DuPont™ Teflon® FEP CJ 99

FLUOROPOLYMER RESIN

(Previously TE 9481)

Product Information

DuPont™ Teflon® FEP CJ 99 (previously TE-9481) For Primary and Jacket Insulation Applications

Description

DuPont™ Teflon® FEP CJ 99 is a melt-processible fluoropolymer resin specifically designed for primary insulation and jacketing applications that demand a high degree of stress crack resistance.

As shown in **Table 1**, this resin provides the electrical and mechanical properties needed for low-voltage applications. Teflon® FEP CJ 99 has a higher melt flow rate than Teflon® FEP CJ 95, but it retains similar stress crack resistance.

Like all Teflon® fluoropolymer resins, Teflon® FEP CJ 99 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.

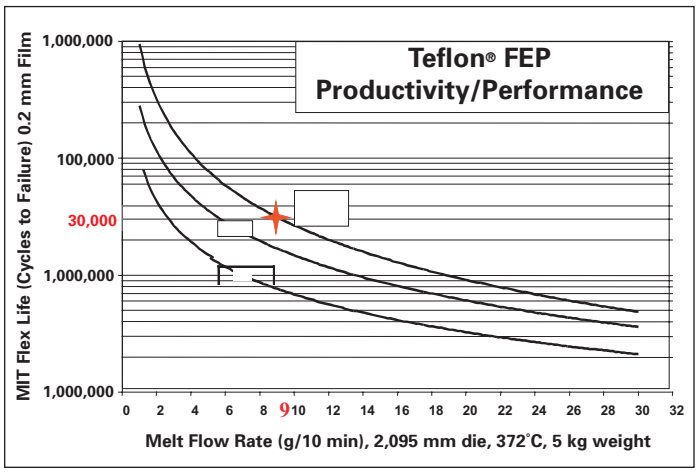
Table 1
Typical Properties of
DuPont™ Teflon® FEP CJ 99 Fluoropolymer Resin

Property	ASTM Test Method	Unit	Value
Electrical			
Dielectric Constant	D1531		
1 kHz (103 Hz)			2.02
1 MHz (106 Hz)			2.02
Dissipation Factor	D1531		
1 kHz (103 Hz)			0.00006
1 MHz (106 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	9
Specific Gravity	D762	–	2.12–2.17
Tensile Strength	D1708	MPa	26
		psi	3770
Elongation	D1708	%	300
Hardness,Durometer	D2240		D55
Thermal			
Melting Point	D2116	°C	255
		°F	490

The miracles of science™

Teflon® FEP CJ 99 can be processed by conventional thermoplastic techniques, melt extrusion and transfer molding. It shows, compared to Teflon® FEP CJ 95, a higher MFR and critical shear rate at processing temperatures. In similar constructions, it can be processed at much higher rates and line speeds. The final product will show comparable physical properties. It can be used in place of Teflon® FEP 100 when the application requires a higher degree of stress crack resistance.

Figure 1. DuPont™ Teflon® FEP Family



Stress crack resistance is an important element in establishing end-use performance. Extensive testing of wire and cable constructions is required for definitive performance evaluation. However, the MIT folding endurance or flex life test (ASTM D2176), when performed on a thin film of resin, can have a good correlation with extensive cable testing. The higher the MIT flex life, the higher the stress crack resistance of the resin. The folding endurance of the high productivity grade Teflon® FEP CJ 99 is comparable to Teflon® FEP CJ 95, which is slower in processing. DuPont does, however, always recommend, in particular for applications involving repeated thermal and flex cycling, to undertake more extensive and more specific tests on the final product itself. The MIT test results should be viewed as a guide to comparative performance of the various grades of resin.

Applications

Teflon® FEP CJ 99 fluoropolymer resin can be used in many applications. One of the largest uses is as a jacket for telecommunications/data cables where Teflon® FEP CJ 99 not only provides excellent fire performance and physical properties but also outstanding electrical performance. In this role, it is ideal as a jacket material for constructions meeting Article 725 and Article 800 of the National Electric Code (NEC) where Teflon® FEP CJ 99 provides superior dielectric properties for rapid, clear signal transmission. Because of its exceptionally low flame and smoke properties, cables made with Teflon® FEP CJ 99 can be made to meet the requirements of Underwriters Laboratory "UL 910 Steiner Tunnel Test" for installation in plenums without metal conduits.

As a cable jacket, Teflon® FEP CJ 99 helps ensure long, reliable cable life and easy, economical installation. Its low coefficient of friction and flexibility makes cables easy to pull around corners and obstacles and through air-return plenums. Its toughness and abrasion resistance help eliminate cut-through and other damage that can occur during installation. Because jacketing of Teflon® FEP minimizes reel set, it provides for fast, economical installation. Cables jacketed with Teflon® FEP CJ 99 possess the outstanding chemical resistance of Teflon® FEP and stand up to most exposure conditions, including: heat, weather, ultraviolet light, and moisture.

Processing Guidelines for Wire and Cable Use

Extrusion Equipment

Teflon® FEP CJ 99 is fabricated using the same melt processing techniques as other thermoplastics. A brief description of the extrusion equipment used with Teflon® FEP CJ 99 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[(a)], Inconel(b), Monel[(b)], and Xaloy[(c)] are the materials of choice.

