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METALCAST S.A. DE C.V.
FUNDICIÓN DE PRECISIÓN

Metalcast improves Investment Casting with simulation solution ProCAST

THE CHALLENGE

Metalcast is casting increasingly complex parts in alloys that are difficult to cast. Yet Metalcast's customers expect them to continually meet their strict quality specifications and at the same time maintain or reduce product development time and expenses.

THE BENEFITS

- Multiple design iterations via simulation to reach an optimal design thereby reducing shop floor trials ;
- Reduction in product development times ;
- Rejections reduced from 25% to 3% on a valve body casting part.

"Computer simulation of the casting process helps understand the root cause of defects and evaluate the performance of modified designs without having to build tooling."

Stefan Plotz,
Foundry and Engineering Consultant.

Previously, Metalcast engineers designed molds based on experience and produced wax models using manual machining methods. Metalcast began looking into using computer simulation for the investment casting process in an effort to meet their challenge: optimize product quality while reducing product development time and expenses. Simulation makes it possible to accurately predict metal flow and heat transfer inside the mold, enabling engineers to get the mold design right the first time and reduce scrap and trial expenses.

Stefan Plotz, a foundry and engineering consultant based in Puebla, worked with Metalcast engineers and identified ESI's ProCAST as a simulation tool with features that address the specific needs of investment casting foundries.

Plotz, along with Metalcast engineers Omar and Miguel Martinez received training on ProCAST at ESI's Detroit facility. Back at the foundry, they began using the software to evaluate several existing parts where high scrap rates had been experienced. One part was a valve body that the company had been producing for some time but on which it was having difficulty maintaining yields due to excessive porosity. The rejections were at a high of 25%.

Valve component

Simulating valve components

A CAD model of the existing gating system was imported into ProCAST. ProCAST's automatic shell generator was used to create the shell for this investment casting tree with valve bodies so as to obtain a close match with the real slurry-based shell. Existing production conditions were considered to run the simulation and predict the metal flow inside the cavity (based on the full Navier Stokes equations) and heat transfer to the mold and external environment (taking into account conduction, convection and radiation including shadowing effects). The heat release associated with phase changes during solidification and subsequent solid phase transformations was described by an enthalpy formulation.

The simulation results showed the filling sequence of each mold cavity. ProCAST provided a time-sequence animation of the filling process with

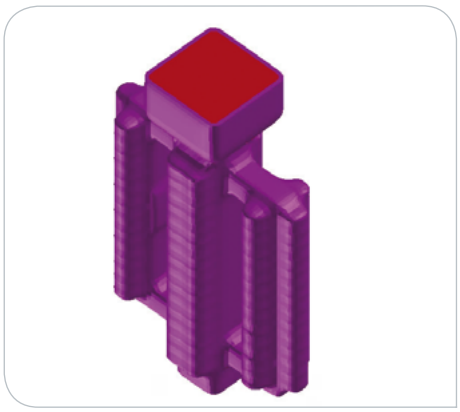
the solidification lines and the solid and liquid fractions plotted. Engineers looked at the solidification line to identify borders where no more filling can occur. The software calculated porosity percentages for areas that were separated from the main filling line.

Identifying root causes

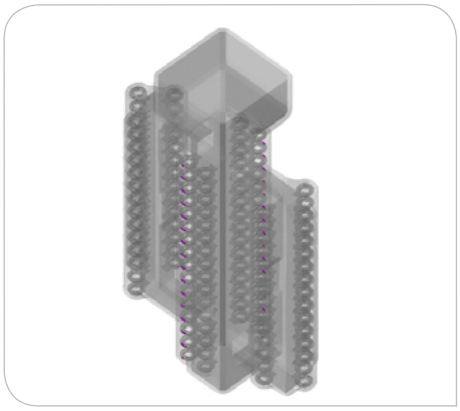
Metalcast engineers observed in the simulations that there were several formations of air pockets with no path for the air to escape through the mold. These entrapped air pockets led to gas porosity defects in the final part. The feeder diameters were too small to feed the part properly during solidification. After standard calibration to take into account foundry specificities, the simulation results showed very close correlation with the production conditions, including the location and amount of shrinkage and gas porosity.

Once the baseline simulation model was set-up, next step was to begin making changes to this simulation model in an effort to eliminate porosity. Some possibilities which Metalcast investigated included connecting the parts in different locations to the tree by adding exhaust tubes, modifying regions where porosity was seen by opening up the feeding line from the tree to part, changing the part orientation, modifying the mass of the tree and adding exhaust vents. In some cases where the part was machined, they also investigated slight changes in the part geometry.

In all, Metalcast simulated about 20 different mold design iterations, while still keeping the same number of parts on the tree as initially to avoid any increase in production costs. The outcome of this was a clean part without porosity. A trial on this modified design with the same production conditions as in the simulation, revealed a good match between simulation and shop floor trial. Finally, during the production, the number of rejects was reduced from 25% to 3%, generating over $6.000 in immediate savings.



Mold design with ProCAST



Part porosity displayed in ProCAST

Physical tree of valve component

"Conventional trial and error-based process design methods involve high costs for prototyping and trying, yet are often incapable of determining the root cause of a quality problem. Computer simulation based on finite element analysis can overcome this challenge", Plotz concluded. "The result is a substantial reduction in rejects, which has helped improve Metalcast's competitive position".

ABOUT METALCAST S.A.

Metalcast S.A. de C.V. is an investment casting company with 200 employees located in Puebla, Mexico. Metalcast specializes in producing smaller parts up to 1 kg in size. The company's major markets include the medical device industry, which accounts for 25% of its production, as well as the oil tool and the valve industries. More information can be obtained on www.metalcast.com.mx

ABOUT ESI GROUP

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