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Tedur®
Processing Guide
Injection Molding

Tedur® is based on linear polyphenylene sulfide (PPS) and belongs to the group of high-temperature resistant, semi-crystalline engineering materials. Due to its very good flowability, Tedur® compounds are mainly available filled.

Linear PPS is characterized by very good flowability, which allows high filler contents with various fillers, such as glass fibers, minerals, carbon fibers or special fillers. Despite high filler contents in some cases, Tedur® compounds are easy to process. Thin wall thicknesses and long flow paths are possible without any problems. The processing of the various Tedur® compounds, is significantly influenced by the filler used and the filler content. A small part of the Tedur® portfolio consists of unfilled, impact modified compounds, which differ from the filled Tedur® compounds mainly in their processing temperatures.

Pre-drying

PPS is not a hygroscopic material, but Tedur® can absorb water due to its filler content. Moisture can lead to surface defects and molecular degradation during processing. Pre-drying is therefore recommended, especially in case of longer storage periods and opened containers.

Processing

Machine equipment and wear protection

The high filler content leads to an increased risk of wear on the injection molding units and molds. Molds, barrel and screw must therefore be adequately protected against abrasion and corrosion.

For processing Tedur® with high production quantities, tools made of corrosion-resistant steels should be selected (see table below):

Steel type	Name acc. DIN 17 006	Material no.	Surface hardness HRc	Comments
Corrosion resistant steels	X 90 CrMoV 18 X 105 CrMo 17	1.4112 1.4125	57 – 59 57 – 60	polishable
Corrosion resistant PM-steels	X 10 Cr 13 X 105 CrMo 17 X 200 CrVMo	1.4006 1.4125	> 56	Powder metallurgical steels (PM steels)
PM-special steel	Uddeholm „Elmax“ Böhler „M 390“ Zapp CPM T440V		57 – 60 57 – 60 58 – 59	very high wear and corrosion resistance
Hard material alloys	Ferro-Titanit S		66 – 70	Extremely highly wear and corrosion resistance

When using non-corrosion-resistant steels, the surface must be protected by common coating processes. Coating materials containing chromium are suitable. Due to the high filler content of Tedur®, a surface hardness of > 56 HRc is recommended. However, the steels should not be hardened by nitrating, as this promotes corrosive attack. Wear and corrosion protection should be considered throughout the injection molding units.

Injection unit	Comments
Cylinder	Spinning out with suitable armor layer, mostly Fe-Cr-Ni-B base, use of spun-out bushings, carrier tube made of nitrated steels. (e.g.: 34 CrAlNi 7 (1.8550) or 31 CrMoV 9 (1.8519)
Screws	High Cr-alloyed through-hardeners, partially ionitrided (e.g. X 155 CrVMo 12 1 (1.2379), X 165 CrMoV 12 (1.2601), X 210 Cr 12 (1.2080), X 220 CrMo 12 2 (1.2378), X 210 CrW 12 (1.2436)); Stellite hardfacing with ionitrided CR steels with chromium-plated screw base and flanks
Cylinder head	High-alloy Cr steels, ionized standard nitrated steels, hard-chrome plated
Backflow valve	Tip and thrust collar: high-alloy Cr steels, ionitrated if necessary, high Cr alloy through-hardeners
Locking ring	High Cr-alloyed steels with good toughness, through-hardened or quenched and tempered / ionitrided (e.g. X 155CrVMo 12 1 (1.2379), X 40 CrMoV 5 1 (1.2344), X 35 CrMo 17 (1.4122))

Gate points should be kept as large as possible to reduce abrasion. This must be considered especially with highly filled Tedur® grades. Injection molding with spot and tunnel gating is possible, but the diameter of the gating point should be > 1 mm. A supporting ejector is beneficial for spot gates.

Processing temperatures

The melting point of PPS is approximately 280 °C. Accordingly, Tedur® can already be processed at temperatures of 280 - 300 °C. In order to achieve good mixing of the fillers, however, a processing temperature of 320 - 340 °C is recommended for filled compounds. Processing temperatures higher than 350°C should be avoided to prevent corrosive damage to the mold. The processing temperature of impact modified Tedur® should be chosen lower in order to avoid thermal damage to the impact modifier.
High processing temperatures reduce the melt viscosity and increase the flow path lengths. The flow behavior is significantly influenced by the filler system. Fibrous fillers, such as glass, carbon and aramid fibers, have a negative effect on flowability, resulting in shorter flow path lengths. Mineral fillers, on the other hand, increase the viscosity, but not as much as fibrous fillers. Furthermore, due to the powder form, minerals have no anisotropic effect on warpage.

Injection pressure / holding pressure

Highly filled systems require high injection speeds. This applies to components with low wall thicknesses, which results in high injection pressures. High holding pressures of 700 bar and more have proven themselves.

