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MODIFICATION OF GATING SYSTEM FOR PROPER MOULD FILLING OF BRACKET CASTING USING PROCAST

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Abstract: Gating system is an important factor in the production of quality castings. The objective of this paper is the modification of gating system for truck bracket using Procast software. The gating system for simultaneous casting 6 brackets has been optimized by changing choke area.

Keywords: truck bracket, gating system, mould filling, procast.

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1. INTRODUCTION

Mould filling plays a very significant role in casting quality control [1]. Due to the importance of mould filling, extensive research effort has been made in attempt to study the effect of gating design on the flow pattern of melt entering the mould [2]. It has been shown that an optimum gating system design could reduce the turbulent extent of the melt flow, minimize gas and entrap inclusion and dross [3]. The formation of various casting defects could be directly related to fluid flow phenomena involved in the stage of mould filling [4]. The botton gate was used to study the effect of gate sizes on the entry velocity of molten metal into the vertically-cast plate mould. Their results indicate that a critical entry velocity is present during mould filling, under which oxide entrapment is minimized. The geometry of gating system is another very important factor influencing mould filling patterns [5].

Gating system is an important factor in the production of quality castings, therefore, should be fully considered in the design and construction of pattern. The objective of this paper is the modification of gating system using Procast software. The product is truck bracket. The bracket is to be cast through vertical pouring of the mould. The number of brackets per mould is 6. The material of bracket is ductile cast iron (EN-GIS-500-7).

2. MATERIALS AND METHODS

The material used to make the brackets is ductile cast iron. The chemical composition of ductile cast iron is C: 2.7-3.7,Si: 0.8-2.9, Mn: 0.3-0.7, P: ≤0.1, S: ≤0.02, Fe: remaining.

The mechanical properties of ductile cast iron are given below:

- Tensile strength is minimum 500 Mpa.
- Yield strength is minimum 320 Mpa.

- Elongation is minimum 7%.
- Hardness range is Brinell Hardness 170-230.

The typical casting products using this grade are such as iron brackets for trucks, tractors, other agricultural and construction machinery as shown in figure 1.

Figure 1: Typical applications of ductile cast iron

The solid drawing of bracket used in the present work is shown in figure 2.

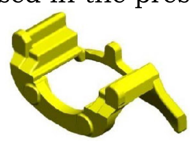

Figure 2: Solid drawing of bracket

To get better gating system to produce 6 brackets per mould the following procedure is adapted:

Step-1: Solidification Simulation
Simulation of solidification helps to identify for proper design of the risers (number, location, and size). For every pair of parts 3 risers with 5 cm in diameter by 7.7 cm in height were applied. With solidification simulation any defects related to solidification in cast part can be detected.

Step-2: Mould filling Simulation
In this the gating system is checked for its dimensions. Proper design of an optimized gating system was made easier by application of fluid flow simulation. To design the gating system the following factors were considered:

- Minimizing turbulence
- Rapid mould filling
- Maximizing yield
- Removal slag, dross, and inclusions
- Facilitate gating removal
- Desire thermal gradients

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It is important to fill every mould quickly, but turbulent flow needs to be avoided. Figure 5 shows the initial structure of gating system for the bracket.

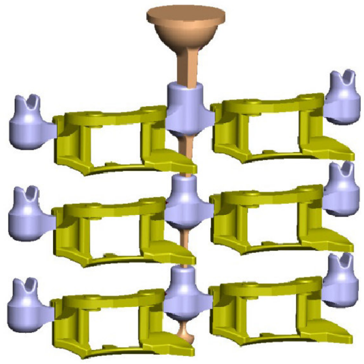

Figure 5: Gating system

To speed up the calculation of gating systems and Design the appropriate choke, equation (1) can be used.

$$\text{Choke area, } A = \frac{1036 \times W}{t \times f \sqrt{h}} \qquad (1)$$

where, W is weight of molten metal
t is filling time (8 seconds)
h is height (h1, h2, h3)
f is coefficient of friction (=0.5).

