

FLUOROPOLYMERS AND TECHNOPOLYMERS

© 2018 All rights reserved

The fluoropolymers or fluorocarbon resins are special compounds for special application where high performances, in terms of working temperature, electrical property, chemical resistance, are required.

The fluoropolymer can be chosen according to the application field and property required.

The fluoropolymers can be:

- partially or fully fluorinated;
- omo-polymers or copolymers;
- thermoplastic or cross-linkable.

Some example:

- **FEP** (Fluorinated Ethylene Propylene);
- **PVDF** (Polyvinylidene Fluoride or Polyvinylidene difluoride);
- **ETFE** (Ethylene tetrafluoro Ethylene);
- **PFA** (Perfluoro Alkoxy);
- **MFA** (Tetrafluoroethylene Perfluoromethylvinylether);
- **X-ETFE** (Cross-linkable ETFE);
- **PTFE** (Poly tetrafluoro ethylene);
- **PCTFE** (Polychlorotrifluoroethylene);
- **ECTFE** (Ethylene Chlorotrifluoroethylene).

PROPERTY	UNIT	FEP	PFA	ECTFE	ETFE	PVDF
Melting Point	°C	260 - 280	300 - 312	240 - 245	245 - 250	168 - 178
Specific Gravity	g/cm ³	2,13 - 2,15	2,12 - 2,17	1,67 - 1,69	1,7 - 1,8	1,74 - 1,78
Hardness	Shore D	55 - 60	55 - 60	75	75	78
Limiting Oxigen Index (LOI)	%	95	95	50 - 65	30 - 35	41 - 65

All fluoropolymers compounds are highly corrosive. In order to process the Fluoro resins, special corrosion-resistant materials must be used for all the parts of the extrusion equipment that come into contact with the melt. Nickel-based alloys such as Hastelloy[®], Inconel[®], Monel[®], and Xaloy[®] must be used.

Here below a brief explanation of the main Fluoropolymers used. For further processing information do not hesitate to contact Eurotek.

Important recommendations for the operators

- Pay attention to do not breath fluorine smoke during the extrusion process.
- Proper safety masks must be worn all time during the extruding.
- Safety glasses and high temperature resistance gloves must be worn.
- Smoking suction device must be placed close to the extrusion head.

FEP

FEP is a clear/transparent semi-crystalline copolymer of hexafluoropropylene and tetrafluoroethylene. It is known for the excellent chemical resistance, excellent electrical property and high service temperature up to 200 °C as well as unique flame resistance.

Some of the main characteristics are:

- lower melting temperature than PTFE (~260 °C);
- transparent/clear;
- low dielectric constant (insulating);
- chemically inert;
- very low co-efficient of friction;
- antistick properties;
- UV resistant (does not age);
- not hygroscopic (water absorption <0.01%);
- working temperature from -200 °C to +205 °C.

FEP and PFA are clear, yet PTFE is translucent. FEP and PFA have better mechanical properties in comparison to PTFE.



Fig. 1 - New distributor for technopolymers

PFA

Perfluoro Alkoxy is a semi-crystalline resin, transparent thermoplastic fluoropolymer specially designed for high temperature service and combine most of the property of ETFE and FEP.

It is copolymer of tetrafluoroethylene (C₂F₄) and Perfluoroethers (PerfluoroAlkylvinylether).

The working temperature is from -200 °C up to +260 °C.

PFA melting point is between 300 °C and 312 °C.

The extruder, head and tools temperature profile must be chosen according to the extruder size, the maximum output and the screw rpm to avoid the critical shear rate. The maximum line speed and the mx extruder rpm depend on:

- surface aspect;
- melt fracture effect or draw resonance;
- tools dimension, shape and temperature.

By tube tools the melt fracture appears first on the inner surface of the cone.

In order to reduce or shift up higher screw rpm, it possible to proceed as described below:

- heat up the tip holder or distributor;
- increase the die temperature;
- increase the Draw Down Ratio in order to reduce the material speed through the tools: too high DDR can generate a "drop effect" as well as loss of concentricity and cone breakage during the start or the production cycle.

GENERAL PROCESSING

The fluorocarbon resins must be processed using corrosion-resistant equipment.

The extruder must be realized with bi-metallic barrel and screw in Hastelloy®.

The Hastelloy® is softer than steel and for this reason can be easily damaged. All the operations (maintenance, cleaning, setting, etc.) must be carried on by brass Tools or brass brushes only.

Do not use steel tools and steel brushes.

The cross head must be equipped with opened breaker plate and without any meshes or filters.

All components of the extrusion head must be able to achieve high temperature up to 450 °C and holding it during the extrusion process.

The heating system must be powerful and efficient in order to reach the temperature profile as quickly as possible. The temperature must be stable and constant during the process. For this reason, the cross head must be designed to reduce the heat loss.

The fluoropolymers are sensitive to shear rate.

The maximum line speed and the mx extruder rpm depend on:

- surface aspect;
- melt fracture effect or draw resonance;
- tools dimension, shape and temperature.