Shrinkage

The flow behavior as well as the shrinkage are influenced differently by the filler system. For example, a fiber filling not only leads to lower flowability, but also to anisotropic shrinkage, i.e., different shrinkage along and across the flow direction. Shrinkage is also strongly dependent on the selected injection molding parameters and the part geometry. The shrinkage values given in the data sheets have been determined on sample plaques (60 x 40 x 2 mm) under special conditions and are guide values only. These values may vary depending on the process, processing conditions and component geometry. For the individual material types, shrinkage can only be given within a scattering range due to the large number of different influencing factors.

By selecting the appropriate filler system, the shrinkage difference along and across the flow direction can be reduced. This significantly reduces the tendency to warp in flat parts. The gate type and position should be selected so that a uniform flow front is created, and linear filling of the mold cavity is possible.

Adding regrind

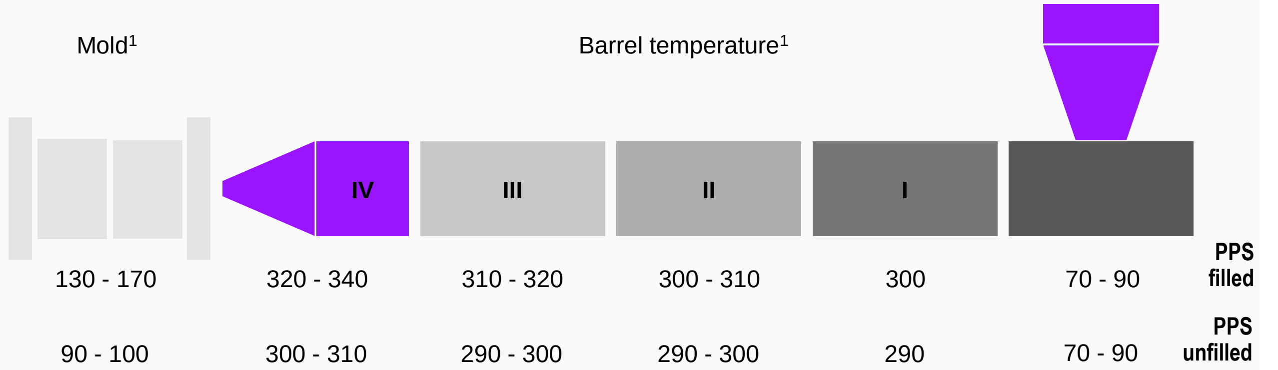
The addition of ground sprues and rejects is generally possible. The amount of material that can be returned to the process depends on the process and the requirements for the final part. Therefore, it is recommended that the ideal proportion of regrind be determined through a series of tests, starting with a low percentage addition. The regrind or ground material supplied should be free of any impurities. Grinding or regranulation of the production waste to a particle size comparable to that of the original product is recommended. Experience has shown that a maximum amount of 30% sieved regrind should not be exceeded.

Downtimes / cleaning

Before changing the material to PPS, the screw must be completely cleaned of residues of the previous material. PA and PMMA are suitable cleaning agents. The screw is cleaned with the respectively valid processing temperatures of PMMA or PA. The barrel temperatures are then raised to the usual processing temperatures of PPS. The processing of Tedur® can be started when the complete plasticizing unit is free of the cleaning material.

Changing from Tedur® to another material works vice versa: Cleaning starts with the barrel temperatures of PPS and as soon as the screw is free of of PPS residues, the barrel temperature can be lowered to the processing temperature of PMMA or PA.

If production is interrupted, the barrel temperature should be lowered to 270 - 300 °C and purged with PPS prior re-starting production.



Temperatures in degrees Celsius (°C)

[1]Guide values. For the start-up process, average values are initially recommended; for reinforced PPS, values above or below the average values can be selected (standard PPS).

Properties

Polymer	PPS
Density (ISO 1183)	See technical data sheet

Injection machinery

Screw stroke	Metering stroke between 1 x D and 3 x D (D = Screw diameter)
Screw type	Three zone screw with L/D ratio 18:1 to 22:1
Nozzle type	Closed nozzle is preferred
Hopper type	Standard

Pre-processing

Storage	Dry, protected from heat and UV radiation	
Dryer type	Air circulating	Dry air (desiccant)
Drying time	-	2 - 4h[3]
Drying temperature	-	130 – 140 °C[3]
Permissible moisture content	-	

Processing conditions

	PPS unfilled	PPS filled
Mass temperature	290 – 310 °C[3]	320 – 340 °C[3]
Mold temperature	90 – 100 °C[3]	> 130 °C[3]
Coolant	Oil tempering is recommended	
Throughput coolant	Turbulent flow must be achieved	
Peripheral screw speed	100 mm/s to 250 mm/s, low to medium screw speeds to be preferred	
Back pressure (specific)	50 – 100 bar	
Residence time	< 10 min	< 20 min
Injection speed	Slow to fast, depending on mold geometry and filler	

Shrinkage[2]

Strongly dependent on the filler and / or additive used, values can be taken from the data sheet

[2] Shrinkage is not a pure material property, but is influenced by fillers, the part/component geometry, its wall thickness and the position and size of the gate. The processing parameters, such as mold wall and melt temperature, also play a decisive role. [3]General guide values, type-related values can be taken from the data sheet.

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