

# ZEDEX<sup>®</sup>

Tribological Polymer Solutions

## Post heat treatment

Semi-finished products

Granules

Special Compounds

# Post heat treatment

## Introduction

The plastic is subjected to a heat treatment, and it will be quoted as annealing. The annealing target is to reduce the tension and increase the crystallinity of the component. All the ZEDEX® high performance plastics are anneal treated, in order to reduce the processing-related inner tension. When the interference-fit temperature of pressed plain bearing bushes should be increased, two annealing at the operating temperature range are advisable. However, the admissible long-term service temperature can not be exceeded.

## When is an annealing process advisable?

In the following cases, we suggest an additional annealing process and/or an intermediate annealing between machining and the final machining:

- when tight tolerances are required
- when an asymmetrical material removal or a big chip removal is required
- with a big walls' thickness variation on the end products
- when sharp corners and edges must be machined
- when the end product have got a cross-section discontinuity

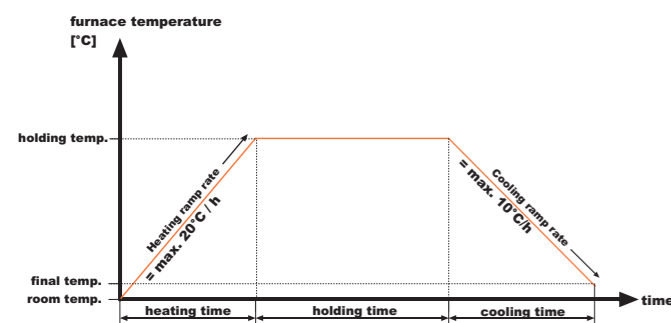


Figure 1: annealing ramp rate

## Realization of the annealing process

The annealing should take place in a circulating air drying oven. The temperature in the oven follows a ramp function (see figure 1). The heating rate is 20°C per hour, whereas the cooling rate 10°C per hour. Higher heating and cooling rates should be avoided. The holding period depends on the maximum wall thickness of the workpiece and can be taken from the figure 2. The holding temperature depends on the material and can be taken from the figure 4 (page 3). The annealing process is completed, when the final temperature is reached. From this point on, the oven can be turned off. The workpiece should be removed from the oven only when its temperature matches with the room's one.

## Hints regarding the annealing process

An adequate large allowance must be provided before annealing. The use of a support during the annealing process reduces deflection and deformation. The annealing process could form oxide layers on the surfaces, thus their colour affect. These layers reach, in the semi-finished products, a maximum thickness of 0,2 mm, and, normally, they are removed through machining.

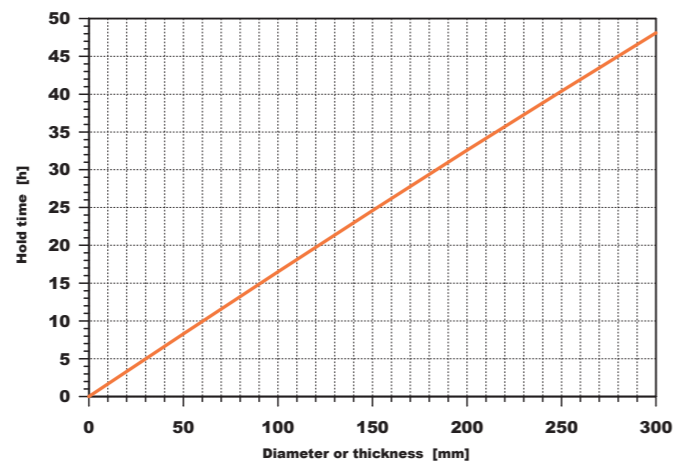


Figure 2: holding time related to material thickness

## Tensions

Processing (extrusion and injection moulding) induces technologically the chains orientation, generated in the polymers structure. The plastic structure, after the melting process, starts to solidify in a "forced position", which causes a strong restoring force and produces an internal tension in the plastic. Now if additional external stresses are added, e.g. through machining, the overlapping of the internal and external stresses, could overstep the material strength resistance and create tears and even the break of the semi-finished products.

