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Particle Distribution in Horizontal Centrifugal Casting Using Paraffin Wax

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ABSTRACT: Melt flow in centrifugal casting plays a major role in determining the acceptability of the casting size & shape. The mechanical properties of casting are determined by factors such as in rotational speed, pouring temperature of melt, fluid properties like viscosity, mould dimension, orientation and aspect ratio. Since it is difficult to study the melt flow as melt & mould are opaque and casting process is rapid Hence in the current investigation Casts are obtained using paraffin wax having melting temperature of about 55-65⁰ C . Also in order to study the particle distributions solid particles of lower density has been introduced to the liquid and melt by doing this we can optimize the parameters to get better cast.

KEYWORDS: Centrifugal casting, rotational speed, paraffin wax

I. INTRODUCTION

Centrifugal casting is the casting technique in which the molten metal is poured into a rapidly rotating mould or die. The centrifugal force due to rotation causes the molten metal to be spread over the mould surface such that a hollow cylinder type casting is produced after complete solidification. Because of the centrifugal force, the lighter impurities are gathered towards the centre of the case. The centrifugal force causes high pressure to develop in the metal as it freezes with directional solidification, helps in metal feeding and contributes to the removal of non-metallic inclusions and evolved gases toward the inner surface of the hollow casting. The casting is usually a fine-grained casting with a very fine-grained outer diameter, owing to chilling against the mould surface. Most of the castings are solidified from the outside first. This may be used to encourage directional solidification of the casting, and thus give useful metallurgical properties to it. In this process castings are relatively free from defects when compared to conventional method, have higher production rate and also have better mechanical properties.

Several researchers have conducted experiments to determine the effect of processes variable, mould temperature, pouring temperature and rotational speed of the mould on the quality of the centrifugal casting. They concluded that as the mould temperature increase solidification time increases and hence rate of solidification decreases. The three major factors deciding the quality of the cast are geometric nature of particle flow in the cylindrical mould, the angular velocity and solidification rate. For a given set of operating condition, the thickness of the particle rich region in the composite decreases with an increase in rotational speed, particle size, and relative density difference between particle and melt, initial pouring temperature and initial mould temperature.

Investigators had also found that the displacement of the particle in alloy toward the inner or outer casting surface depends upon their density difference and the rotational speed of the mould and particle size. The magnitude of the centrifugal force is regarded as of major importance in this process as it causes segregation by the difference in the densities of the particle and matrix

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II. METHOD AND MATERIAL

In our present investigation in order to study the particle distribution in centrifugal casting casts of paraffin wax, with minute solid beads in it have been obtained using horizontal centrifugal casting process at different rotational speed and mould wall thickness. As the cast was translucent in nature the particles were clearly identifiable, hence we could observe the particle distribution. The experimental setup is as shown in figure .The centrifugal casting set up consists of mild steel mould fixed to a flange which is connected to the shaft of a 1HP DC shunt motor whose speed can vary from 20 rpm to 2000 rpm.



Figure 1. Experimental set up for Centrifugal casting

In this process the molten metal was poured into a horizontally rotating mould ,when the molten metal was poured in the mould due to centrifugal force acting in the outward direction makes the molten metal to spill out in outward direction and sticks to the wall of mould. This leads to the formation of hollow cylinder with required thickness. In horizontal centrifugal casting at higher speeds of rotation of mould, the formation of hollow cylinder was perfect due to higher centrifugal force acting on the fluid and also the cast obtained was of a better quality.

III.OBSERVATIONS

A few castings of paraffin wax with minute solid particles were prepared with 5mm and 3mm mould wall thickness at 600rpm and 1200rpm are shown in figure 2.



600 rpm

1200rpm

Figure 2.Cast of 5mm thickness obtained at different speed

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Once cast is obtained it has been cut into small specimens of dimension 10mm x 10mm. Starting from the pouring end the no particles which was found to settle down at different places had been determined and tabulated below and particle distribution have been plotted in the graph.

Table 1. Particle distribution in wax casting

Distance from Pouring end	No. of particle	
	600rpm	1200rpm
10	0	55
20	0	9
30	3	15
40	75	73
50	65	84
60	17	45
70	3	31
80	0	5

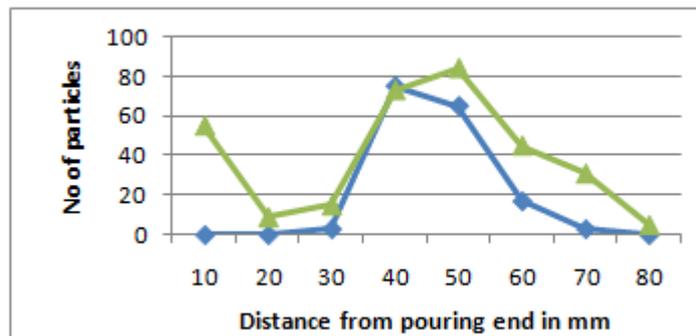


Figure 3. Particle distribution with respect to distance from pouring end.

