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Reducing casting defects in ductile iron castings by optimized pouring system

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Abstract

In the study, various version pouring systems have been designed for ductile iron castings in the industrial conditions and a computer-aided design solid modeling program was used in the design of pouring systems for ductile iron castings. Pouring system for ductile iron castings and the gating system ratio of the casting part was selected as 1:3,5: 2,5. The flow and solidification of the casting part was simulated by using magma flow and solidification program. The study clearly shows that the kalpur direct pouring system has revealed that it plays a significant role in preventing non-metallic casting defects in ductile iron castings. In addition, it has been observed in the study that clean parts can be obtained in ductile iron castings with an effective and well-designed pouring system design.

Introduction

Casting process plays a very important role in manufacturing industry. Modern foundry engineering is a well-developed and sophisticated industry utilizing cutting-edge technologies and tools including 3D printing, robost and automated manufacturing. Despite this, the most important poruduction technology remains the use of greensand molds poured with cast iron or steel. Major applications and uses of castings are in automobile industry, agricultural industry, construction machinery etc. [1-3].

Oxide, sand, and slag iclusions are casting defects that are troublesome and damaging to casting performance. In carbon and low alloy steel castings, reaction between oxygen in the atmosphere and most reactive elements in deoxidized steel results in reoxidation inclusions. In ductile iron castings, the reaction of magnesium oxide and silica during magnesium treatment and further during mold filling is responsible for the formation dross inclusions [3-6].

Pouring system is one of the important design terms of ductile iron casting. And it refers to those channels through which the metal flows from the ladle to mold cavity. High casting quality depends on a reasonable pouring system design. An improper pouring system could result in turbulance, air entrapment and inclusions in the filling process [7-9].

The benefit of filters, especially reticulated foam filters, besides their turbulence-reducing effect, is to prevent non-metallic inclusions such as sand and slag from entering the casting part during pouring the molten metal into the sand mold [11-12].

Kalpur Direct Pouring System

The kalpur direct pouring system developed by FOSECO for foundries is used in greensand molding lines and resin molding lines to obtain high part efficiency and clean casting parts. The kalpur direct pouring system includes many critical components within its own structure; exothermic feeder, ceramic foam filter, and collapsible breaker core etc. The main purpose of the kalpur direct pouring system is; reduced fettling cost, reduced non-metallic inclusions, lower turbulence related defects, improved directional solidification, good surface finish optimized yield, and increased space on the pattern plate. Parts molded with the kalpur direct pouring system can be poured with lip pouring ladle or bottom pouring ladle [11-15].

Material and Method

In this study, the pouring systems designs of connecting casting part are based on the modulus and geometry of the casting part. In the study, the material of the part is determined according to the DIN EN 1563 standard and material of the casting part has been selected as GGG50. The chemical composition of the casting part is shown in Table 1 and the image of the connecting casting part is shown in Figure 1.

Table 1. Chemical composition of the connecting casting part

Contents	% C	% Mn	% S	%P	% Si	% V	% Cu	% Mg	%Pb
Min.	3,6	0,18	0	0	2,4	0	0,29	0,03	0
Max.	3,75	0,22	0.01	0,1	3	0,02	0,31	0,06	0,02

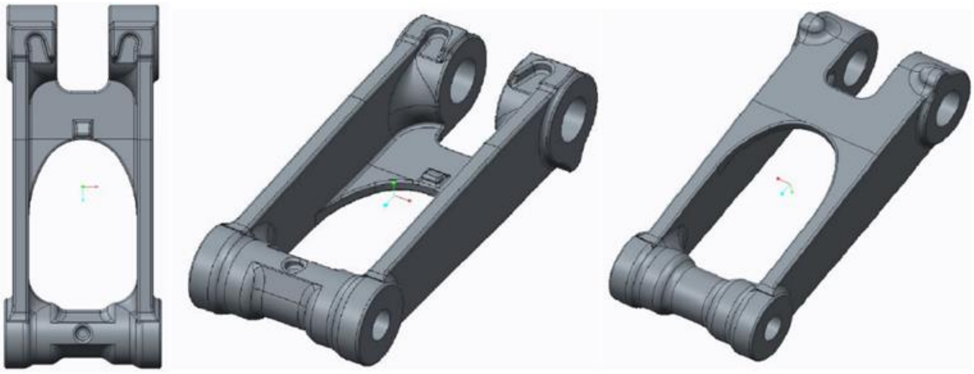

Figure 1. Schematic representation of the connecting casting part

In the first pouring system study, pouring system design of the connecting casting part is based on total gross weight of the part (total gross weight including gating system and feeders) and effective casting height. Total gross weight of the casting part is 105 kg and effective casting height is 32 cm. The gating system ratio of the casting part has been chosen as 1:3,5:2,5. Flow and solidification of the part has been simulated at 1350 °C by choosing lip pouring ladle. The designed pouring system ratio and dimensions of the casting part are shown in Table 2 and the images of the simulation results of the casting part are shown in Figure 2.

