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INFLUENCE OF PROCESS PARAMETERS ON CASTABILITY AT FULL MOLD CASTING

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This paper examines the effect of the temperature of pouring the melt, the density of the model of foamed polystyrene and the casting with or without a vent on castability. The testing was carried out in accordance with the experiment plan 2^3 i.e. during testing the value of the parameters of influence was changed at two levels: the melt pouring temperature of 640 °C and 600 °C, casting with or without a vent, and the density of foamed polystyrene model of 15 kg/m^3 and 30 kg/m^3.

Key words: casting, full mold casting, castability, temperature, density of polystyrene

INTRODUCTION

The characteristic common to all molding and casting processes, whether traditionally in use or developed over decades, is the application of a hollow mold. At this, the mold cavity is obtained in a well-known way of the casting contours design in the mold material by means of a permanent model, which can be fabricated from different materials. Upon this the model is separated from a part of the mold and the mold cavity is formed by assembling separate parts of the mold. Previous to assembling, cores are put into the mold cavity if the mold casting technology requires it [1].

After this the melt is poured into the mold and upon a cooling period in the mold, the casting is removed.

In contrast to this technique, the lost polystyrene foam model, used at full mold casting, is inserted into the mold and most frequently closed at drag (by the mold mixture or sand).

If necessary, the model for the pouring system can also be made from foamed polystyrene.

The pouring system sometimes functions in a conventional way with a permanent model so that a „hollow“ pouring system is obtained following the completed molding. After the model and the pouring system in the mold is filled up by the mold material (mold mixture or dry sand), the mold is ready for pouring the melt in.

During pouring the melt fills the mold, the pouring system and the model gradually evaporate so the melt takes place of the pouring system and the foamed polystyrene model and solidifies.

The full mold procedure is satisfactory for the current demands of the molding and casting technology. A number of problems occurring in practice that seemed to be unsolvable could eventually be solved by this process.

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Foamed polystyrene models that evaporate are used for full mold casting. The used mold is most often of one piece and the process is called the „lost model“ procedure because the model is made from polystyrene foam and by being poured into the mold, the melt gradually evaporates the model, takes its place and solidifies. Although the full mold casting technology was used earlier, for art objects first of all, it is common in the current casting production.

EXPERIMENTAL

With full mold casting defects on castings are possible. According to [2-5] they are particularly connected with the following:

- fabrication of models
- assembly of models
- coating of models
- performance of the casting process.

Most defects occurring at single-use sand mold casting also occur with full mold casting. The model that evaporates during the melt pouring additionally affects the occurrence of defects.

Castability testing at single-use full mold casting was performed in the Foundry Laboratory at the Faculty of Mechanical Engineering and Naval Architecture in Zagreb using the method of sampling (specimens) (Figure 1).

At full mold casting of specimens the following parameters of influence that were to change during casting were defined: the melt pouring temperature, the foamed polystyrene model density and the casting with or without a vent.

The testing was carried out in accordance with the experiment plan 2^3 i.e. during testing the value of the parameters of influence was changed at two levels: the melt pouring temperature of 640 °C and 600 °C, casting with or without a vent, and the density of foamed poly-

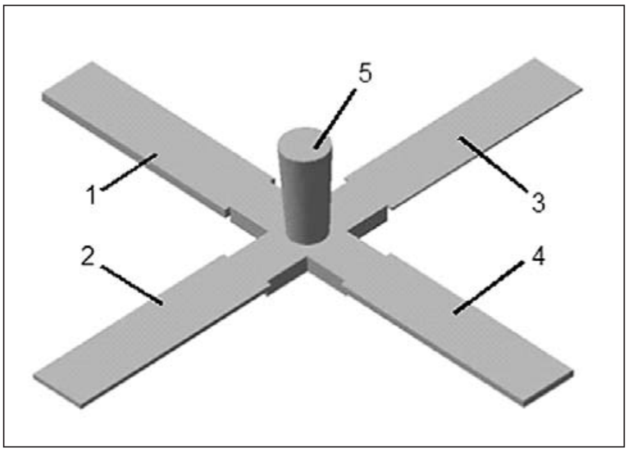

Figure 1 Polystyrene model for castability testing by the method of sampling 1, 2, 3, 4 - specimens of different density 5 -pouring system

Figure 3 Removal of castings

styrene model of 15 kg/m^3 and 30 kg/m^3. The models of the density of 12 kg/m^3 and 20 kg/m^3 were also cast.

