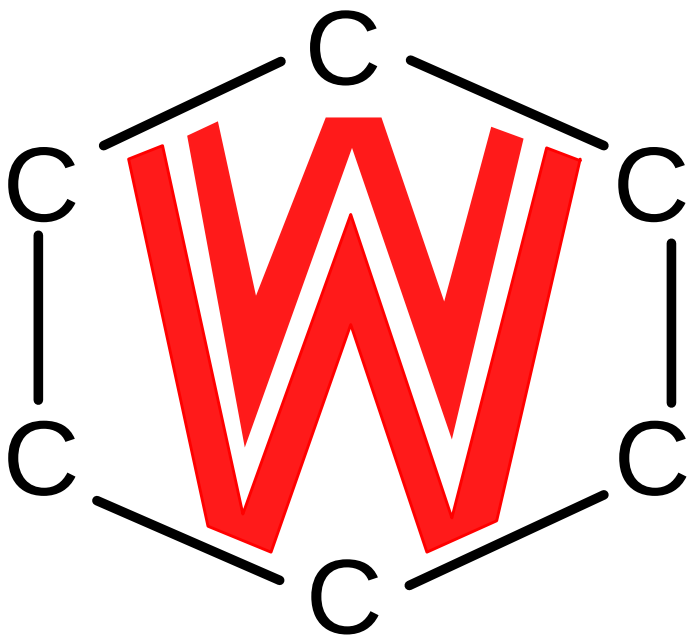

Wolf

Injection molding processing ZEDEX-530

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1.Introduction

The injection molding and extrusionprocess is the preferred method of processing of ZEDEX-530. The polymer must be supplied to the injection molding machine in a completely dry condition. Despite the very low moisture absorption a predrying is advisable. We recommend a predrying of at least 3 hours at 160-°C or 4 hours at 150°C in the dry air funnel.

2. Machine conditions

Concerning the screws including back flow valves we recommend to carry out surface treatments such as e.g. with boron or the coating with rigrid substances such as titanium nitrite. Furthermore, the bottom hardening (on the basic of Co/Cr/W) of the screw turned out to be reliable. Moreover, also a wear resistant liner of the cylinder is advisable, although in general, the working life of the cylinder is longer than of the screw.

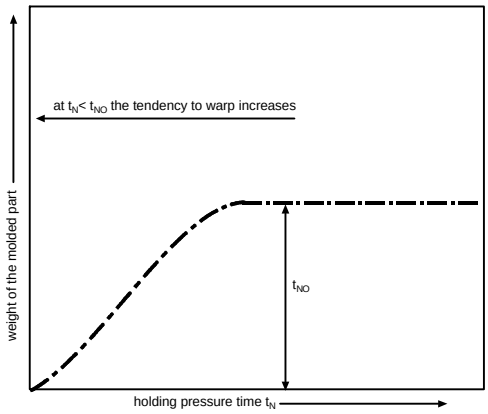
The cylinder size should be turned to the final weight to the extent, that the benefit of the increases final capacity is to 30 to 70%.

Anyway, a heatable shut-off noozle should be preferred to an open noozle. The plasticating screw should be provided with a back flow valve.

We recommend melt temperatures of 295 to 305°C. However, if required by the part geometry, e.g. with operating with very small wall thickness, also melt temperatures up to 350°C may be possible. The extrusions pressures should be between 500 and 1000 bar. Usually, the follow—up pressure is adjusted to 100 up to 500 bar (respectively as a specific pressure, to be conveited into hydraulic pressure).

The dynamic pressure affecting the screw when plasticating should be low. In most cases, dynamic pressure is not necessary. High dynamic pressure supports screw wear. If, however, dynamic pressure is required to achieve a better plasticating. 100 bar should not be exceeded. The most optimum screw speeds are between 40 and 100 $min^{-1,}$ depending on the screw diameter. The most favourable filling speed has to be determined for every mold. A too quick injection supports flash, whereas a too slow injection may create shrink marks.