## Stress relaxation, warping

Semi-finished and end-products, during a long-term storage, reduce the existing tensions, thanks to the stress relaxation. Besides, the tensions are reduced because of the warping effect. This can also arise during the use of the end-product. Through a plastic

storage, with a temperature closed to the heat distortion temperature, the chains mobility increases and the stress relaxation accelerates. In this case, the stress relaxation and the associated warping are faster and more intensive. If the semi-finished products are subjected to an annealing process, the warping is partially anticipated.

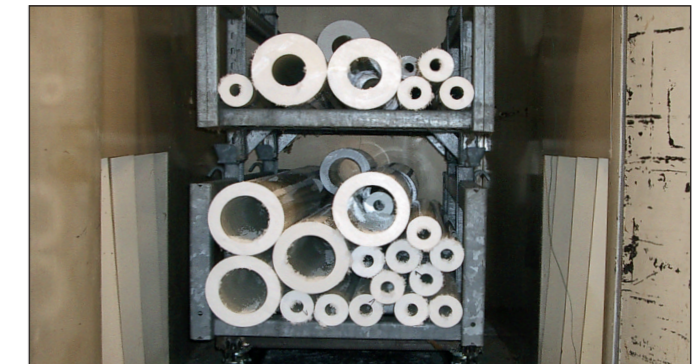


Figure 3: Annealing to reduce tensions

Material identification	Max. heating ramp rate [°C / h]	Holding temperature [°C]	Max. cooling ramp rate, [°C / h]	Cooling to [°C]	Structure	Cold crystallization temperature [°C]
ZX-100K	20	140	5	40	semi-crystalline	> 140
ZX-100EL55 /63	20	50	5	40	semi-crystalline	-
ZX-100MT	20	150	5	40	semi-crystalline	> 140
ZX-324	20	250	5	60	semi-crystalline	> 300
ZX-324V1T	20	175	5	60	semi-crystalline	> 300
ZX-324V2T	20	250	5	60	semi-crystalline	> 300
ZX-324V3T	20	250	5	60	semi-crystalline	> 300
ZX-324V11T	20	175	5	60	semi-crystalline	> 300
ZX-324VMT	20	250	5	60	semi-crystalline	> 300
ZX-410	20	175	5	60	amorphous	-
ZX-410V7T	20	175	5	60	amorphous	-
ZX-410VMT	20	175	5	60	amorphous	-
ZX-530	20	150	5	40	semi-crystalline	> 110
ZX-530CD3	20	150	5	40	semi-crystalline	> 110
ZX-530EL3	20	150	5	40	semi-crystalline	> 110
ZX-530EL3AG2	20	150	5	40	semi-crystalline	> 110
ZX-530KF15	20	150	5	40	semi-crystalline	> 110
ZX-550	-	-	-	-	semi-crystalline	-
ZX-550PV	-	-	-	-	semi-crystalline	-
ZX-750V5T	20	230	5	60	semi-crystalline	290
ZX-750V5KF	20	230	5	60	semi-crystalline	290