The selected values of technologic parameters were conditioned by the market available plates of foamed polystyrene, the dimensions of existing molds and the capacity of aluminum alloy casting electric furnace. Dimensions of the models for specimens were 140x30x5 mm. As four models for each specimen were placed in every mold, each model of different density, it was necessary to produce sixteen models all together for the specimens that were inserted in four different molds. Out of all together four molds two were made with a vent and two without a vent. Four specimens were deposited in every mold in the direction of the mold diagonals while the pouring system was centrally placed (Figure 2). Pouring the melt at full mold casting procedure in operating conditions was carried out manually.

The casting procedure was performed using aluminum alloy ingot marked AL 19037 003, pouring it at the temperature of 600 °C into molds 1 and 3 and the temperature of 640 °C into molds 2 and 4. The aluminum alloy was melted in electric furnace before it was poured into a mold. The temperature of the melt was measured by thermo steam. Cooling time of the casting after pouring the melt was determined by experience to be 5 minutes i.e. 300 seconds. Cooling time of the castings was the same in all four molds. Removal and cleaning of castings was performed manually (Figure 3).

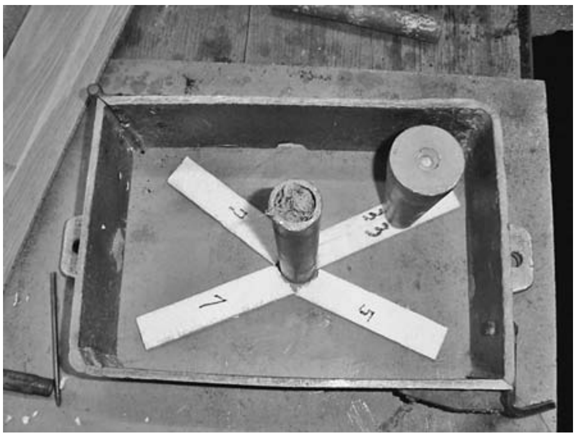

Figure 2 Models of specimens. Mold making in accordance with the plan of experiment

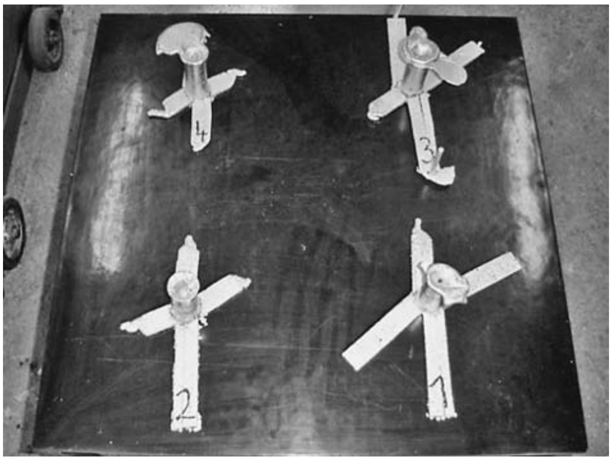

Figure 4 Castings (specimens) before measuring by a vernier caliper

The finished castings (Figure 4) were measured by a vernier caliper so the length of every particular specimen was measured in mm, and defined as castability.

The results of the specimens' length measuring are displayed in Table 1.

Table 1 **Results of measuring the castings (specimens)**

Polystyrene density / kg/m^3	Pouring temperature / °C	Vent	Length of the cast specimen / mm
15	640	with	140
30	640	with	60
15	600	with	72
30	600	with	58
15	640	without	138
30	640	without	108
15	600	without	98
30	600	without	64

Based on the results displayed in Table 1 and on the data processing program Statistika12.0 the following mathematical expression is obtained: for casting with a