Therefor a rathermedium injection speed is usually preferred. The necessary holding pressure time is a function of the wall thickness of the molded part, the melt temperature and the mold wall temperature. It can be determined by extending it with an altogether constant cyde at the time and by determined the corresponding weight see ill.1.



Ill. 1: Determination of the optimum holding pressure time

t_{NO} is the optimum holding pressure time. An extension does not cause an further weight increase of the molded parts. Please note, that too small blank dimensions may have disturbing influence on this improvement due to premature freezing and may therefor hinder the determination of the optimum holding pressure time. The execution of this trial is advisable , wen extremely low distortion moldings have to be produced. A too short holding pressure time supports warpage.

The dwell time inside the cylinder should not exceed 60 minutes (at melt temperatures of 320°C), otherwise a thermal degradation takes place. This is hown in a viscosity decrease and a drop in the mechanical properties going along with this. ZEDEX-530 shows a very good free-flowing. The flow distance at wall thickness of 2mm, $\&_m$= about 300°C, p_{Sp}= 1000 bar and $\&_W$= about 140°C is 350mm.

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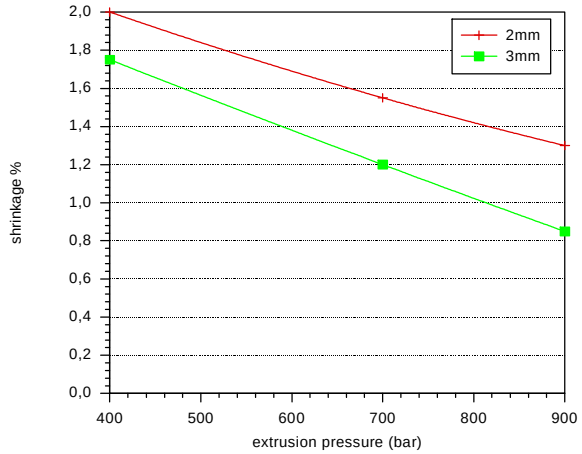
3. Shrinkage

The shrinkage determined on test boards (130 x 120 x 2 mm or 3 mm) in dependency on the extrusion pressure is shown in ill. 2.



ill. 2: Shrinkage of ZEDEX-530 determined on test boards of 2 to 3 mm in dependency on the extrusion pressure

4. Mold wall temperatures

As already mentioned at the beginning, the mold wall temperature is very important to the injection molding processing of ZEDEX-530. It should be above the glass transition temperature and the post-crystallization temperature. We recommend mold wall temperatures of at least 140°C. There is a sufficient high rate of crystallization and crystallinity at this temperature. At these mold temperature the components may possible stick inside the mold. In such cases, the mold temperature should be reduced. Mold temperatures of about 60°C are possible.

5.Mold design, design guidelines, runners and gate

Concerning tool steels, cured steels (full hardener), steels employed in the state of delivery (pre-tempered steels) and corrosions resistant steels have turned out to reliable. The surface of the cured and the pre-tempered steels should be protected against corrosions. This can be done by means of hard substances coating (e.g. TiN) or also e.g. by means of a nickle plating without current.

6.Transitions from ZEDEX-530 to another thermoplastic material

ZEDEX 530 is displaced from the cylinder after a retracted injection unit by means of one of the mentioned cleaning materials (e.g. PP,PE or PMMA). As soon as the melt is free from contents of ZEDEX-530, the cylinder temperatures will be reduced to the effective temperatures of cleaning material. Moreover, the melt is free formed on this occasion. As soon as these temperatures are reached, the cleaning of the machine has been finished.

