)

Note: Typical properties are not suitable for specification purposes.

Processing Guidelines for Wire and Cable Use Extrusion Equipment

Teflon® FEP 140 is fabricated using the same melt processing techniques as other thermoplastics. A brief description of the extrusion equipment used with *Teflon*® FEP 140 is given here; for more detailed processing information, consult the DuPont "Extrusion Guide for Melt Processible Fluoropolymers," which can be obtained from your DuPont representative.

Molten *Teflon*® resins are corrosive to many metals; therefore, special corrosion-resistant materials must be used for all parts of extrusion equipment that come into contact with the melt. Nickel-based alloys such as Hastelloy, Inconel, Monel, and Xaloy are the materials of choice. Hardened electroless nickel plate can be used, but even small holes, chips, or cracks in the plating can compromise its performance. Chrome-plated materials are not recommended. Additional information on materials of construction can be obtained from your DuPont representative. Corrosion is likely to occur if dead spots exist in the equipment, processing temperatures are too high, or hold-up time is too long. In addition, resin degradation will accelerate corrosion.

A 38–64-mm (1.5–2.5-inch) extruder with a barrel length-to-diameter ratio of 20:1–30:1 is recommended for extruding *Teflon*® FEP 140.

Extruder barrels should have three to five independently controlled heater zones with temperature controllers capable of accurate operation (±0.6°C [±1°F]) in the temperature range of 316–425°C (600–800°F). Heaters should be made of cast bronze or aluminum. Controllers with proportional-integral-derivative (PID) action are recommended.

A 3:1 compression ratio screw consisting of a relatively long feed zone, a one- to three-turn transition, and a metering section that comprises approximately one-fourth of the length of the screw is recommended. The addition of a mixing section at the end of the screw can improve processibility. Contact your DuPont representative for more information.

A melt thermocouple and melt pressure probe should be installed in the adapter section of the extruder. To obtain an accurate measurement, the thermocouple should extend to the centerline of the flow channel.

Degradation of the resin during processing greatly reduces the performance of *Teflon*® FEP 140 in stringent applications. Degradation is caused by excessively high melt temperatures, long residence time in the extruder, or excessive shear from the screw. In general, increases in the melt flow number (MFN) greater than 10% during extrusion should be avoided. This 10% rise in MFN will occur after 5–10 min at 393°C (740°F) or approximately 20 min at 382°C (720°F), but it increases

only 5% after 60 min at 360°C (680°F). This indicates the importance of maintaining resin flow through the extruder while at operating temperature and shows why temperatures should be decreased if the extruder is down for even a short period of time.

Other processing conditions that can reduce the resin's performance include melt fracture, very low or uneven melt temperatures, and the presence of hydrocarbon or silicone oils that act as stress crack promoters.

Wire-Coating Techniques

Teflon® FEP 140 is typically applied as a wire insulation using tubing techniques. Draw-down ratios (DDR) generally ranging from 50:1 to 200:1 are common, with the higher DDRs usually allowing greater line speed. A draw-ratio balance (DRB) ranging from 0.9 to 1.1 is recommended. A complete discussion of DDR and DRB can be found in the DuPont "Extrusion Guide for Melt Processible Fluoropolymers," which can be obtained from your DuPont representative.

A controlled vacuum is required at the rear of the crosshead to adjust the melt cone to the desired length. A melt cone that is too long results in excessive caliper variations while a melt cone that is too short results in excessive spark failures and cone breaks. Laboratory experience has shown that a cone length of 64–76 mm (2.5–3.0 in) yields satisfactory results with a DDR of 122:1 and a DRB of 1.05. Control can be achieved at a shorter cone length if a higher DRB is used.

An electronic wire preheater located as close to the crosshead as possible is recommended for preheating the wire. Although the amount of preheat will depend upon the application, the preheater should be capable of heating the wire to 149–204°C (300–400°F) while operating at a typical line speed of 46 m/min (150 ft/min).

Stationary pulleys should be located on both sides of the crosshead to reduce wire flutter. The wire should pass through the crosshead, without touching the crosshead or the extrusion tip. Sponges should not be used to reduce flutter downstream of the crosshead because they can produce insulation faults.

The coated wire should pass through a 0.3–1.5-m (1–5-ft) air gap to allow uniform cooling and prevent the formation of shrinkage voids in the insulation.

Processing conditions depend on the equipment size and line speed. **Tables 2** and **3** list the actual processing conditions for a 15-mil wall of *Teflon*® FEP 140 on AWG #14 solid copper wire. Adjustments may be necessary for other equipment.

Table 2
Typical Temperature Profile for Extruding *Teflon*® FEP 140 on AWG #14 Solid Copper Wire*

Zone	°C	°F
Rear Zone**	366	690
Rear Center**	382	720
Center	388	730
Front Center	396	745
Front	399	750
Clamp	399	750
Adapter	399	750
Crosshead	410	760
Die Holder	416	770
Melt	397	747

* Based on a 60-mm extruder with a 30:1 L/D; adjustments may be necessary for other equipment.

** For a smaller machine, it will be necessary to raise the temperature to ensure that the resin is completely melted before entry into the extruder's transition zone. A surging output at the die could be caused by incomplete melting.

Table 3
Typical Operating Conditions for Extruding *Teflon*® FEP 140 on AWG #14 Solid Copper Wire*

Extruder Speed	rpm	8.5
Line speed	m/min (ft/min)	46 (150)
Wire Preheat	°C (°F)	—
Pressure	MPa (psig)	5.3 (770)
Die	mm (in)	25.4 (1.0)
Tip	mm (in)	16.5 (0.650)
DDR	—	122:1
DRB	—	1.05

*Based on a 60-mm extruder with a 30:1 L/D; adjustments may be necessary for other equipment.

Color Concentrates

Teflon® FEP-based color concentrates are commercially available from several manufacturers. Only inorganic pigments should be used due to the high temperatures used to process *Teflon*® FEP. Concentrate loading will normally depend on the compositions of concentrate, wire size, insulation thickness, and intensity of color desired (information is available from the manufacturer). Your DuPont representative can provide additional information on suppliers.

Band Marking

Band marking inks for *Teflon*® FEP 140 are commercially available from several manufacturers. In-line band marking of *Teflon*® FEP can be accomplished by positioning the band marking unit as close to the crosshead as possible and by using inks with high-boiling solvents. Your DuPont representative can provide additional information on suppliers.

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

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