International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 11 (2018) pp. 9790-9793

Influence of Pressure Head and Sand Fineness on Filling Ability of US A356

Dr. Samavedam Santhi

Assistant Professor, MGIT, Hyderabad 500075, India.

Abstract

Most of the defects in castings generally originate at the filling stage. A good mould filling ability alloy assists to produce long thin walled sections and reproduce finer contours of the moulds[1]. To understand the mould filling ability, pin test piece with cylindrical cores proposed by Engler & Ellerbrok [2] is used. The Parameters that are affecting the mould filling ability are pressure head, alloy composition, fineness of sand, mould coat and pouring temperature. In the present study, process parameters such as graphite mould coat, fineness of sand and pouring temperature are emphasized [1,3]. The mould filling ability of aluminium alloy US A 356 has been studied in the present investigation.

Keywords: Cast Aluminum Silicon Mgnesium Alloy**,** mould filling ability, pressure head, fineness of sand and Pouring temperature

INTRODUCTION

The casting process initiates with the molten metal filling the mould. Filling conditions play a significant role on the quality of casting as cited by Lubos Pavlak [4]. Alloy US A356 is the most useful of aluminum alloy structural castings and it is a hypo eutectic Al-Si alloy [5]. Mould filling ability is essential for the entire casting cycle [3]. The mould filling ability characteristic depends upon the metallostatic balance between the prevailing metal pressure and surface tension of metal. J.A. Capadona et al. stated the importance of mould filling ability of casting where cross sectional area of channels is reduced [6, 7].

EXPERIMENTAL STUDIES

The mould filling ability of Cast Aluminum Silicon Mgnesium Alloy, US A356 alloy is investigated by pin test piece with cylindrical cores designed by Engler and Ellerbrok (Figure 1). The test casting consists of two fins of metal at both sides. The inverse of the diameter of curvature of the edge tip of the fin gives the value of the mould filling ability. Process Variables studied are Sand fineness, Mould coat and Pouring temperature. 4 experiments have been conducted for calculating the mould filling ability characteristics of cast aluminium alloy. The details are provided in Table 1. The filling ability characteristic is largely influenced by the alloy composition, for the present study Cast Aluminum Silicon Mgnesium Alloy US A 356 (Al-7Si-0.5Mg) is considered. Fineness of the sand shows significant difference in the casting characteristics, which influences surface finish and strength of the casting. AFS sand fineness numbers 25 and 48 are considered for the study. Mould coat is one of the process parameters that provides smooth surface and improves the quality of the casting [1,8].

Table 1. List of experiments for experimental validation studies

S.No	Alloy	Sand Fineness (AFS No.)	Mould coat
1	US A356	25	Graphite (GC)
2	US A356	25	No coating (NC)
3	US A356	40	Graphite(GC)
4	US A356	40	No coating(NC)

Tooling for the mould filling ability experiments are given in Figure 2. The moulds are provided with dowel pins for perfect matching of cope and drag. Moulds are prepared with slight ramming. The patterns have been stripped after 3 hours. Moulds are prepared using green sand process consisting of Bentonite (5%-6% of sand weight) and water (5%-8% of sand weight). The mould hardness is in the range of 75-80 on B scale. In case of mould coatings, the graphite paint is sprayed on to the mould and dried immediately by lightening a flame on the painted surface.