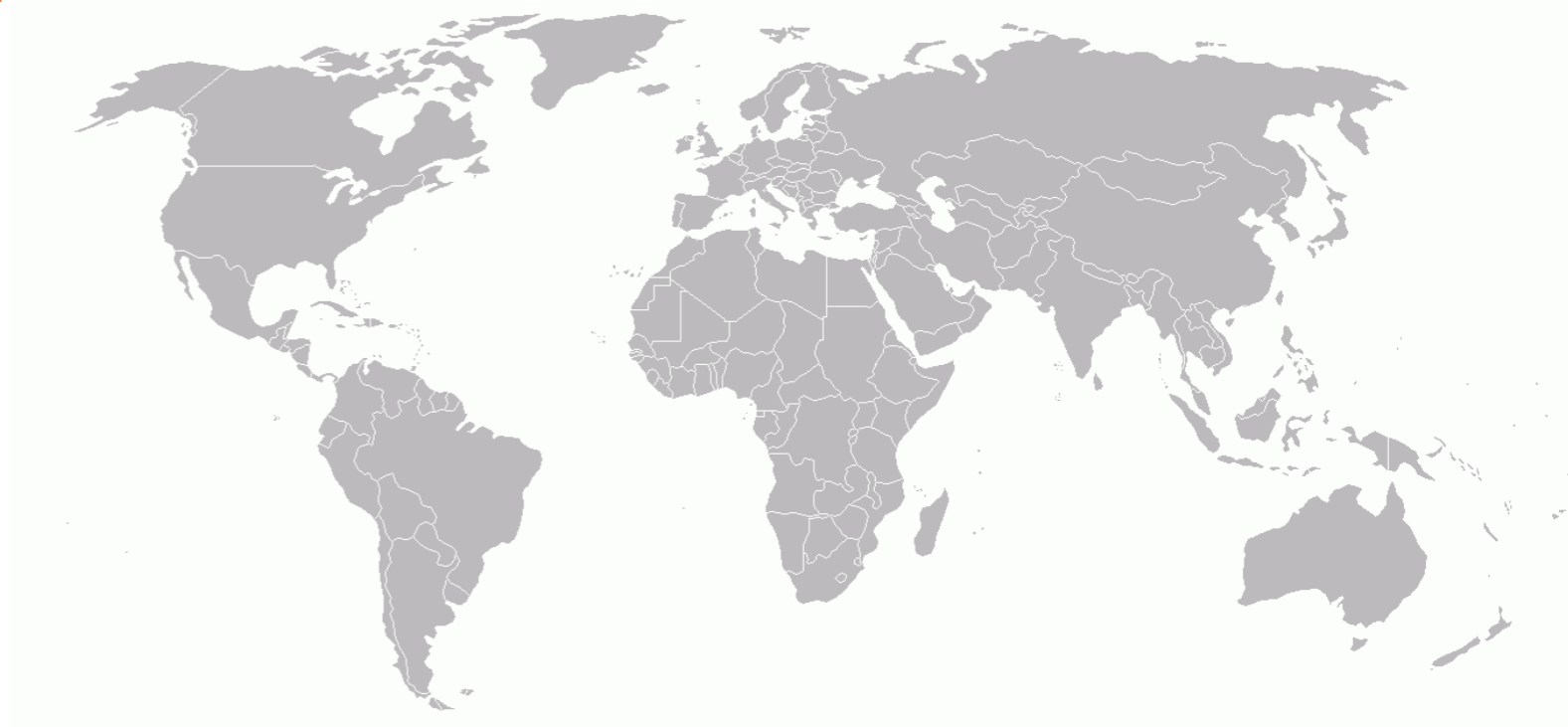
Figure 4: annealing parameters

## Degree of crystallinity

Semi-crystalline polymers have the tendency to crystallize partially. At the end of the annealing process, the material cross-section crystallinity is not uniform. In the same way, there are differences about the degree of crystallinity of thick-walled and thin-walled semi-finished products. Through a following warm-up of the semi-finished products, over the cold crystallization temperature, and a slow cooling, the degree of crystallinity increases and reaches a homogeneous level. However, this cold crystallization doesn't reach a high degree of crystallinity as a slow cooling directly after the melting process. The semi-finished products, through the cold and post-crystallization, are subjected to a warping and the change of the following properties:

- lower elongation at break
- higher density
- higher stiffness
- higher strength
- higher chemical resistance
- higher permeability
- higher wear resistance due to sliding friction
- higher PV-value
- higher thermal conductivity
- higher melt temperature
- increasing of the interference fit temperature for pressed plain bearing bushes (twice annealing at operating temperature range necessary).

Before the shipping, the ZEDEX® high performance semi-finished products are subjected to a second thermal treatment, by doing so, during a standard annealing process, the user can have just a little increment of the degrees of crystallinity. Please contact us, if a higher crystallization degree is required. ■



## SUPPORT

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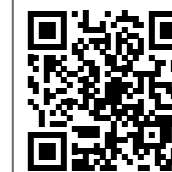
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### Consulting

If you have got problems with plastic components, we support you from the analysis through the solution to the delivery of the problem-free products. Our support includes:

- Assistance for problem analysis
- Telephone support
- Analysis through questionnaires
- Personal advice on site
- Training and conferences
- Calculation software for customers



For a complete list of our international sales representatives, visit our website or take it easy and scan this QR-Code with your phone. You will find them directly on our website.



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