Table 2. Designed pouring system ratio and dimensions.

Gating system ratio	Vertical runner	Horizontal runner	Ingate
1:3,5:2,5	1	3,5	2,5
	12,56 cm^2	43,96 cm^2	17,5 cm^2

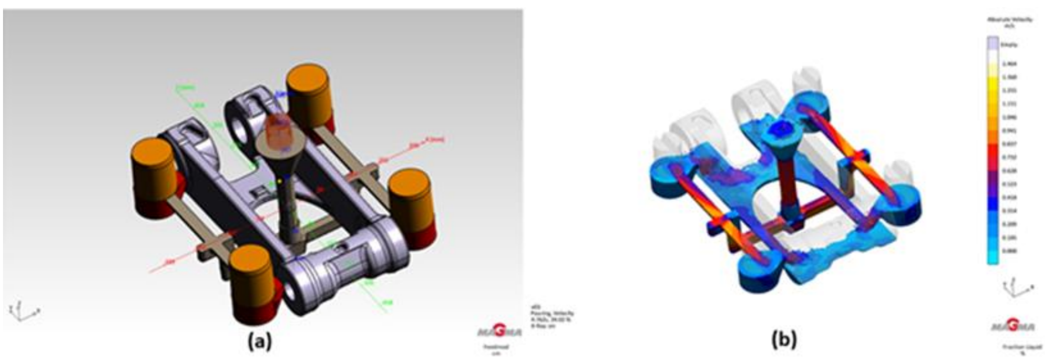

Figure 2. (a); The image of the casting part geometry**, (b);** The image of the metal flow and filling simulation of the casting part

After simulation results, one part was molded in the greensand molding system in ÇİMSATAŞ foundry and the casting has been carried out with a lip pouring ladle at 1350 °C and in 20 seconds. Total gross weight of the casting part has been detected as 105 kg. Image of the designed pouring system mounted in the part model and image of the poured part with designed pouring system is shown in Figure 3.

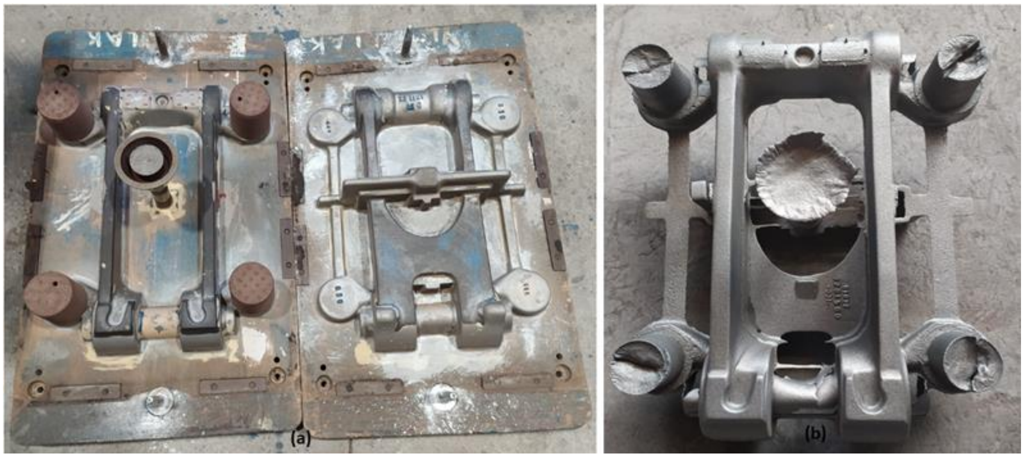

Figure 3. (a); The Image of the designed pouring system mounted to the part model, **(b);** The image of the poured part with designed pouring system

The part poured with the designed pouring system was examined and then a design change was made in the part solid data. The kalpur direct pouring system was placed at the cope side in the casting part solid data and flow and solidification of the part was simulated at 1350 °C by choosing lip pouring ladle. Images of the simulation results of the casting part are shown in Figure 4.