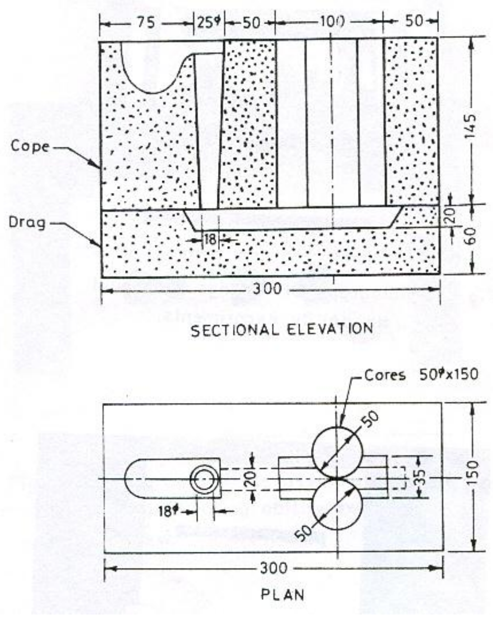
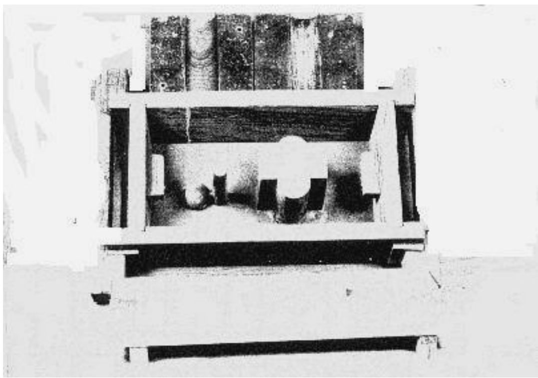
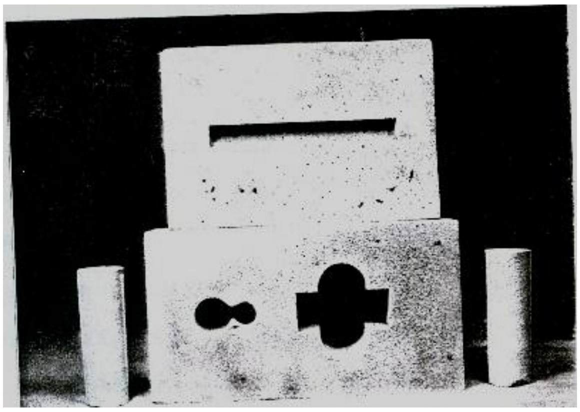


Figure 1. Schematic view of Mould filling ability studies

The alloys are melted in an electric resistance furnace of capacity 20Kg provided with mild steel crucible. Temperature is measured with the help of a thermocouple. The furnace is put off and the crucible is lifted and put in a tilting device. The metal is tapped into a smaller crucible for pouring into the mould. The pouring height is maintained constant to avoid turbulence and difference in surface oxidation and oxide pick-up. Figure 3 depicts the solidified mould filling ability test casting. The value of mould filling ability is calculated as the distance between the two fins.



