Assignment # 3, Module 5, Casting

Solutions

Q1) A rectangular metal bar, $1 \times 3 \times 4\ m$, solidifies in 10 seconds in a sand-casting process. What is the value of mold constant according to Chvorniov's rule?

according to Chvorniov's rule:

$\frac{V}{A} = \frac{12}{38}$, $t_{solidify} = B.(\frac{V}{A})^2$, $10 = B.(\frac{12}{38})^2$, $B \cong 100\ \frac{Sec}{m^2}$

Q2) A cylindrical riser must be designed for a sand-casting mold. The casting itself is a steel rectangular plate of $7.5 \times 12.5 \times 2.0\ cm$. Experimental tests have indicated that the total solidification time for this casting is about 100 seconds. The cylinder for the riser will have a height/dimeter ratio of 1. Determine the dimension of the riser so that the total solidification time is not more than 2 min.

First, we find the mold constant:

$t_{solidify} = B.(\frac{V}{A})^2$, $100 = B.(\frac{187.5}{267.5})^2$, $B \cong 203\ \frac{Sec}{cm^2}$,

Now, using the same mold, the total solidification time for the riser must be maximum, 2 min (120 Sec):

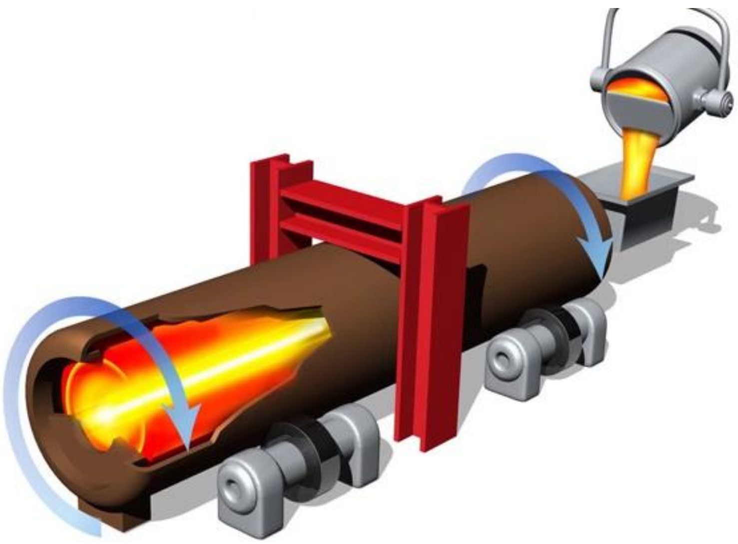
$\frac{V}{A} = \frac{\frac{\pi D^2 H}{4}}{\pi D H + 2 \times \frac{\pi D^2}{4}}$, with assumption: $\frac{H}{D} = 1$, we obtain $\frac{V}{A} = \frac{D}{6}$

$t_{solidify} = B.(\frac{V}{A})^2$, $120 = 203\left(\frac{D}{6}\right)^2$, $D = 4.6cm$, $H = 4.6cm$

Q3) The enclosure for a gearbox is made of two aluminium castings components. The larger component has the shape of a dish sink, and the second one is just a flat cover which is attached to the first component. Sand casting is used to produce the two castings, both of which are plagued by defects in the form of misruns and cold shuts. The foreman complains that the parts are too thin, and that is the main reason for the defects. However, it is known that the same components are cast successfully in other foundries. What plausible explanation can be given for the defects?

Misrun defects occur when castings solidify before completely filling the mold cavity. ***Cold shuts*** occur when two portions of the metal flow together but there is a lack of fusion between them due to premature freezing. Typical causes of these two defects include, 1- fluidity of the molten metal is insufficient 2- pouring temperature is too low (the superheat (ΔTs = $T_{pour} - T_m$) is insufficient) 3- Pouring is done too slowly 4- Cross section of the mold cavity is too thin.

Q4) In centrifugal casting the mold is rotated at high speed so that centrifugal force distributes the molten metal to the outer regions of the die cavity. Watch this short video.



One important parameter which needs to be calculated in each centrifugal casting operation is, how fast must the mold be rotated for the process to work successfully, otherwise if rotation is too slow, the liquid metal will not remain forced against the mold wall during the upper half of the circular path but will "rain" inside the cavity or if too fast then slipping occurs between the molten metal and the mold wall, which means that the rotational speed of the metal is less than that of the mold?

You have been hired to assist a foundry which produces copper tube with cross section OD=25cm, and ID=22.5cm. Your first task is to conduct some studies and find an optimum rotation speed for this operation? Please provide a formula you used with the reference you found it.

The centrifugal force is $mr\omega^2$

The weight is mg

According to this reference, the G-Factor is defined as: $G-Factor = \frac{mr\omega^2}{mg}$

http://www.rapsri.com/centri_manufacturing.html

$\omega = \sqrt{\frac{(G-Factor)g}{r}}\,\frac{rad}{sec}$, OR, $Rotation\ speed\ (rpm) = \frac{60}{2\pi}\sqrt{\frac{2(G-Factor)g}{D}}$

On empirical bases, $G-Factor = 70$ gives an optimum speed (According to: beeley P. R. Foundry technology, newnes butterworth, London,

https://www.elsevier.com/books/foundry-technology/beeley/978-0-7506-4567-6).

$Rotation\ speed\ (rpm) = \frac{60}{2\pi}\sqrt{\frac{2(70)g}{0.25}} \cong 700\ rpm$

Now, let's check it with this website:

https://www.gibsoncentritech.com/speed-and-coating-calculations-rpm/