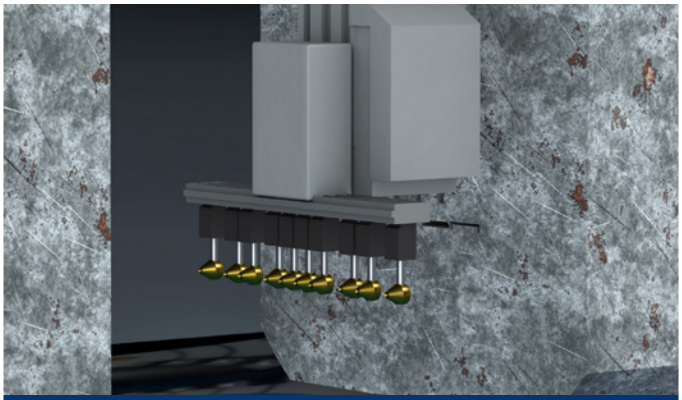
WHITE PAPER

3 Methods to Prolong Die Life in High Pressure Die Casting

By Zach White, Product Manager

High pressure die casting continues to be the most efficient and lowest cost, large throughput manufacturing process for casting parts from non-ferrous metals, such as aluminum, magnesium, zinc, copper, brass, and lead alloys. This process involves forming parts by forcing molten alloy into a die cavity at very high pressures. While high pressure die casting allows for low incremental costs for high volume production, tooling costs and other capital expenditures associated with the process are very significant, as a result, preserving tools and prolonging die life is integral to ensuring processes are profitable.

A key contributor to shortened die life is thermal fatigue. In high pressure die casting, production cycle times typically range from a few seconds to just over a minute. Within this span, the die cavity is being sprayed with die lubricant (the lubricant may be cold, cool, or hot, depending on the environment), then the die is sprayed with compressed air, closed, and finally injected with very hot molten alloy. Throughout this production cycle, the temperature of the die steel sharply rises and falls. As a die is continually cycled, the yield strength of the tool steel is reduced, which causes tensile stresses that lead to cracking of the tool. In order to minimize the effects of this thermal fatigue, it is important that the changes in temperature over the cycle, referred to as the delta t of the die steel is as low as possible. Typically, this thermal control is maintained through effective internal heating and/or cooling of the die, as well as proper die lubricant selection and application.



Die and Spray Head

Proper preheat is also critical to minimize thermal shock during start-up. During the start-up process, a start-up lubricant or die conditioner should be used instead of a conventional die lubricant. These oil- and wax-based products allow for sufficient release of the parts while the die gets to operating temperature.

Aside from thermal fatigue, another important consideration is wear reduction of the die face. Aluminum metal exhibits a high affinity for iron, which leads to the tendency for aluminum alloys to weld or stick to the die cavity. This adherence, called soldering, causes part defects, stuck parts, and premature wear of the die. In order to prevent soldering, proper selection of chemistry and precise application of the die lubricant is paramount to achieve optimal operating efficiency.

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The primary function of the die lubricant is to provide a protective barrier coating on the surface of the die steel to prevent the molten alloy from coming into direct contact with the surface of the die. In order to prevent solder, die lubricants are formulated with thermodynamically stable components that are able to withstand both the high temperatures of the molten alloy and transfer heat from the alloy to the die steel. These thermodynamically stable components, which include synthetic polymers, oils, and waxes, allow for the effective release of the part from the die cavity upon ejection, minimizing wear on the surface of the cavity.

Another important aspect of die lubricant application is proper selection and optimization, since overapplication of the barrier coating can cause build-up on the die face. Optimization of the lubricant involves determining the minimum amount of lubricant that must be applied to the face of the die to prevent solder and not build-up. This is typically achieved through dilution ratios as well as spray volumes, pressures, time, and angle of spray heads.

Beyond thermal control design and wear reduction through lubricant selection, a key contributor to prolonging die life includes appropriate maintenance over the lifespan of the die. Ensuring that cooling lines are free flowing and heat transfer fluids are kept within specification can ensure the performance of the system and prevent hot spots. Routine inspection of the die face and spray equipment can help spot and diagnose lubrication application issues before they become significant problems. The application of quality lubricants within the die also ensure that the moving parts of the die are effectively lubricated, such as ejector pins and cores.

As the use of high pressure die casting becomes more expansive, processes are becoming more efficient and part requirements are becoming more complex. Operators are striving for shorter cycle times and lower die lubricant consumption, which lead to hotter, more rigorous die conditions. For example, new applications for die casting, such as structural die casting for automotive parts utilize low-iron alloys that are more susceptible to solder. Overall, dies are more intricate and processes are more demanding, all of which makes attention to die life and proper die maintenance more critical than ever.

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