Dr. Die Cast

Simulation: When is Enough, Enough?

Why simulation? Perhaps the most important reason for simulation is to produce higher quality castings "sooner" in the product development cycle. In the not too distant past, tool designers used their "best-guess" experience to create a gate design. Hopefully, the first step of the design was based on the engineering principles taught in the NADCA Gating manual. Following the tooling design and build, many tooling engineers "threw the tool over the cubical wall to production" and it was the responsibility of the die casting set up and process engineering team to develop a process using the existing gate and temperature control circuit design to reach the required quality. Following was a period of "trial and error" process development that produced "process instructions" that was reproducible. On a good day, the development lasted less than a shift. On a bad day, a lot of people lost sleep and weekends.

Most die casting producers, die casting tool shops and end users of die castings know that die casting simulation software exists. Many are not fully aware of the power and limitations of the software.

Who are some of the owners/users of simulation software? Most are "larger foundry and die casting companies and tool shops". There is at least one smaller die casting company that recognizes the value of simulations and even contracts simulation time to other die casters and tool shops. Some are owned or leased by "independent die casting tooling designers" who design and simulate dies for a number of different companies.

Regardless of who performs the simulation, what are the most wasteful situations for a simulation customer?

1. Stopping after only one iteration. (Improvements can almost always be made.)

2. Limiting to a flow simulation only. (There are at least 2 other key simulations that should be part of the routine.)

3. Making decisions with no knowledge of the critical features of the casting. (Quality criteria).

How do you get the most out of the investment of time and money in a simulation project?

1. Get an expert review. (Some simulation engineers have limited knowledge of the machine and process limitations. Getting feedback from the end users provides insight that can prove invaluable.)

2. Review fill patterns (usually step one) for air pockets. These can appear in the runners and gates as well as the casting.)

3. Look for "pre-fill" or blockages to overflows and vents. Metal that arrives "early" to a vent or overflow can block the vent and trap air in the casting.

4. Review areas of high air pressure. These can be the result of the filling pattern but also can be due to closing vents or vacuum channels early in the filling process.

5. "Recirculation": This happens when metal flows into an overflow early and then is pulled back in to the casting. The resulting entrained cold metal serves to create cold shuts inside the casting. This can even happen when metal "back feeds" into an adjacent gate entry and potentially freeze off and block or at least restrict the 2nd gate entry.

6. Thermal simulations: Look at the solidification patterns. Are your gates freezing long before critical features (usually heavy bosses) where shrinkage porosity will be a major defect? Are there hot spots that will need additional cooling lines? Are there features that were identified in the thermal simulation that may require negotiation with the casting customer? Does the current casting design locate the "Neutral thermal axis" in the spot that will cause the greatest exposure when machined? Should the casting design include cores to remove material and reduce machining? Viewing the simulation with the casting customer will help them understand the physics behind the defect(s). It could help open discussions of product design changes that will be easier to produce.

Who's Dr. Die Cast?
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a. Once a critical hot spot is identified, there are several options to apply that will greatly improve casting quality and in many cases allow for increased shots per hour.

i. Conformal cooling has already solved numerous hot spot issues and the cost, quality and deliveries of this technology are improving rapidly.

ii. If a "solid" area gets heavily machined or drilled, consider adding (a) core(s) to reduce machining.

iii. Jet cooling" is also becoming more widely used and can cool small features that have "always" ran without cooling.

iv. "Heat tubes". This is a DME product that uses Freon in a closed tube to transfer heat to a water line. There is a "High temperature" version of the Heat tube for die casting.

v. Consider reducing cooling in the gate entry. If freezing the gate too soon is a problem, take steps to elevate the temperature or at least delay solidification in the gate while critical areas cool. (Most gates I have reviewed run too cold resulting in increased shrinkage porosity).

7. Comparative review: By saving key animations and screen shots of various iterations it is possible to measure significant improvements from gating and vent changes. It is possible to run animations side by side in PowerPoint. This helps demonstrate the difference between iterations.