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Theory of similarity at pressure dies

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Abstract

We get from equations for laminar and turbulent flow criterion equations containing competent criteria without size. Two processes at pressure die casting are similar when their corresponding criteria are equal. We can introduce instead of the real flow the similar model flow. It is possible to introduce then the coefficients of size and pressure similarity for the model liquids of the alloy AlSi water, mercury, Woods metal, and tin solder that is in the table.

Keywords: Pressure dies casting; Laminar flow; Turbulent flow; Coefficient of size similarity; Coefficient of pressure similarity.

1. Introduction

For pressure die-casting it is possible to determinate the flow equation of Bernoulli in turbulent form

$$p = \frac{v^2}{2} \cdot \left(1 + \sum \xi\right) \cdot s + \frac{32 \vartheta y v}{d^2} + ysg + ays \qquad (1)$$

where is: p – pressure of pressing piston on metal in pressing sleeve,
y – height of molten metal column in die cavity,
s – specific mass of molten metal,
v – linear velocity of molten metal column,
$\sum \xi$ – sum of resistance coefficients from gate,
a – linear acceleration of molten metal column,
g – acceleration of gravity,
υ – kinematic viscosity of molten metal,
d – hydraulic diameter of die cavity.

At laminar form of flow that is in less extent at pressure die casting the first member on the right hand of the equation (1) is not present.

2. Description of the approach

Two processes at pressure die casting are similar if their flow equations are equal. Instead of real flow we can introduce similar model flow by model liquid on model machinery. We use instead most used aluminium alloy AlSi as model liquids Woods metal, tin solder, mercury and water.

In case of similar model flow coefficients of the flow equation should be equal or very near at least. For turbulent flow

$$\frac{\left(1 + \sum \xi\right) \cdot s}{2} = \frac{\left(1 + \sum \xi_m\right) \cdot s_m}{2} \qquad (2)$$

and for turbulent and laminar flow

$$\frac{32 \cdot \upsilon \cdot s}{d^2} = \frac{32 \cdot \upsilon_m \cdot s_m}{d_m^2} \qquad (3)$$

where is: $\sum \xi_m$ – sum of resistance coefficients of model machinery,
s_m – specific mass of model liquid,
υ_m – kinematic viscosity of model liquid,

d_m – hydraulic diameter of model die cavity.

3. Results

If we do not consider the third and fourth member on the right hand of the equation (1) then for laminar flow for similarity of model machinery the relation (3) is valid. Graphically it is the dependence on the figure 1.

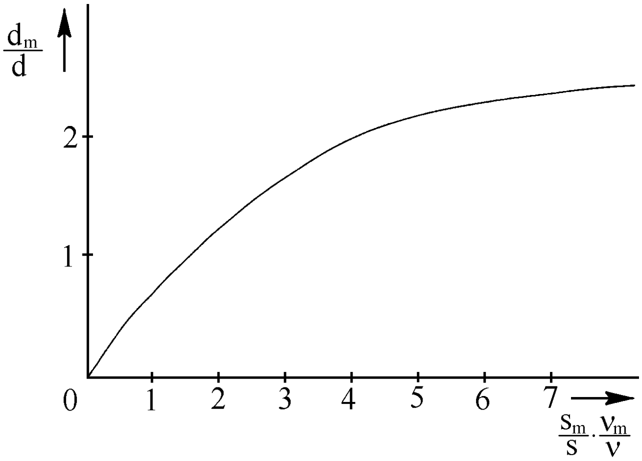

Fig. 1. Dependence of modelling and actual quantities for laminar flow

For turbulent flow they are the relations (2) and (3), that are graphically on the figure 2.

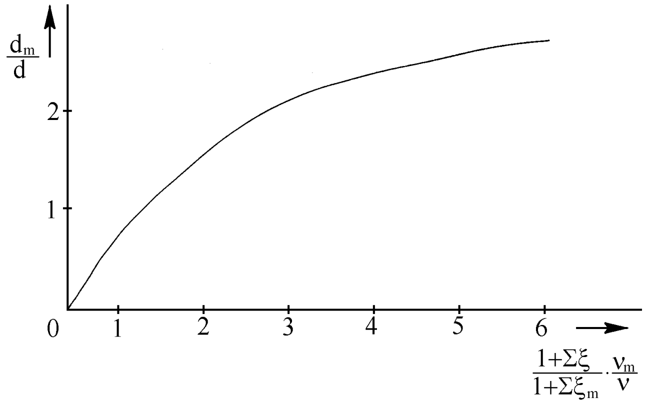

Fig. 2. Dependence of modelling and actual quantities for turbulent flow

On the other hand it means that at modelling of aluminium alloy by water according to the relation (2) the model machinery had in proportion of specific masses of liquids greater sum of resistance coefficients and according to the relation (3) had equal proportion of dynamic viscosities and squares of hydraulic diameters of die cavities.

4. Conclusions

It is necessary to realize the further measurement of flow at pressure die casting and its modelling that contribute to precision of flow similarity.

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