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Effects of Gating System on the Mechanical Properties & Quality of Metal Castings

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Abstract

This paper presents on Casting as a manufacturing process which is used for making components of complex shapes of molten metal in mass production. Casting may experience many different defects such as porosity, incomplete filling, etc. Improving and maintaining the casting quality becomes an important task. Gating/riser system design is critical to improve the casting quality. Different gating systems have different effects on the quality of castings. Two gating systems namely stepped and tapered runners were used to cast strip samples with different thicknesses by CO2/silicate process using sand grain sizes of AFS 151 and 171. Mould coating has effects on the properties of thin-wall ductile iron. To access this, half of the moulds were coated while the rest were left uncoated. Molten metal with the carbon equivalent of 4. 29% was prepared and poured at 1450° C. The results obtained by this experiment are studied and thus, the effect of different gating systems is studied. Also, the mold filling affects the gating design. During light metal casting processes, the quality of a casting can be considerably affected by the pattern of mold filling. In this study, the effect of gating design including gate geometry and size on the flow pattern was presented by pouring molten metal of aluminum alloy A413 into a sand mold. The experimental results indicate that the pattern of mold filling is greatly influenced by the size and geometry of the gate and the ratio of the gating system.

Keywords: *Gating System, casting defects, mould coating, mechanical properties, casting quality.*

1. INTRODUCTION

Gating systems includes all elements, which are connected with the flow of molten metal from the ladle to the mould cavity. The various elements that are connected with a gating system are pouring basin, sprue, sprue base well, runner, runner extension, in-gates. Any gating system designed should aim at providing a defect free casting. This can be achieved by making provision for certain requirements while designing the gating system.

The mould should be completely filled in the smallest time possible without having to raise the metal temperature or use higher metal heads. The metal should flow smoothly into the mould-cavity without any turbulence. A turbulence occurred in metal flow tends to form dross in the mould. Unwanted material such as slag, dross and other mould material should not be allowed to enter the mould cavity. An aspiration of the atmospheric air is prevented by controlling the entry of molten metal into the mold cavity. A proper thermal gradient should be maintained so that the casting is cooled without any shrinkage cavities or distortions. Gating or mould erosion can be avoided by maintain a fluid flow i.e. filling pattern of mold. The gating system should ensure that enough molten metal reaches the mould cavity. The gating system design should be economical and easy to implement and remove after casting solidification. Throughout a casting operation, mold filling is key operation. This plays very essential role in casting quality control. Due to the importance of mold filling, extensive research effort has been made in attempt to study the effect of gating design on the flow pattern of melt entering the mold. 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.

The formation of various casting defects could be directly associated to phenomena of fluid flow (molten metal in our case) involved in the stage of mold filling. For instance, rigorous streams could cause mold erosion; highly turbulent flows could result in air and inclusions entrapments; and relatively slow filling might generate cold shuts. To have proper control on filling pattern of mold the following design has to be taken into consideration i) Gating system, ii) Overflow system. Owing to awareness of energy conservation and environmental sustainability, demand in the use of light materials and new technologies in automotive industry has been created[I-2]. In recent years, thin wall ductile iron CTWDI) has been considered as substitute for steels and light alloys owing to its properties such as high strength and good ductility'<l, very good cast ability and machinability, and high wear and impact resistance [3-6]. In the past, thin-wall casting has been used in the automotive industry for parts such as cylinder head, engine block, and outlet manifold with thickness less than 6 mm. The thickness requirement then gradually decreased to the thickness of less than 5 mm and finally 4 mm. Today, parts with thickness of less than 3 mm can be found in automotive

parts and thin light-duty parts with 1 or 2 mm in thickness produced by casting like manifold are under investigation.

2. LITERATURE REVIEW

Hassan Jafri, et. al. during this analysis, the influence of gating systems is studied. 2 gating systems specifically stepped and tapered runners were used to forged strip samples with completely different thicknesses by COz/silicate method using sand grain sizes of AFS 151 and 171. To assess the impact of mould coating on the properties of thin-wall ductile iron, half the moulds were coated while the remainder were left uncoated coated. molten metal with the carbon equivalent of 4. 29th was ready and poured at 1450 ·C. Microstructure of the specimens was analyzed by optical and scanning negatron microscopes.

M. Masoumi, et.al. during this analysis, the impact of gating design on the mould filling is studied. the standard of a casting may be significantly plagued by the pattern of mold filling. during this study, the impact of gating design as well as gate pure mathematics and size on the flow pattern was investigated by pouring liquefied metal of Al alloy A413 into a sand mould. The direct observation technique was employed by that numerous flow patterns ensuing from completely different gating styles was recorded by a video camera, and more analyzed by a processed

system. The experimental results indicate that the pure mathematics and size of the gate and also the ratio of the gating system features a great influence on the pattern of mould filling.

