Safety

Refer to the Hyflon® PFA Material Safety Data Sheets (MSDS) for detailed recommended procedures for safe handling and use. Contact your regional Solvay Specialty Polymers office for a copy.

As with all polymers exposed to high temperatures, good safety practice requires the use of adequate ventilation when processing Hyflon® PFA. Ventilation should be provided to prevent exposure to fumes and gases that may be generated. Excessive heating may produce fumes and gases that are irritating or toxic.

Processing Basics

General considerations

Hyflon® PFA are truly thermo-processable resins. They are semi-crystalline polymers. When heated above their melting point they do not cross-link and undergo a consistent reduction of viscosity which makes it possible to process them with the standard techniques known for common plastics, for example, polyethylene or PVC. The outstanding thermal stability of Hyflon® PFA allows long residence times in the molten state without degradation or reduction of properties.

Color masterbatches

It is recommended only to use Hyflon® PFA based color masterbatches. Masterbatches based on other fluoropolymers can negatively influence the superior processing and electrical performance of Hyflon® PFA resins. A list of suppliers can be obtained from your Solvay Specialty Polymers sales representative.

Rheological properties

The flow behavior of Hyflon® PFA is determined through dynamic rheology in the linear viscoelastic regime (10^{-2}–10^{2} rad/s) and through capillary rheometry (1 – 10^{4} 1/s).

At low shear rates, and independently of the shear viscosity value the flow behaviors are Newtonian. When critical shear rate values are reached, melt instability occurs. These values are inversely proportional to the shear viscosities. Processing must be done below the critical shear rate.

Handling

No special treatment is required. Drying is unnecessary since the resin will not absorb water. The low water absorption inhibits the dissipation of frictional static charges. Consequently, the resin container should be covered at all times to prevent the deposition of contaminants on the pellets. When bringing the resin from a colder room, the closed drum liner should not be opened until the resin has come to the temperature of the processing room. This avoids condensing of atmospheric moisture on the pellets. Provide for good ventilation and/or adequate suction equipment in working areas.

Materials of construction

It is important to consider that all parts coming into prolonged contact with the molten Hyflon® PFA resin should be made with corrosion resistance materials. Chrome or nickel plating is normally sufficient protection in the case of brief processing tests.

Injection molding

Hyflon® PFA can be injection molded following the same processes used for normal thermoplastic resins. The low viscosity grades are particularly designed for injection molding of complex shapes.

It is recommended to use three independently controlled heater zones for the barrel and one for the adaptor. The heater controllers must be capable of accurate temperature control up to 450 °C (845 °F).

Reciprocating screw equipment is recommended to assure proper plasticating and reduce polymer stagnation and thermal degradation. The screw should have a short transition section, a constant pitch and a flight depth ratio from the feed section to metering section of about 3 : 1.

Conventional type reverse tapered nozzle is recommended. The bore should be as large as possible and tapered to prevent dead spots or rapid changes in resin velocity. The non-return valve prevents the molten resin from flowing backward along the screw flights during the injection process.

Mold temperature should be set not lower than 180 °C (355 °F) to reduce delamination in the part. Optimization of mold temperature must take into account part thickness to minimize shrinkage, surface appearance and total cycle times.

Injection pressure should be set as low as possible, depending on the item to be molded. In general, low injection pressures reduce warpage thus resulting in improved dimensional stability. Injection pressure has to be set in function of the molded item, its thickness and the presence of weld lines. In most cases a hold pressure should be applied to reduce shrinkage and voids. Injection speed should be set moderately slow, thus resulting in good surface appearance without roughness.

Conversely, too low injection speeds must be avoided because they negatively affect the filling stage. Generally low rotational speeds are required, even if moderately low back pressure could result in better homogenization without unmelted particles. Increasing back pressure should be carefully checked to avoid increasing the melt temperature.

Temperature profile along the injection cylinder should be increased from the rear zone to the nozzle as reported hereinafter to avoid thermal degradation. Melt temperature should not be higher than 400 °C (750 °F) and hold-up or residence time must be obviously reduced if operating at the highest temperatures.

	Units	M640	P450
Z1 (rear barrel)	°C (°F)	300 (570)	320 (610)
Z2	°C (°F)	325 (620)	345 (655)
Z3	°C (°F)	335 (635)	355 (670)
Z4	°C (°F)	340 (645)	360 (680)
Nozzle	°C (°F)	360 (680)	380 (715)
Melt temperature	°C (°F)	380 (715)	380 (715)
Mold temperature	°C (°F)	200–240 (390–460)	200–240 (390–460)
Injection pressure	kg/cm^2 (psi)	270 (3,850)	345 (4,900)
Pack pressure	kg/cm^2 (psi)	270 (3,850)	345 (4,900)
Screw velocity	cm/s (mil/s)	0.2 (80)	0.2 (80)
Screw rotation	rpm	21	21
Cycle time	s	100	100

Mold dimensions: 102 mm disk, 3 mm thick

Table 11: Typical molding conditions for Hyflon® PFA M640 and Hyflon® PFA P450

Injection molding shrinkage and post shrinkage

An overview of the typical shrinkage is charted in table 14. The dimensional analysis was carried out measuring the shrinkage of injection molded specimens obtained with a disk cavity mold. The diameter of the cavity was 102 mm (4 inches) and its depth 3 mm (120 mils). The equipment used was a 100 ton injection press with a 30 mm screw. The working conditions are the ones which granted the best quality as concerns color and superficial aspect.

For every condition at least five samples were molded and measured, so as to have a minimal statistical set of data. The shrinkage has been evaluated as percentage ratio between the linear dimensions of the molded disk and those of the mold considering the parallel and perpendicular flow direction. The post-shrinkage measurements were taken after conditioning the samples at three different levels of temperature (150, 200 and 250 °C) for 2.5 hrs in an oven.

	Injection/pack pressure [kg/cm²]		
	259	344	431
After molding [%]			
M640	4.83	4.63	4.39
P450	–	4.66	4.43
After 2.5 hrs @ 150 °C (300 °F) [%]			
M640	4.90	4.63	4.39
P450	–	4.70	4.50
After 2.5 hrs @ 200 °C (390 °F) [%]			
M640	4.91	4.70	4.46
P450	–	4.73	4.53
After 2.5 hrs @ 250 °C (480 °F) [%]			
M640	5.19	4.96	4.80
P450	–	5.07	4.92

Table 12: Typical shrinkage of Hyflon® PFA M640 and P450