[(a)] Hastelloy is a registered trademark of Cabot Corporation, Kokomo, IN.

[(b)] Inconel and Monel are registered trademarks of International Nickel Company, Huntington, WV.

[(c)] Xaloy is a registered trademark of Xaloy Inc., New Brunswick, NJ.

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 to 64 mm (1.5 to 2.5 in) extruder with a barrel length to diameter ratio of 24:1–30:1 is recommended for extruding Teflon® FEP CJ 99. 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 to 425°C (600 to 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 1 to 3 turn transition and a metering section that comprises approximately 1/4 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 at least two-thirds of the way to the center line of the flow channel.

Degradation of the resin during processing greatly reduces the performance of Teflon® FEP CJ 99 in stringent applications. Degradation is caused by excessively high melt temperatures, long residence time in the extruder, and/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 only 5 min at 393°C (740°F) or approximately 15 min at 382°C (720°F), but as the temperatures are lowered, it is reduced to only about 7% 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 silicon oils that act as stress crack promoters.

Jacketing Extrusion

The choice of jacketing tooling is usually based on the largest die the crosshead can accommodate. Draw-down ratios (DDRs) of 20:1 or 30:1 are common for large cables, while ratios of up to 70:1 are common for some smaller cables. The land length of the die should be of sufficient length, usually at least 25 mm (1 in), to ensure enough back pressure to eliminate the weld line. Vacuum is essential to obtain a tight jacket. Higher DDRs are preferred if sufficient die diameter is available because higher line speeds are usually more easily achieved with higher DDRs. Processing conditions depend on the equipment size and line speed. **Tables 2** and **3** list processing conditions for a Teflon® FEP CJ 99 fluoropolymer resin on a FEP-insulated copper wire substrate. Adjustments may be necessary for other equipment.

Table 2
Typical Temperature Profile for Extruding DuPont™ Teflon® FEP CJ 99 on a 330-mil FEP Insulated Copper Wire Substrate[1]

Zone	°C	°F
Rear Zone[2]	366	690
Rear Center[2]	382	720
Center	391	735
Front Center	396	745
Front	396	745
Adapter	396	745
Crosshead	404	760
Die Holder	418	785
Melt	404	760

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

[2] For a smaller machine, it will be necessary to raise the temperature to ensure that the resin is completely melted prior to 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 a Jacket of DuPont™ Teflon® FEP CJ 99 on an FEP-Insulated Copper Wire Substrate

Condition	Value
DDR	20–30:1
DRB	1.02–1.06

Extruder output and line speed will vary with the machinery employed; the conditions cited here are suggested as a good starting point.

Primary Extrusion

Crosshead and tooling sizes should be based on final dimensions for the finished primary. Draw Down Ratios (DDR's) between ranging from 80:1 to 100:1 are typical, but can be higher for high speed applications. Process conditions will be differ based on extruder size, heater type, line speeds, etc. Tables 4 and 5 list process conditions on a 45mm, 30:1 L/D, fluoropolymer extruder. This application profile was used for extruding a 0.010" primary coating of FEP CJ 99 over 18 gauge stranded copper wire.

Table 4
Typical Temperature Profile for Extruding DuPont™ Teflon® FEP CJ 99 onto a 18 Gauge Stranded Copper Wire Substrate[1]

Zone	°C	°F
Rear Zone[2]	366	660
Rear Center[2]	382	670
Center	391	685
Front Center	396	700
Front	396	720
Adapter	396	735
Crosshead	404	735
Die Holder	418	740
Melt	404	755

[1] Based on a 45-mm extruder with a 30:1 L/D; adjustments may be necessary for other equipment.

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

Table 5
Typical Operating Conditions for Extruding a Primary Coating of DuPont™ Teflon® FEP CJ 99 onto a 18 Gauge Stranded Copper Wire Substrate

Condition	Value
DDR	80–130:1
DRB	1.02–1.06

Extruder output and line speed will vary with the machinery employed; the conditions cited here are suggested as a good starting point.

Color Concentrates

Color concentrates having a base of Teflon® FEP are commercially available from several manufacturers.

Only inorganic pigments should be used due to the high temperatures used to process Teflon® FEP. Concentrate loading information is available from the manufacturer. It will normally depend on the compositions of concentrate, insulation thickness, and intensity of color or tint desired, but is generally lower than that used for primary applications.

Your DuPont representative can provide additional information on suppliers. For best results, it is recommended a color concentrate based on Teflon® FEP CJ 99 be used.

Band Marking

Band marking inks for Teflon® FEP 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.

Safe Handling

Use of an adequate ventilation system allows safe processing of Teflon® FEP in extruders at high temperatures. Before using Teflon®, read the Material Safety Data Sheet and the detailed information in the Society of the Plastics Industry publication, "Guide to the Safe Handling of Fluoropolymer Resins." Copies may be obtained from your DuPont representative.

Packaging

Teflon® FEP CJ 99 is supplied as pellets and is available in 55-lb (25-kg) bags.

Freight Classification

For rail shipments, Teflon® FEP CJ 99 is classified as "Plastic, Synthetic, OTL, NOIBN;" for truck shipments as "Plastic Materials, Granules;" and for express shipments as "Plastics, Synthetic."

For more information call (302) 479-7731

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