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CASTING DESIGN TOOLS FOR HPDC

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Abstract

Throughout the manufacturing industry, process simulation has been accepted as an important tool in product design, process development, improving yield and in solving processing problems. Rapid development in process simulation software and the increase in speeds of personal computers has led to the success of these technologies in industrial applications.

In high pressure die casting, issues which strongly influence the integrity of the casting include parameters such as gating design, location and size of in-gates, vent positioning, casting temperature, mould temperature and flow characteristics of the specific alloy. During process development, casting design decisions are focused at optimising filling behaviour and controlling solidification in order to prevent defects and produce castings within the required specifications. The paper presents an industrial case showing the application of the simulation software, ProCAST, in optimising the filling behaviour of a cast motorcycle hand grip component.

Key Words

Process simulation, process optimisation, gating design, ProCAST.

1. Introduction.

The development of a new metallic component is often completed in separated departments. First, the marketing department identifies a new need. Then, the design department completes the first drawings. The engineering department usually calculates the mechanical stability, and finalises the design of the component. Finally, the production department needs to bring the component into production according to strict specifications. As production is the last major step before the part arrives at the customer, it is under tremendous pressure to produce an excellent product within a tight time schedule. Unfortunately, the persons involved in production rarely participate in the design and engineering phases, prior to the costly production stage.

In this respect, and thanks to the rapid increase in computer technologies, process simulation enables the production engineers to participate early in the development stage. The excellent compatibility between the CAD world and the virtual processing environment, permits the testing of novel component designs, alloys and processing routes, during the early design phase, by first processing the part on the computer. Thus, decisions that influence the final quality of the product can be taken rapidly, thereby drastically reducing costly trial and error developments.

2. The Die Design Process.

Designing dies for high pressure die castings is usually based on standard rules which determine cavity orientation, in-gate area, vent positioning, cooling channel design and processing parameters. Even though these rules are good for achieving an efficient starting point they do not always guarantee a defect free component.

In order to obtain an optimal casting cavity orientation and in-gate positioning, one method of using casting simulation is to compare different die designs and then select the best one. Further simulations can then be used to position vents and control solidification.

3. The Application of Simulation in the Selection of an Optimum Gating Design.

During the process development of a high pressure die cast motorcycle hand grip component, three possible gating designs were identified and simulated with the aim of selecting the design with the most optimal filling behaviour. This safety critical component requires stringent process control with minimal defects in the fastening region, see **Figure 1**.

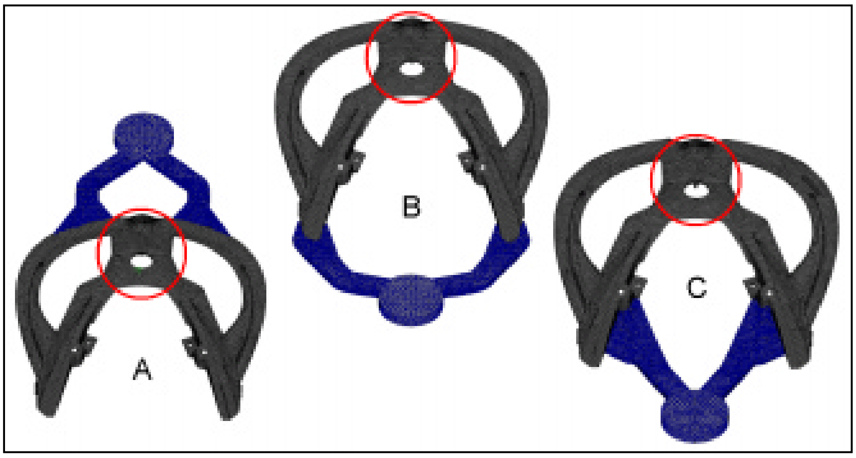

Figure 1: *Geometry of three different gating systems,* ***Design A*** *– fed on the thicker handle section,* ***Design B*** *– positioned on the bottom bracket and* ***Design C*** *– positioned on the thinner inside bracket. The gating system is shown in blue and the red region indicates the safety critical fastener area.*

From the results of the filling simulation the three gating designs were compared showing considerably different filling behaviours, see **Figure 2**. The regions of gas entrapment are indicated with black rings and arrows pointing to further gas entrapment. Clearly from these pictures **Design C** showed the best results with little gas entrapment in the gating system.