3. RESULTS AND DISCUSSION

In figure 3, 4 the simulation results show the shrinkage and Liquid mapping of the process. It is observed from figure 4 that the cast parts are free of shrinkage. The shrinkage is observed only in the risers. Therefore, the location and sizes of riser were selected properly.

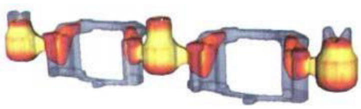

Figure 3: Liquid mapping

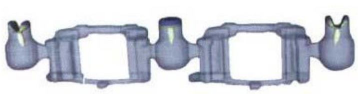

Figure 4: Shrinkage

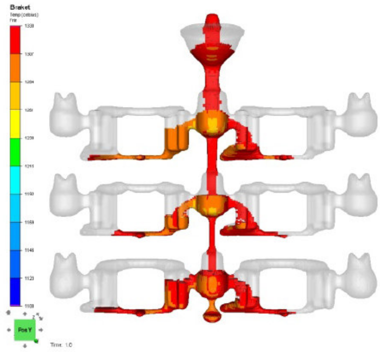

Figure 6: Mould filling time at 3 seconds

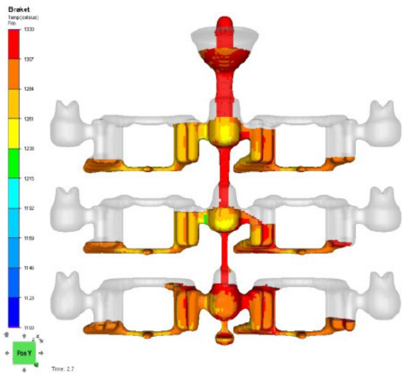

Figure 7: Mould filling time at 5.5 seconds

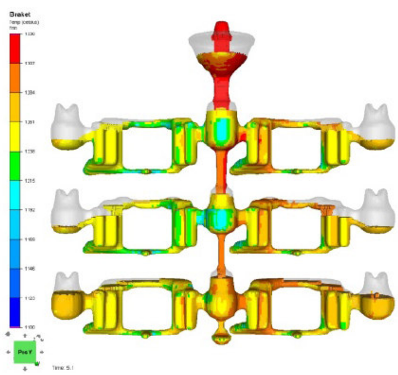

Figure 8: Mould filling time at 3 seconds with recalculate choke area

By mould filling simulations the results at 3 seconds and 5.5 seconds time of filling (figure 6 and 7), confirm that this gating approach is not appropriated, because some cavities are going to fill (vertical parted moulds as a guide) in less than 8 s (bottom) and some after 8s (top). All of cavities should be filled by molten metal at the same time.

To re-sizing chocks area and to set up the filling time in upper and middle and lower cavities, the *A1, A2, A3* were recalculated based on 8 seconds. It is important to know that the real coefficient of friction (*f*) can be determined only after mould filling simulation. Once applied changing, the mould filling simulation was run again to see how all of cavities are filling by molten metal. Figures 8 and 9 show after 3 seconds and 5.5 seconds these confirmed all cavities are filled at the same time.

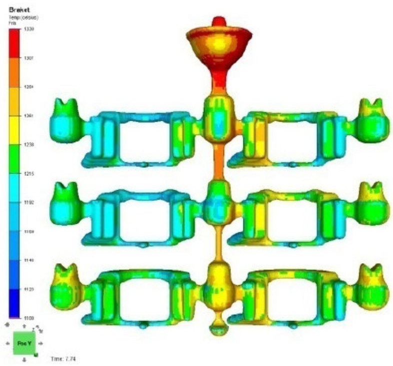

Figure 9: Mould filling time at 5.5 seconds with recalculate choke area

With application of simulation, the design of gating can be optimized in the short period of time and decreasing cost.

4. CONCLUSIONS

The outputs from the present work are as follows:

1. Proper design (location, number, and size) of the risers can be determined from solidification simulation
2. A predicted map of possible macro-shrinkage defects.
3. The appropriate of choke and gating system can be determined quickly through fluid flow simulation.

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