

Dr. Die Cast



Pre-Fill, a Hot Topic

At the recent NADCA Exposition and Congress “Pre-Fill” was a hot topic of discussion. First a definition as applied to High Pressure Die Casting. Pre-fill is a “process technique” that is the result of significantly delaying the start of fast shot beyond the “P-2” or “Metal at the gate” position. It can be stated as a “Percentage of cavity fill” or as a “distance beyond metal at the gate”. It should be stated that “P-2” and “Beginning of Fast Shot” are not synonymous.

Some die configurations and castings are easier to work with than others. Following are some of the characteristics that make it easier to develop a pre-fill process.

1. Timing is everything. If there are multiple gate entries then it is almost essential that metal begin to enter the die cavity at the same time. The runner must be pressurized enough to prevent “stalling” due to gravity. If the metal stalls out, that is, stops flowing due to back pressure then it can solidify in one or more gate entries forcing other entries to do all the work. If the pre-solidified material dislodges inside the cavity it may cause a “cold joint” that weakens the casting or leaves a surface blemish.
2. Single cavity tools. From a process development perspective, it is desirable to have only one cavity to deal with it. As noted above, the more gate entries on the die, the more

difficult it is to create a simultaneous flow front.

3. Bottom filling gate. When applying pre-fill it is desirable to have a bottom filling casting. Think of it as filling a bottle from the bottom up. It reduces turbulence and expels air at the top of the bottle or in our case, casting all at the same time. The example below weighed only $\frac{3}{4}$ of a pound and yet was able to benefit from pre-fill because of the gate location.



4. How much is enough? At least one machine manufacturer published recommendations to calculate a 33% pre-fill. One of their assumptions was that all dies would be bottom filling single cavity.

Personally I don't believe that it is very wise to make a blanket statement about the start of fast shot position since there are many factors that will affect the final success of a process. I have heard of specific castings that operated with significantly greater than 33% pre-fill and others that would not or could not operate successfully with pre-fill.

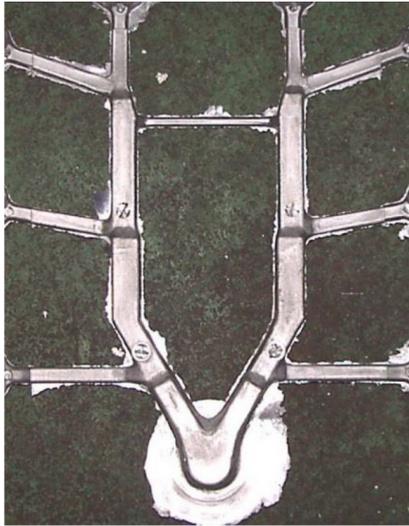
5. Repeatable biscuit length. Since biscuit length affects the actual metal at the gate position it is greatly beneficial to have a repeatable biscuit. Anything that changes the percentage of pre-fill will have a negative effect on the repeatability of the casting quality.
6. Thicker walled castings. Castings that have heavier wall sections will generally have more tolerance to a delayed fast shot (i.e.: pre-fill). Conversely if the casting has some relatively thin features these may not form completely when attempting pre-fill. For example if there are sharp edges on a feature they may appear to have radii even though the features in the die are nearly sharp.
7. Size/volume of the casting. It seems that the larger the casting, the more likely it is to benefit from pre-filling. Examples abound of pre-filling engine blocks and transmission cases.

Who's Dr. Die Cast?

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What about pre-filling multi-cavity tools? As stated above, bottom filling is nearly essential.

Regardless of the characteristics of the casting it would be very difficult to maintain consistent quality if attempting a pre-fill process with the above gate. What happens is that the lower gate entries begin to “ooze” metal into the cavities due to gravity before the runner is completely pressurized. The lower cavities attempt to “fill early” and the metal can pre-solidify either blocking the gate completely or creating frozen particles that can cause cold joint defects in the castings.

Vacuum and pre-filling. Vacuum can also pull metal into the gates before the runner is adequately pressurized. When attempting to pre-fill on a die with vacuum be sure your slow shot velocity is fast enough to keep the runner full to avoid freezing off in the gates. The “symptom” of this phenomena is a sudden dip in the fast shot velocity in the middle of the fast shot.



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