7.General safety precautions on processing

While processing polymers made from ZEDEX-530 the temperatures of the melt (considering the permissible dwell times inside the cylinder) should not exceed 370°C. Excessive thermal stress causes a decomposition of ZEDEX-530 into sulfur dioxide and carbonyl sulphide. Furthermore, we recommend to install cooker hoods above the extruder, so that exhaust gases which are possible occurring due to excessive heating may securely be picked up and dissipated, If thermal decompositions is supposed or determined inside the cylinder, the material must be pumped away after having switched off the barrel heaters. Thermally dissipated material should functionally be dipped into water, in order to avoid odour nuisance.

The polymer ZEDEX-530 is inherent flame resistant. However, it is in the professor's interest to take precautionary measures against fire while storage, processing and assembly. For certain end products or ranges of applications may exist specific fire technical requirements.

A safety data sheet according to DIN (German industrial standards) is available for ZEDEX-530.

The hardness should be at least HRc 55, in order to achieve a sufficient protection against wear on corrosion resistant steels. The increase in hardness must not be effected by means of nitriding, because this would considerably reduce the resistance against conosive attack.

An alternative to the full cured steels with conocions protection are steels, which have been manufactured by means of powder metallurgy (PM-steels). These steels are also suitable, owing to their properties, as to say conosion and wear resistance.

Practically, the heating of the molds is carried out by means of a circulating oiltemperature control

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system or an electric heating. However, hot water systems are less suitable. We recommend a power density of 400 to 500 W/kg, when using an electric heating.
All mold cavities must be deaerated effectively. A mold which has not been adequately deaerated may create signs of charring to the molded part, which is caused by high compression of trapped air (so-called diesel-effect). An effective deaeration may be carried out e.g. by means of wide (2 to 9m m), flat (0.0006 to 0.0007mm) channels on the mold parting line. Furthermore, the deaeration may also be effected or improved by means of equivalent ejector pins. Moreover, deaeration of the distribution channels has turned out to be advisable. The flow line strength of molded parts made from ZEDEX-530 may also be improved by means of suitable constructive measures such as the enlargement of the wall thickness in the field of the flow line. Here, also the positions of the gates is very important.
Gates and distributors should have a draft of 2 to 3°. A gate diameter of 4mm has turned out to be reliable. The distributors gate channels should be polished. Undercuts should be avoided.
Furthermore, we recommend to keep the gates as big as possible, in order to reduce abrasion. An injection molding by means of pin-point gating or tunnel gate is principally possible, but the pin gate should be bigger than 1mm. Concerning the tunnel gate, it is advisable to install an ejector at the height of the gate, which supports the demolding. The molded part should be provided with the draft of 1°. For the processing of ZEDEX-530 on hot runner molds, you should use externally heated systems, showing good temperature uniformity. Therefor we recommend to install the hot runners nozzle inside a bushing with air insulation or inside a bushing , which is capable of having its temperature kept under control. Moreover, the hot runner nozzles should be equipped with a protection against wear and corrosion.

8.Addition of reclaim

The addition of reclaim should not exceed 25 to 30%, otherwise there may be a danger of material decomposition. Several tests with reclaim, three times processed, yielded to the following alterations in the physical properties:

properties	decrease to %
tear ressistant	80
ultimate elongation	100
flexural strength	90
modulus in flexure	87
notched impact test	72-84
HDT	97
color	darker

9.Transitions from another thermoplastic material to ZEDEX-530

Due to the fact, that many other plastics become thermally unstable at processing temperatures of ZEDEX-530 they must completely be removed from the machine before. We recommend to use e.g. polypropylene, polyethylene or polmethyl methacrylate for leaning of the machine. These materials are quickly free formed at the respectively valid melt temperatures of the retracted cylinder as the previous contaminants have completely been displaced, the barrel temperatures are adjusted to the level suggested for ZEDEX-530. Furthermore, the cleaning solvents (PP,PE, or PMMA) are free formed. As soon as the cylinder has reached the necessary barrel temperatures for ZEDEX-530, ZEDEX-530 is added to the injection molder and the cleaning solvents become displaced. Please note, that the injection molding of the fittings cannot be started until the cleaning solvents have completely been displaced.

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