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BIFILMS AND HOT TEARING OF Al-Si ALLOYS

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Hot tearing is one of the most interesting defects that can be found during casting of aluminium alloys. The definition of this defects has some uncertainties such as "it does not always appear under apparently identical conditions" or "the defect is highly specific to certain alloys". There are several works in the literature on the modelling and analytical approaches. However, the experimental findings have not been satisfactory. In this work, A356, A380 and A413 alloys were cast in two different moulds to investigate the hot tearing tendency with regard to the melt quality. It was found that bifilms had dominant effect over the hot tearing.

Keywords; Hot tearing, casting simulation, Al-Si alloys, Sand and permanent mold casting

1. INTRODUCTION

Casting methods are one of the most economical method of forming parts. However, there are some defects that can be faced during the casting processes. Generally; segregation, pore formation and hot tearing are the leading defects on this list. Main reasons that cause hot tearing are contraction in mushy zone, restricted shrinkage and lack of feeding [1, 2]. It is not easy to estimate this defect because of some complex events occurring simultaneously during solidification. Although there are plenty of studies on hot tearing [3-8], yet, it cannot be fully understood [1]. Characteristic properties of hot tearing can be listed as follows:

- Occur as messy and branched cracks.
- Main tearing and its extensions observed to be intergranular.
- Defect surface has a dendritic morphology.
- Defect surface is usually packed with heavy oxides.
- Generally located on hot spots where shrinkage deformation takes place.
- Not always seen under the same conditions.
- Specific to certain alloys; not seen in all alloys.

Campbell [1] recommend that there are some applications where this problem can be controlled:

- With chill applications
- With grain refinement
- Working with different alloys
- Using suitable mould
- Proper runner and sprue design; i.e. controlled filling

Each of these parameters are actually related to bifilm [1]. Thus, low melt quality in casting triggers plenty of casting defects [9-13].

In industrial applications, economy, i.e. profit, plays a significant role. There are some parameters such as raw material, energy, labour etc that affects the cost in foundries. It is very

difficult to decrease the cost with parameters like this. On the other hand, there are some parameters that increase the casting defects such as re-melting that is occur during manufacturing. Eliminating these parameters without the increased cost means both work at full capacity and desired profit can be reached. In this point, computer-based casting simulation programs are very helpful for foundries that both aids the foundries by means of casting and eliminating defects prior to casting on computers before the actual doing the casting.

In this study, MagmaSoft has been used to simulate the process and the effect of melt quality has been incorporated into the equation and new idea has been proposed for the formation of hot tearing defect in Al-Si.

2. EXPERIMENTAL STUDIES

There were several mould design to test the hot tearing tendency of alloys from 1930 to 2015.

1- Ring mould
2- Cold finger mould
3- Backbone mould
4- CRC mould
5- T shape mould
6- WPI mould
7- T shape mould with load cell modification
8- Other moulds

In this present work, CRC and T shape moulds were used and their dimensions are given Figure 1.

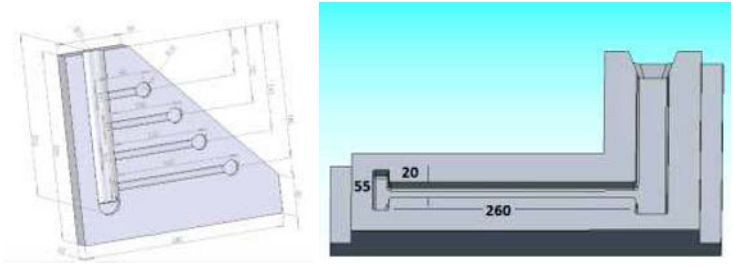

Figure 1: (a) CRC mold, (b) T shape mold

Three different Al-Si alloys were used and the chemical compositions are given Table 1.

Table 1: Chemical compositions of Al-Si alloys used in experimental studies

	Si	Fe	Cu	Mn	Mg	Ti	Al
A357	6,6	0,20	0,02	0,03	0,30	0,08	Rem.
A380	8,1	1,1	2,6	0,5	0,02	0,09	Rem.
A413	11,3	0,13	0,02	0,01	0,1	0,09	Rem.