(a) Mould filling pattern and Cylindrical cores



(b). Cope box, drag box and cylindrical cores

Figure 2. Tooling for mould filling ability experiments

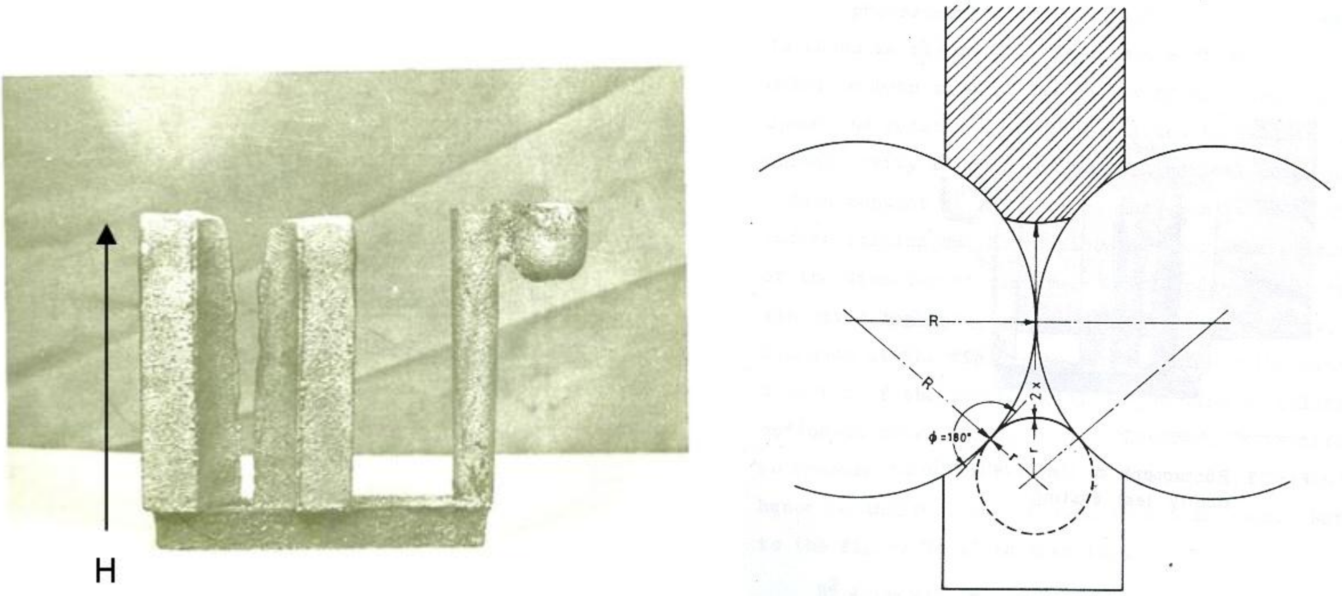


Figure.4. Measurement of mould filling ability

RESULTS

Methodology adopted for calculating mould filling ability

The inverse of the diameter of curvature of the edge tip of the fin gives the value of the mould filling ability. The diameter at the tip of the fin gives the meniscus diameter of the liquid metal at the time of solidification as represented in the Figure.4 for one particular pressure head. It is difficult to measure the diameter of the tip of the edge and hence an indirect way of calculation has been used.

As per the Figure 4;

$$R^2 + (r+x)^2 = (r+R)^2 \qquad \text{Equation 1}$$

$$\text{so } 1/d = (R-x)/x^2$$

R = radius of the sand core, mm,

r = radius of the meniscus (2r=d), mm

2x = distance between edges, mm

1/d = mould filling ability, 1/mm

Height gauge has been used to mark the height at every 5mm interval for solidified castings. The distance between the fin edges 2x is measured with vernier micrometer. The mould filling ability values have been calculated for every 5mm increment by using **Equation 1**. The mould filling ability values at various pressure heads for 4 experiments are given in Table.2.

Table 2. Mould filling ability values for experimental 1 to 4

H,mm	Distance between the fin edges, 2x (mm)			
	1	2	3	4
35	0.3269	0.1478	0.597	0.124
40	0.3946	0.1562	0.6240	0.131
45	0.3667	0.1739	0.6427	0.220
50	0.4090	0.220	0.6617	0.233
55	0.4100	0.330	0.7208	0.2777
60	0.5183	0.338	0.7412	0.3398
65	0.5351	0.3464	0.7619	0.409
70	0.6481	0.3531	0.8708	0.4856
75	0.650	0.3598	0.8818	0.535
80	0.6811	0.3639	0.9878	0.550
85	0.8043	0.3666	1.2250	0.5697
90	0.826	0.4091	1.5518	0.5879

Influence of pressure head

Increase in height of the sprue increases metallostatic pressure. The mould filling ability is expressed as the reciprocal of the diameter of the meniscus of fin edge in the solidified test casting. It is expressed as a curve showing its variation with respect to pressure head (H). Figure 5 shows the effect of pressure head on mould filling ability of US A356. Increase in pressure head leads to increase in the metallostatic force, allowing the liquid to enter the finer contours between the cylindrical cores thereby reducing the fin edge and increasing the mould filling ability values.