Mazhar Iqbal. during this analysis, the gating design criteria is studied accordingly that affects the casting quality and mechanical properties of the metal castings. The gating system ought to make sure that enough liquefied metal reaches the mould cavity. The gating system design should be economical and simple to implement and take away when casting solidification. Ultimately, the casting yield should be maximized. A gating system is that the passage network through that liquid metal enters a mould and flows to fill the mould cavity, wherever the metal will then solidify to create the required casting form.

G.K. Sigworth. The idea of quality has been explained during this thesis using metal castings. The idea of metal quality has been pervasive, nonetheless elusive. everybody uses the term; however, few are able to provide an exact definition for it. One approach has been to use a 'standard' mould to judge metal quality. the 2 most ordinarily employed in North America are the ASTM B108 test bar, and a 'step' casting planned by the metal Association (AA). Some results with these molds are given for A356-T6 alloy. it's seen that higher degassing practices have resulted in vital enhancements in casting quality over the last thirty years.

3. GATING SYSTEM & DESIGN VARIABLES

Fig.1 Casting Process

Methods used to promote any of the desirable design considerations discussed below often conflict with another desired effect. For example, attempts to fill a mold rapidly can result in metal velocities that promote mold erosion.

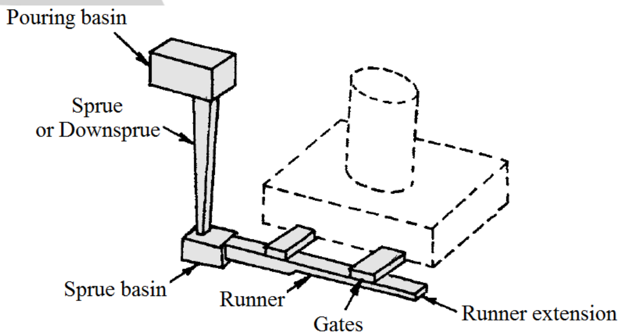

Fig.2 Elements of Gating System

As a result, any gating system will generally be a compromise among conflicting design considerations, with the relative importance of the consideration being determined by the specific casting and its molding and pouring conditions.

1) To minimize Turbulence.
2) Avoiding Mold and Core Corrosion
3) Removing Slag, Dross, & Inclusions
4) Promoting Favorable Thermal Gradients
5) Maximizing Yield
6) Economical Gating Removal
7) Avoiding Casting Distortion
8) Compatibility with existing molding/pouring methods
9) Controlled flow conditions

Some Gating Ratios used in practice are as follows:

Table.1 Gating Ratios

1	Aluminum	1:2:11: 3:31:4:4
2	Aluminum Bronze	1:2.88:4.8

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3	Brass	1:1:11: 1:31.6:1.3:1
4	Copper	2:8:13: 9:1
5	Ductile Iron	1.15:1.1:11.25:1.13:1
6	Grey Cast Iron	2:1.5:12:3:1
7	Magnesium	1:2:21: 4:4
8	Malleable Iron	1:2:9.51.5:1:2.52:1:4.9
9	Steels	1:1:71: 2:11:2:1.5

4. MOULDS

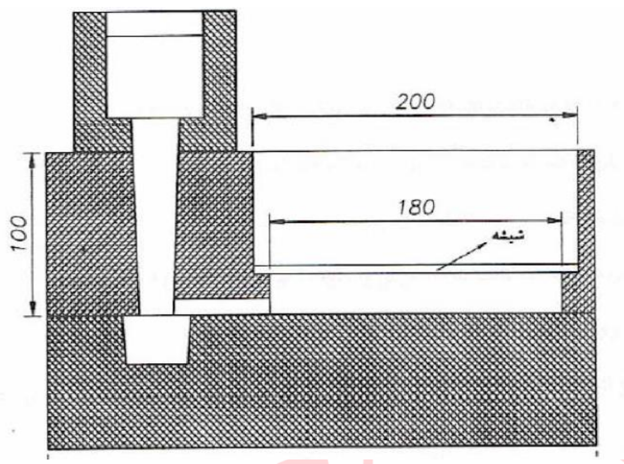

Fig.3 Cross-section of Mould

5. CONCLUSION

1. Pouring basin, sprue, sprue base well, runner and runner extension serves the aim of permitting clean liquid(molten) metal to enter the mould cavity.
2. Parting gate is the most widely used gate while the top and bottom gates are sometimes used for specific application that favors them.
3. Fluid mechanics law, together with empirical relations, is applied to the design the optimum gating system.
4. It is important to make sure that slag entering the gating system be removed completely before the metal enters the mould cavity.
5. Sometimes chills may be need to be added to reduce porosity at isolated sections that are not fed by risers.
6. A considerable effect of the geometry of a gate with a constant cross section area on flow pattern has been observed, which primarily results from the change of the metal head pressure at the entrance of the mold.
7. In no pressurized gating systems, the deviation of melt flow from the centerline of the mold or incomplete gate filling tends to appear. To avoid the problem of melt flow deviation or incomplete gate filling, a gating system ratio of G: R=1 is recommended for the design of an effective gating system.

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