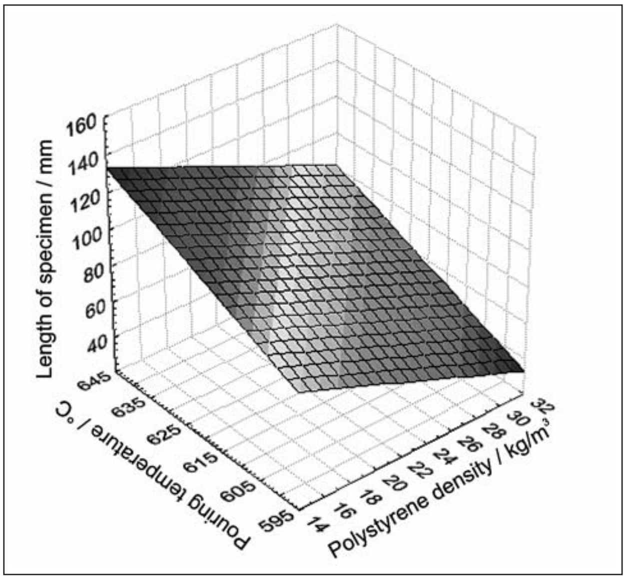

Figure 5 Illustration of castability dependence on the temperature of pouring and the density of foamed polystyrene for casting with a vent

vent expression (1), for casting without a vent expression (2).

$$L_L = -455{,}5 - 2{,}8667 \cdot \rho_p + 0{,}975 \cdot \vartheta_u \quad (1)$$

$$L_L = -501 - 2{,}133 \cdot \rho_p + 1{,}05 \cdot \vartheta_u \quad (2)$$

where:

L_L - length of the cast specimen,

ϑ_u - pouring temperature,

ρ_p - polystyrene density,

Figure 5 shows the influence of the melt pouring temperature and the polystyrene specimens' density on the length of the cast specimens, for casting with a vent.

It can be seen from the diagram (Figure 5) that the castability declines as the density of polystyrene (ρ_p) increases and that the castability improves as the temperature of the melt pouring increases.

Figure 6 shows the influence of the melt pouring temperature and the polystyrene specimens' density on the length of the cast specimens, for casting without a vent.

It can be seen from the diagram (Figure 6) that the castability declines as the density of polystyrene (ρ_p) increases and that the castability improves as the temperature of the melt pouring increases.

In this case the use of a vent and its position in the mold, has no significant influence on castability.

CONCLUSION

Based on the results it can be concluded that the melt pouring temperature has a significant influence on castability. Higher pouring temperature increases castability, while lower pouring temperature reduces castability. Higher polystyrene density model reduces castability, while lower polystyrene density increases castability. Use of the vent and its position in the mould did not have a significant influence on improving the castability. Further research should be carried out with more influential parameters (for example, by changing the size and position of the vent in the mold, changing granulation and humidity of mold mixtures, changing the compaction of mold mixtures etc.).

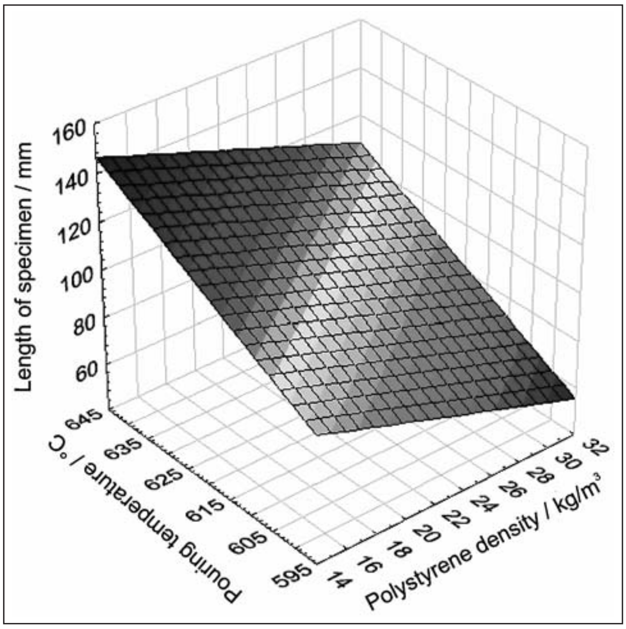

Figure 6 Illustration of castability dependence on the temperature of pouring and the density of foamed polystyrene for casting without a vent

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Note: The responsible translator for English language is S. Setina, Slavonski Brod, Croatia