By tube tools the melt fracture appears first on the inner surface of the cone.

The surface aspect as well as the transparency depend on:

- shear rate and speed gradient (screw rpm, flow distributor channels);
- extruder flow output;
- melt temperature;
- die temperature;
- type of tools used;
- DDR value for tube tools.

Increasing the velocity gradient with same extruder flow rate the cable surface become opaque reducing its transparency.

The flow distributor must be designed in order to keep the gradient in the admissible processing range.

The flow distributor is designed with high conicity up to 60 degrees. The increasing of the conicity, in according with tools dimension to be used, increase consequently the nominal diameter reduce the compound entrance speed.

The high angle increases, according to proper channels dimensions, the cable concentricity as well as the distributor extraction. The flow distributor can be warmed up by dedicated heater and its own thermoregulation.

Tube tools must be used. The DDR must be chosen up to 210 and the DRB must be between 0.96 and 1.08, anyhow according to:

- type of compound and its MFI;
- line speed;
- cable dimension and thickness of plastic;
- surface aspect required.

Higher DDR is preferred for high production speed, small cable diameter, fine thickness. Increasing the thickness and the cable dimension, the DDR can be reduced in order to avoid the drop effect to the exit of the die. The drop effect will act negatively on the cable concentricity and on the thickness distribution.

Too low DDR value, at constant cable diameter and plastic thickness, could create defect on the insulation (void, fractures, bubbles, etc.). The low DDR will as well increase the opacity of the cable surface at the expense of transparency.

In order to increase the surface transparency, these are the characteristics:

- higher DDR must be used;
- higher melt temperature;
- higher die temperature;
- lower screw rpm.

As soon as the cable is getting out from the crosshead, it must be cooled down by air without using water. After 2-6 meters the cable can be cooled down by hot water (up to 70 - 80 °C) and then by cold water. The cable should be cleaned and preheated (warmed up) up to 140 °C before entering into the crosshead. The temperature depends on the line speed and cable conformation.

After processing FEP and PFA, **the crosshead must be cleaned when it is still hot** (working temperature profile).

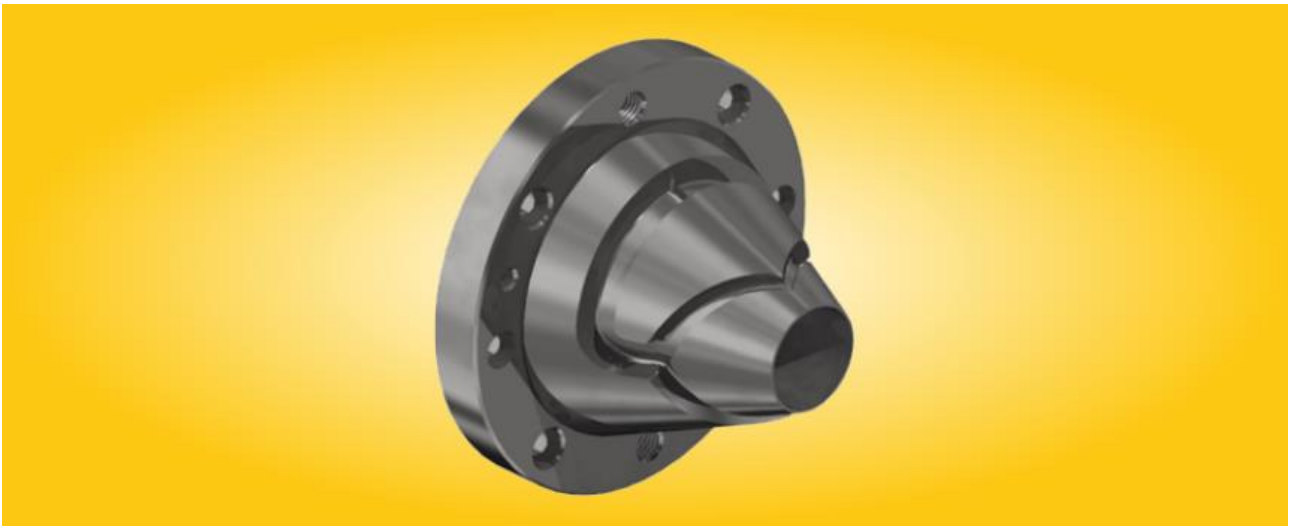


Fig. 2 - New distributor for fluoropolymers

CLEANING PROCEDURE

After processing with FEP and PFA, the cleaning must be done:

- by brass tools;
- by compressed air. Normally, the only compressed air is enough to clean easily the heads, distributor, tools and extruder screw.

For cleaning of X-ETFE, PEEK, Siloxane-polyetherimide copolymer or other kinds of high temperature polymers:

- proper cleaning material, to be processed before stopping the extruder for cleaning;
- Or Using FEP (100 N type or similar) as cleaning material. Then clean everything by compressed air as before described.

For Further information Eurotek team is available.



Fig. 3 - Brass tools