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Mold Shrinkage

What is "Shrinkage"? The dictionary defines shrinkage as, "The amount or proportion by which something is reduced or shrinks." "Mold Shrinkage" therefore is the ratio of the dimension of the molded part to the dimension of the mold, expressed in in./in. or cm/cm at room temperature.

The factors that contribute to a material's mold shrinkage are polymer volume shrinkage caused by cross linking, molecular re-arrangement, thermal expansion/contraction and shrinkage constraint caused by the orientation of fibers and fillers.

"Mold Shrinkage" is used to determine the mold dimensions that will produce a part that meets all its required dimensions. While this appears to be rather straight forward, it is not. As we will see, a number of other factors effect "Mold Shrinkage" and how it relates to a part. As a result, we have to first know how the "Mold Shrinkage" value was obtained.

The "Mold Shrinkage" values reported on Plenco data sheets are obtained by measuring the length of ASTM 5" X ½" x ¼" specimens per ASTM Test Method D 955. If gated, Mold Shrinkage will be in the direction of material flow. While this it the standard method used by all plastic manufacturers to measure "Mold Shrinkage", it is important to understand that there are other ways to measure it and they will each yield a different value. Some of the ways are measuring the ASTM bar in the transverse direction or across the direction of material flow, measuring the diameter of a ASTM disc or measuring the circumference of a hoop.

To determine how the data sheet "Mold Shrinkage" relates to a part, one has to consider all the following factors:

- Molding Material
- Molding Method
- Part's Geometry
- Mold's Configuration
- Postbake.

We will now look at each of these factors with respect to Plenco's thermoset molding materials.

Phenolic, Melamine-Phenolic, granular Polyester and BMC materials are affected to varying degrees by the orientation of their reinforcements. However, BMC materials tend to be affected more, due to the fact that they typically have very low shrinkage and the longer glass fibers used to reinforce them tend to be more prone to orient themselves in the part. This type of fiber orientation changes the shrinkage of the material in the areas of the part where it occurs. Melamine-Phenolic materials have a higher rate of shrinkage and can continue shrinking even after postbake.

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Injection and transfer molding introduces more fiber orientation than compression molding. The reason for this is the gates required for injection or transfer molding change the material flow patterns, which in turn changes the fiber orientation and the areas where it occurs. In compression molding fiber orientation will be lower since there is no gate and there normally is less material flow variation within the cavity.

Part geometry plays a key role in where fiber orientation will occur. Thick to thin transitions, corners, bosses, ribs and other intersections all affect material flow patterns and fiber orientation. Generally the larger the part and/or the more complicated its configuration, the higher the probability dimensional problems will occur.

Mold configuration with respect to gate location also plays a key role in where fiber orientation will occur.

If the part requires postbaking, then it will incur additional shrinkage during the postbake. This has to be taken into account to insure that the part will meet dimensional requirements after postbake.

Only after looking all these factors and determining their total effect on the part's mold shrinkage can one determine the dimensions the mold should be cut to. If possible, mold the material in a tool for a part with a similar configuration and then measure shrinkage. In order to avoid dimensional problem, it is highly recommended that the tool be cut "steel safe" and adjusted as needed after measuring the initial parts molded in it.

It should also be noted that changes in process parameters and/or postbake protocols will affect the part's dimensions. Therefore it is vital that the initial dimensional checks be made on parts produced with the production process parameters and postbake protocol.