In the Cast obtained at 600 rpm most of the particles are found to be settled down at a distance of 40 to 50 mm from the pouring side where as particle distribution towards both the ends are less ,this may be because initially when melt was poured it was having higher flowability , as a result of which the particles are thrown away from the pouring end, but gradually due to phase transformation the particles could not reach the rear end of the cast.

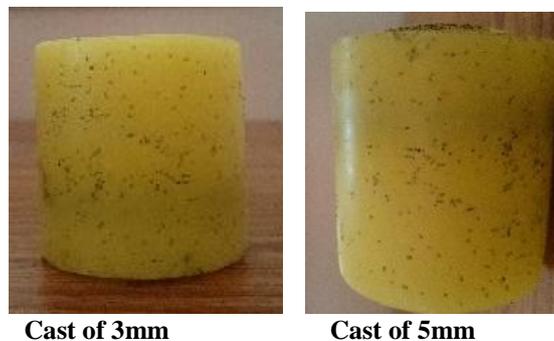


Figure 4 .Particle distributions in wax casting for different mould wall

As in this type of cast the particles introduced were having high density most of them could not reach the rear end of the cast .Almost similar distribution was found in the range of 40 to 60 mm. Some of the particles are found both in the front and rear end .This is due to high rotational speed and hence change in solidification rate which results for little variation in distribution.

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Table 2. Distribution at 800rpm for different mould wall thickness

Distance from pouring end in mm	No. of particle	
	3mm	5mm
10	12	10
20	13	29
30	18	9
40	20	0
50	15	8
60	8	5
70	4	15
80	5	0

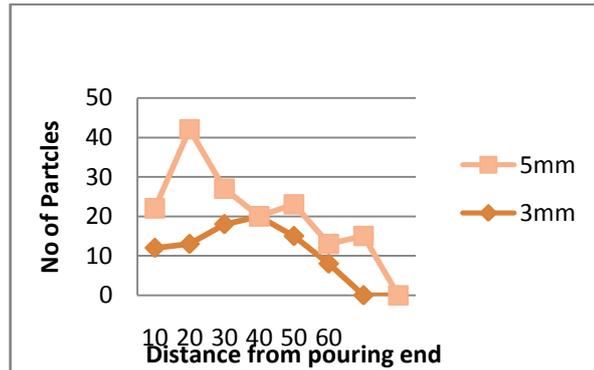


Figure 5. Particle distribution for different mould wall thickness

From the graph it is clear that most of the particle settles down at the peripheral surface of the cast because of high solidification rate near the mould wall. Particles could not reach the inner wall because of phase transformation.

IV. CONCLUSION

Smoothness of cast is better at higher rotation. At higher speed particles are more at outer surface, due to more centrifugal force and at lower speed particles settle down near the outer surface. Density of the particle is three times of the wax and centrifugal force acting on it is enough to throw the particle to the outer surface. Particle distribution is more near pouring side, which gradually decreases with respect to distance to pouring side. That may be because of progressive phase transformation.

Also it has been observed that when particle of higher density is introduced, it was settling down at outer periphery whereas when particle of lower density is used, it was found to settle down somewhere in between inner and outer surface.

Solidification rate is faster in metal mould than that of insulated mould, because of thermal conductivity. Solidification rate is higher at higher speed. The smoothness of the surface of the cast obtained by taking mould of lesser thickness is better than that of mould having more thickness. Solidification is rapid at the outer surface than the inner surface.

V. SCOPE OF FUTURE WORK

In the recent investigation we have carried out the experiment by low melting paraffin wax having density 900kg/m^3 which was approximately one third the density of the metal i.e. aluminum. Similar material that can be solidified at lower temperature can be taken as a working material and can be correlated to the metal having proportionate density. This work could be further taken by analyzing other factors like mould dimension, material pouring, material thickness of casting with viscosity, surface tension and so on for both vertical and horizontal centrifugal casting. Numerical and CFD methods can also be used to study the fluid flow behaviour in a centrifugal casting machine.

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