Case Study

From Die Design to Defect-Free Castings: Shiva Tool Tech Achieves 80% Time Reduction with Altair Inspire Cast

Overview

Shiva Tool Tech is an automotive manufacturing focused, industrial powerhouse based in Pune, India. With over 25 years of experience in designing and manufacturing of gravity die casting (GDC), low-pressure die casting (LPDC), high-pressure die casting (HPDC) Dies, the company supports customers from manufacturing process design to the production stage. Manufacturing processes include milling, drilling, hardening, grinding, Computer Numerical Control (CNC) machining, Electrical Discharge Machining (EDM), inspection and polishing to get the final assembly of the casting die.

> "We are happy that we invested in Altair Inspire Cast. The support provided by Engineers from Altair and their partner DesignTech is excellent and we look forward to new features and capabilities to be added to Altair Inspire Cast in future versions of the software"
>
> Shivaji Pawar
> Managing Director, Shiva Tool Tech

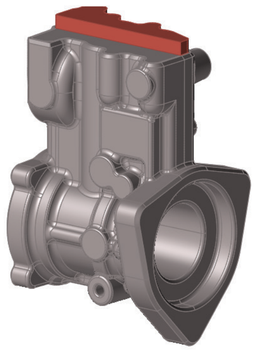

Fig. 1: Pump housing CAD model – gating at top

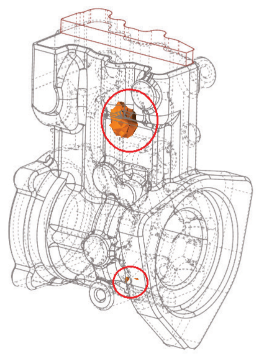

Fig. 2: Macro Porosity Marked

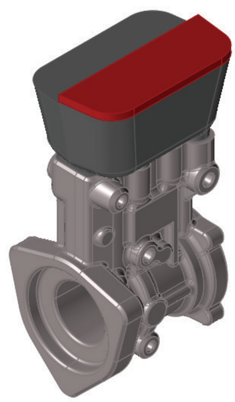

Fig. 3: Shot model with ingate

Obtaining a Defect-free Die Design – Efficiency in the Process

At Shiva Tool Tech casting dies are designed and manufactured for automotive and non-automotive components like brackets, crankcase, housing, cylinder heads, compressor housings, manifolds, alloy wheels, etc. with a lead time from 3 weeks to 8 weeks depending upon the complexity of the project.

The casting die designs are developed based on years of experience for components received form their customers in the form of the computer-aided design (CAD) and or engineering drafts. Once the die for the casting is designed, it is manufactured and assembled at their facility. The die is then sent to the customer for carrying out the physical casting trial. The cast part manufactured from the new dies is sent back to Shiva Tool Tech with an inspection report and defects identified. The die design is then modified to eliminate the defects. This entire process takes about 3-4 physical iterations to get a defect-free die design.

Realizing the value of simulation software in optimizing this design and manufacturing process to save time and money. Shiva Tool Tech began outsourcing casting simulation when needed. However, outsourcing the simulations were expensive and time consuming. In addition to paying for every iteration, the turnaround times for simulation from the service providers were long. This led them to explore options of bringing the expertise in house by investing in simulation software. They chose Altair's casting simulation software Inspire Cast which met their requirements for ease of use, accuracy of results, speed of computational analysis, rich visualization of results while remaining within budget considerations.

Inspire Cast in the Casting Simulation Process:

The updated process at Shiva Tool Tech now involves Inspire Cast in two phases:

- On receiving the CAD of the casting part (Fig. 1), the model is taken to Inspire Cast for running simulations with a virtual gating system on the part. Once the gating location is fixed based on the desired simulation results, the shot model for the component is designed in CAD.
- The shot model is then taken to Inspire Cast for carrying out the detailed casting simulation to understand the occurring defects. The methodology is modified to reduce or eliminate defects by changing the gate size, shape and with additions of risers and chillers.

