SHRINKAGE AND WARPAGE OF GLASS FIBER AND BEAD FILLED PA6

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INTRODUCTION

There is no clear dividing line between fillers and reinforcements but they are the oldest and the most common additives in polymer injection molding. Reinforcements are typically fibers; fillers possess similar properties and size in all three spatial directions. The fillers and reinforcements tend to shrink significantly less than the polymeric matrix to which they are added. The rate of the shrinkage can be decreased more with the fillers than with the parameters of the injection molding technology, which also has a remarkable influence on the shrinkage behavior. Due to the shrinkage the post-mold dimensions of plastic parts will differ from the mold cavity dimensions. That’s why the anisotropic shrinkage is major factor that influence the plastic part dimensional stability.

BODY OF THE ABSTRACT

We have introduced three deformational factors that describe the uneven shrinkage caused by the injection molding technology. We introduce that the conventional method of technology setting is not to be followed; hence the primary aim is not to minimize shrinkage but to keep the deformational parameters at an ideal value. With the help of this method and the shrinkage values calculated this way the deformation of the product can be minimized.

These deformational factors are the following: DFKH is the deformational factor defined by the cross directional and longitudinal shrinkages:

$$DFKH = \frac{S_K}{S_H}\left[-\right], \tag{1}$$

D_{FP} is the deformational factor defined by the shrinkage differences caused by the pressure drop:

$$DFP = \frac{S_{KE}}{S_{KH}}\left[-\right], \tag{2}$$

and D_{FH} is the deformational factor defined by the shrinkage unevenness in the flow direction:

$$DFH = \frac{S_{H0}}{S_{HSZ}}\left[-\right], \tag{3}$$

where S_K is the average cross directional shrinkage, S_H is the average longitudinal shrinkage, S_{KE} is the cross directional shrinkage next to the gate, S_{KH} is the cross directional shrinkage far from the gate, S_{H0} is the longitudinal shrinkage in the middle and S_{HSZ} is the average longitudinal shrinkage on the edge of the specimen.

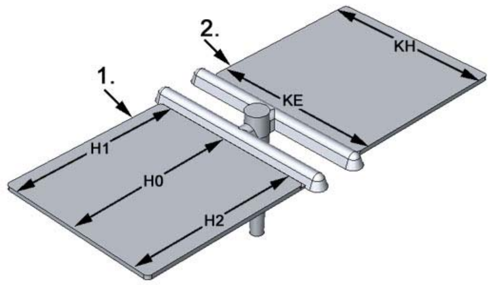

Fig. 1: The injection molded specimens with the shrinkage measuring points (H0 – the length of the specimen in the middle, H1 and H2 – the length of the specimen at the edge, KE – the width of the specimen next to the gate, KH – the width of the specimen far from the gate, and HSZ is the average of H1 and H2)

We have proven that these deformational factors change with time, and this phenomenon can be described with the following relation:

$$DF(t) = m \cdot \ln(t) + DF_0 , \quad (4)$$

where *DF* is the given deformational factor (DFKH, DFP, DFH), *DF0* is a – technological – deformational factor that can be measured in one hour after injection molding, *t* denotes time, and *m* is a constant that depends on processing parameters and the material.

We have examined the shrinkage and deformational properties of systems reinforced with glass fibers and filled with glass beads. We have revealed the beneficial effects of glass beads applied besides glass fibers using the deformational factors introduced by us. We have characterized the influence of glass bead and glass fiber content on the deformational factor, and obtained the following exponential relation for the description of DFKH:

$$DFKH = DFKH_0 \cdot e^{(C \cdot p + A \cdot z + B)x} , \quad (5)$$

where DFKH is the deformational factor defined by the cross directional and longitudinal shrinkages, $DFKH_0$ is the deformational factor defined by the cross directional and longitudinal shrinkages in unfilled and unreinforced systems, x denotes fiber content, z glass bead content, p holding pressure, while A, B and C are constants characteristic of the material.

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