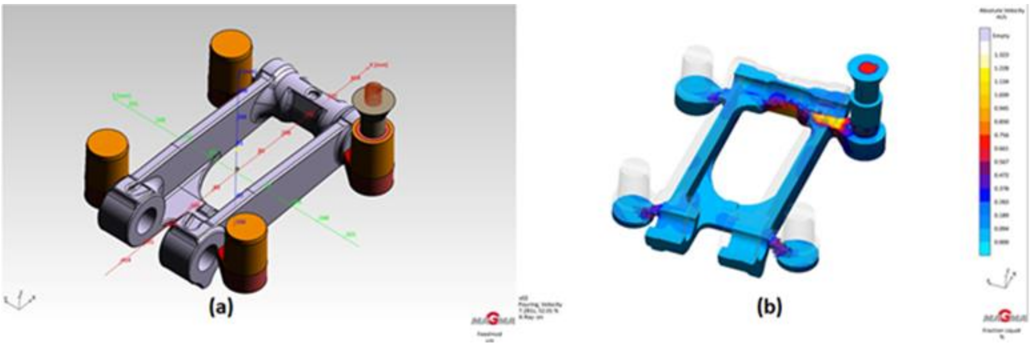

Figure 4. (a); The image of the casting part geometry**, (b);** The image of the metal flow and filling simulation of the casting part

After simulation results, one part was molded in the greensand molding system in ÇİMSATAŞ foundry and the casting was carried out with a lip pouring ladle at 1350 °C and in 15 seconds. Total gross weight of the casting part has been detected as 96 kg. Image of the kalpur direct pouring system mounted in the part model and image of the poured part with the kalpur direct pouring system is shown in Figure 5.

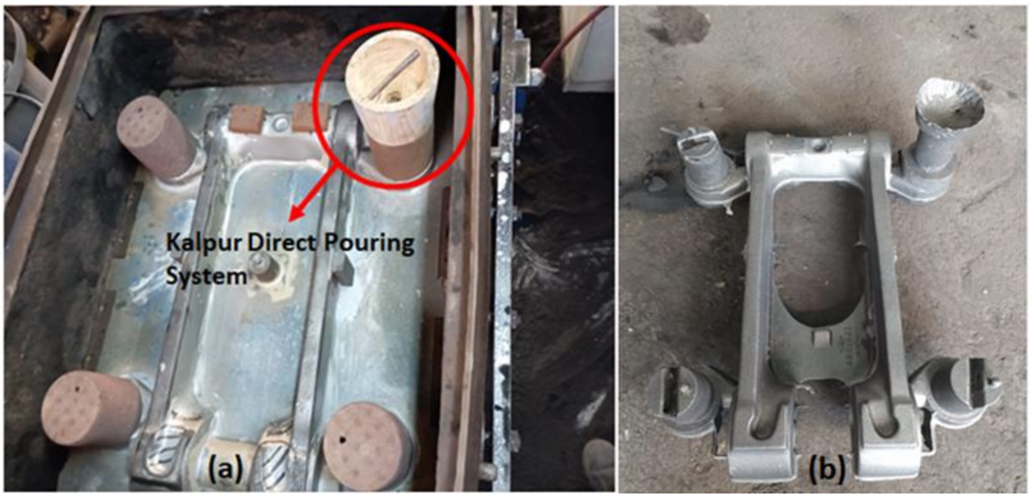

Figure 5. (a); The image of the kalpur direct pouring system mounted in the part model, **(b);** The image of the poured part with the kalpur direct pouring system

Results

- It was found that the simulation results represented nearly the actual casting results.
- The total gross weight of casting part poured with kalpur direct pouring system has decreased from 105 kg to 96 kg. In addition,
- While 4 cores were used in the first designed pouring system, only 2 cores were used in the kalpur direct pouring system. 2 cores has been eliminated in the molding of the casting part by the kalpur direct pouring system.
- It has been observed that clean part can be poured with the gating system ratio of 1:3,5:2,5.
- While the filling time of the poured part with the designed pouring system was 20 seconds, the filling time of the poured part with kalpur direct pouring system was decreased to15 seconds.
- It has been observed that the surface qualities of the poured parts are close to each other in both pouring systems.

Conclusion

It has been observed that designed pouring system with ratio of 1:3,5:2,5 for GGG50 ductile iron castings minimizes the escape of the non-metallic inclusions from ladle into the casting part during filling of the molten metal to the mold cavity. In addition, it has been increased the importance of the use of ceramic foam filters in foundries in recent years.

By using the design of the different version of the pouring systems in the ÇİMSATAŞ foundry, the surface quality of the casting part has improved by design of both pouring systems. It has been seen that ceramic foam filters are cost-effective and efficient way to reduce casting defects.

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