Project Details

For a recent project for the design and manufacture of casting dies for an automotive pump, the housing was to be cast with Aluminum AlSi7Mg by Tilt Pouring process with Steel HDS-H13 as the mold material. Engineers imported the pump housing model in Inspire Cast to evaluate an appropriate gating location. Using the Inspire Cast tilt pouring template, the process parameters were fed in to run the simulations.

From the solidification results obtained, bulk porosity was observed at the top and minor porosities were observed near the bottom (Fig. 2). The bulk porosity at the top could be eliminated by using an appropriate runner for the gating system. Accordingly, the shot model (Fig. 3) was prepared in CAD, and it was again taken to Inspire Cast for carrying out a detailed simulation. The bulk porosity observed earlier shifted to the runner, but the porosity near the bolting location still remained (Fig. 4).

Based on filling results, the liquid fraction animation in Inspire Cast showed the last regions to solidify. It was observed that the bottom bolting location had a slower solidification rate due to the intricate mold cavity geometry. This reflected the reasons for the porosity, obtained after complete solidification of the part (Fig. 5).

It was decided that a second iteration be carried out by adding chillers near the affected bottom bolting location to speed up solidification, keeping the same process parameters. An external chill was placed near the bolting location (Fig. 6).

The liquid fraction plot demonstrated that the solidification occurred evenly at the bolting location (Fig. 7), and the porosities were completely eliminated from the casting component during this phase (Fig. 8). The design of the die was finalized and sent for manufacturing.

The complete die assembly after manufacturing was sent to the customer for carrying out the casting of the pump housing. The prototype of the component (Fig. 9) was sent back to Shiva Tool Tech for performing the inspection and the part was found to be defect-free.

Summary

- 3 iterations were carried on Inspire Cast to finalize the methodology of the pump housing
- It took 2 days altogether to finalize the methodology
- It took about 45 minutes per iteration to get the simulation results in Inspire Cast
- Time saved was 80% over traditional physical trails.

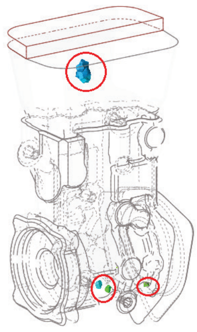

Fig. 4: Macro porosity

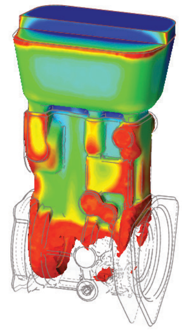

Fig. 5: Liquid fraction

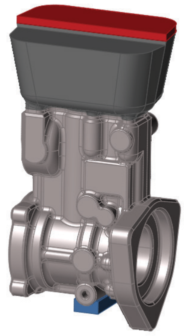

Fig. 6: Shot model including chillers

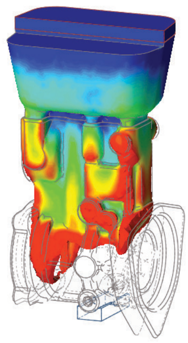

Fig. 7: Liquid fraction

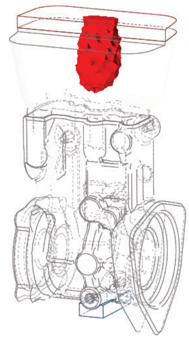

Fig. 8: Macro porosity

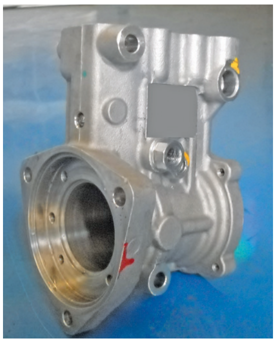

Fig. 9: Prototype component

Visit the Altair Library of Case Studies at altair-india.in

Altair Engineering India Pvt. Ltd.,: Mercury 2B Block, 5th Floor, Prestige Tech Park, Sarjapur Marathahalli Outer Ring Road, Bengaluru-560 103. INDIA. Ph: +91.80.6629.4500 • Fax: +91.80.6629.4700 • E-mail: marketing@india.altair.com • www.altair-india.in