Dr. Die Cast

Die Materials: The Recipe is Everything!

When it comes to optimizing our die casting tool life, the factors that can reduce tool life can fill pages and books. Certainly, the die casting process is important. You can destroy a perfectly good die with sloppy process. For example, if you run excessive gate velocity, you will erode the gate area and adjacent cavity steel. In addition, you will solder excessively. While coatings and lubricants are beneficial, they are not a magic potion that cures poor practice.

Cast metal cleanliness is important also. I have seen gates erode overnight when there was excessive silicon and/or carborundum content. (Aluminum alloy has a natural affinity for steel. This is accelerated when excess silicon or carborundum are introduced to the alloy.) Is there a "Silver bullet"?

Premium grade H-13 is the starting point, but that is no guarantee of expected die life. Even premium grade steel can be ruined by improper or inadequate heat treatment. Proper heat treating procedures are essential.

Die temperature control is another key parameter. We need to ensure that we maintain the most stable temperature possible. This begins from the first shot and continues throughout the production run.

How do you measure and control die temperature? The ideal measuring tool is an infrared camera. This powerful tool has become more effective and affordable as the technology has developed. Your objective is to achieve the most uniform temperature possible throughout the cavity and runner steel. For a starting point, +/- 50 degrees Fahrenheit would be the target. If you do not have an infrared camera and must resort to taking temperatures with a surface pyrometer or a small infrared thermometer, then I recommend that you measure die temperature at multiple locations, starting at the biscuit, then the runner and gate, followed by spot checks in the cavity and overflows. The temperatures should be checked on both fixed and ejector halves. The reason is that the casting is in contact with both halves and will be affected by the "nominal temperature".

Controlling die temperature may require a combination of heating and cooling circuits. This can be simulated during the design stage in order to optimize the location and size of heating/cooling lines. It is sometimes necessary to use more than one heating and/or cooling method on a die. For example it may be necessary to use water cooling in the gate area while heating the upper part of the die and/or cavities with hot water or hot oil in order to achieve a uniform die temperature.

In addition, cores and cavities have significantly different heat transfer characteristics. There are some features that are adversely affected by the casting design. We sometimes refer to this as the part geometry. Features that are several times thicker than the nominal thickness can be prone to shrinkage porosity in the casting as well as die heat checking and soldering. These are difficult to cool due to the mass of heat that must be extracted. In addition, the gate entry and surrounding wall stock is generally solidified long before the heavy features. This is a recipe for shrinkage porosity and voids. It is sometimes beneficial to insert high heat areas with materials that accelerate heat transfer. Anviloy is a popular heat transfer material. It has been used successfully for cores and other features that otherwise run excessively hot.

Die casters have used beryllium copper for vent chill blocks and shot blocks to accelerate solidification and reduce cycle time.

What about holder blocks? Holder blocks in North America are commonly produced using heat treated 4140. This is a durable material that can be reused when replacing the cavity inserts. Using a material that is too soft will result in excess flash and allow the cavity inserts to crush below the parting line. I have seen tools produced offshore that had severe wear on the holder block parting line after only 5,000 shots. The entire tool required replacement at the end of the cavity life. This was an excess cost in the long run.

The bottom line is being sure you are very detailed when you specify tool materials and heat treat procedures. The research has proven the benefits of using good materials and following proven heat treatment practices. Now it's time to enjoy the benefits of that research.

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