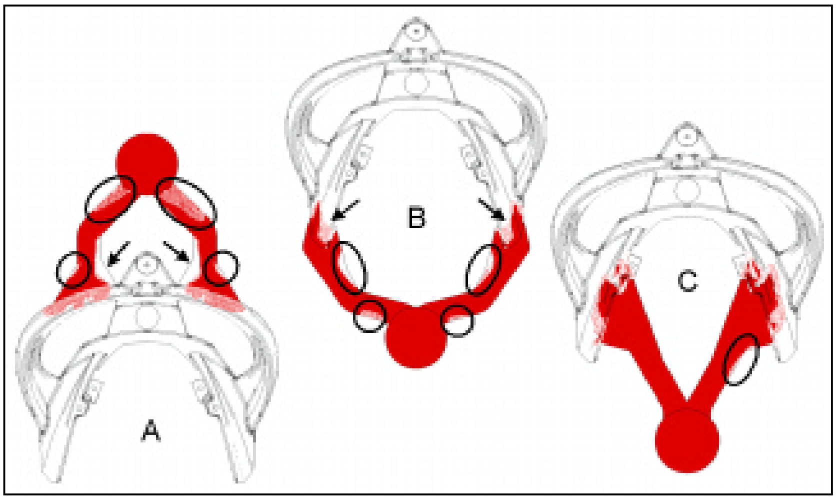

Figure 2: *Three different simulation results showing the flow behaviour in the gates during the early stages of filling for* ***Design A,B*** *&* ***C****. The black rings indicate gas entrapment.*

As shown in **Figure 3**, the cross-sectional cut through the in-gate indicates that in **Design A** there is a significant amount of gas entrapment and turbulence while **Design B** the velocity is greater than 60m/s. The flow behaviour in **Design C** showed velocities around 30 m/s with very little gas entrapment.

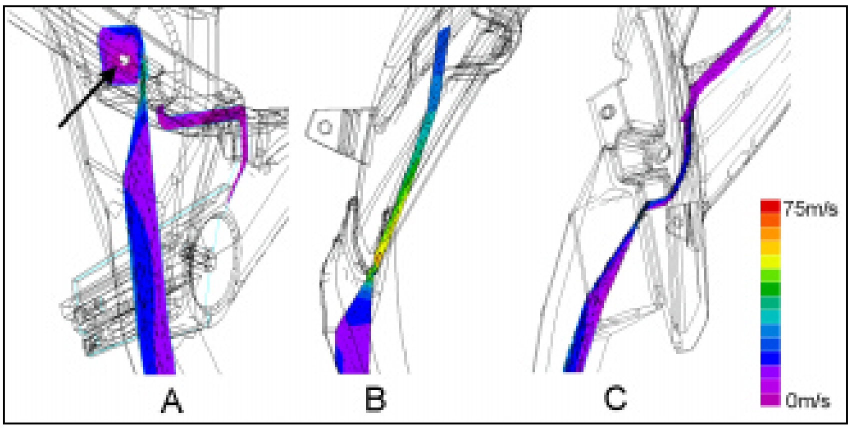

Figure 3: *Cross-sectional cuts through the in-gates showing colour contours of velocity. The arrow indicates gas entrapment in* ***Design A****.*

In the safety critical fastener region of the component a comparison was made of the three designs in order to determine if excessive turbulence could be expected during filling. In Figure 4, Design A shows that gas entrapment is evident at the bottom and top section of the bracket, arrows indicate regions where overflows and vents may be required. In **Design B**, excessive turbulence is shown in the upper regions of the bracket while in

Design C a much smoother filling behaviour is shown with much less turbulence. The positioning of the overflow and vent in Design C would be much simpler and with less risk of gas entrapement.

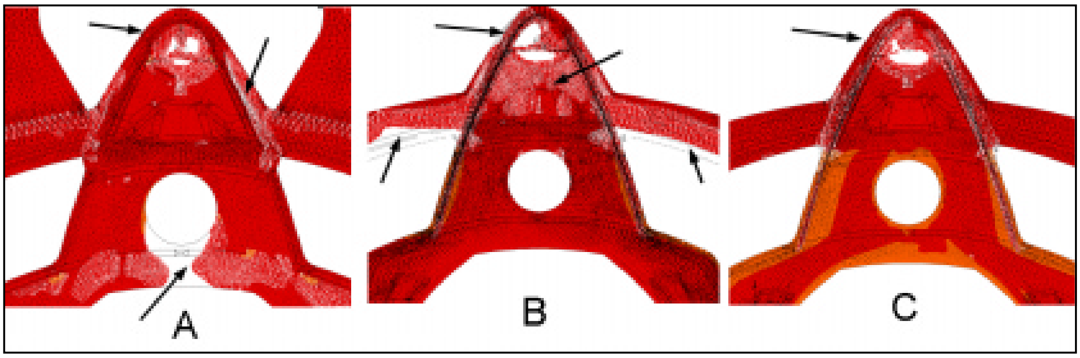

Figure 4: *Flow behaviour in the critical bracket region of the component for **Design A**, **B** and **C**. Arrows indicate the regions where gas entrapment occurs and where overflows and vents may be required.*

4. Conclusion

In this case it was clear from the simulation results that **Design C** would be most optimal in terms of filling behaviour in the gating system and in-gate, as well as in the critical region of the component. After selecting the best gating system and in-gate position, simulation can also be used to complete the vent and overflow positioning, cooling channel design and determine the optimal processing parameters.

Courtesy: Injecta Druckguss AG (ProCAST User)

"With ProCAST we have an efficient tool for checking and optimising what our mould designers could only assume in the past. In our first simulation we were able to successfully correct the gating system of a problematic hpdc tool in an imposing way."

Jörg Lagemann, Engineering Manager, Alu Menziken Injecta Druckguss AG, Switzerland