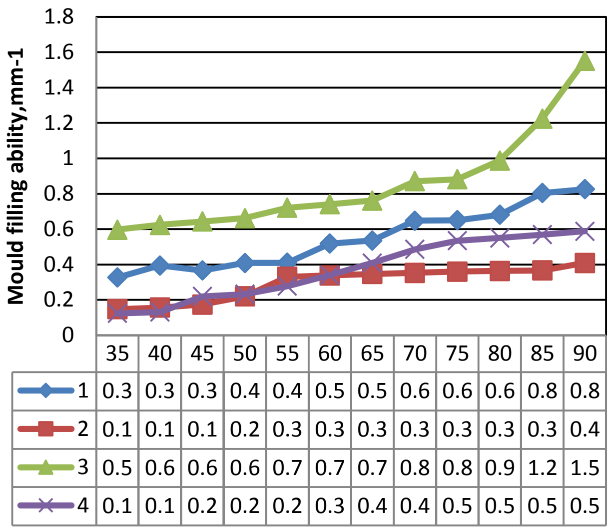


Figure 5. Influence of Pressure head

The factors which influence the mould filling ability in liquid region are surface tension and contact angle. Cooling conditions influence the mould filling ability in solidifying region. In the present studies, experiments have been conducted in the solidifying region where the mould filling ability is influenced by pressure head while the surface tension and density are neglected and an angle of contact of 180^0 is assumed. Higher pressure head leads to higher mould filling ability because the metal has to be in contact with larger area in order to penetrate into cavity which promotes faster solidification.

Influence of sand fineness and mould coat

Sand fineness plays a very important role in the moulding process. The fine sand shows better mould filling ability. Coarse sand has more chilling power and solidifies the metal faster. This restricts the filling up of the cavity contours between the cylindrical sand cores and reduces the mould filling ability as shown in figure 5. To reduce the friction between the metal and mould, the surface on the mould is coated with graphite. Mould coating improves the mould filling ability by influencing the solidification rate, direction and thermal gradients, creating a pathway for liquid metal to fill the finer contours. Mould coat provides an insulating effect during heat transfer and therefore reduces the rate of cooling in the liquid metal.

CONCLUSIONS

Mould filling ability increases with increase in metallostatic/ pressure head. The mould filling ability increases with increase in fineness of sand because coarse sand is having more chilling power and solidifies the metal faster. Mould coat improves mould filling ability by providing less resistance to liquid metal flow. Graphite coat and sand fineness no. 40 are optimal factors, for getting better mould filling ability.

REFERENCES

[1] S. Sundarrajan, H Md Roshan, Studies on mould filling ability characteristics of Mg-Al Alloys, Transactions of American Foundrymen Society, 1989,pp.607-616

[2] S. Engler, R.Ellerbrok, Ueber des formfullengsvermoegen, Giess, Forsch, p49, 1974

[3] O. Bouska, The Effect of Different Casting Parameters on the Relationship Between Flowability, Mould Filling Capacity and Cooling Conditions of Al-Si Alloys, Association Of Metallurgical Engineers Of Serbia, Journal Of Metallurgy, 2007,pp.17-30

[4] Lubos Pavlak, Effect of filling conditions on the quality of cast aluminum cylinder heads, MJOM Journal of Metallurgy, Association of Metallurgical Engineers of Serbia Scientific paper, 2005, pp.31-39.

[5] ASM Metals Handbook Volume 15, Casting, ASM International, The Materials Information Company, 2004

[6] J.A. Capadona, D.L. Albright, Review of fluidity testing as applied to lost polystyrene investment castings, Trans., AFS, Vol.86, 1978, pp.43.

[7] Cooksey, C.J. Kondic,V and Wilcock,J " The casting fluidity of some foundry alloys" the British Foundryman, Vol 52, pp.381, Sept 1959

[8] M. Di Sabatino, S. Shankar, D. Apelian, and L. Arnberg, Influence of temperature and alloying elements on fluidity of Al-Si alloys Shape Casting: The John Campbell Symposium, Ed. by M. Tiryakioglu and P.N. Crepeau, TMS 2005, pp. 193-202