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THE EVACUATION OF PRESSURE MOULDS AS PROGRESSIVE DEVELOPMENTS OF DIE CASTING PROCESS

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ABSTRACT: In these days in foundry branch there is a rapid development of sectors of special casting technology with the aim to increase the quality and the efficiency of pressure casting production. In the production of castings cast under pressure there is an increased attention to the internal homogeneity of castings, where in accordance with the specifics of this technology are the most common casting errors internal cavities (bubbles, pores). Internal homogeneity of pressure casting, characterized by the extent of porosity can be affected by the setup of technological parameters of pressure casting and last but not least by vacuuming the molds, that means to exhaust air and gases from the mold cavity.
KEYWORDS: die casting, vacuum, porosity, quality of casting

INTRODUCTION

Technology of casting metal in a vacuum was being put into the production process already in the middle of last century in the U.S., where three systems were developed (NELMAR, OHSE, Morton). From the point of then state of the techniques its practical use was at one point (closing of exhaust valve) insufficiently met. This technology was introduced to mass production in 80s in Japan. Today, the world leader in metal casting in a vacuum is vacuum systems developed by the Swiss FONDAREX.

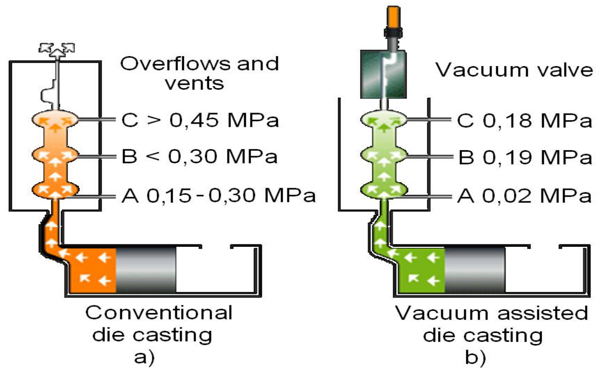

Figure 1. Comparison of conventional and vacuum pressure casting metal

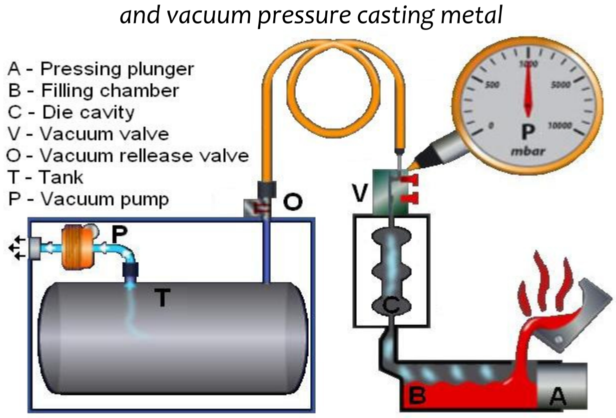

Figure 2. Scheme of vacuuming process [4]

By the conventional method of casting during the molding phase in the inlet system and the mold cavity, anti- pressure of gases and vapors is formed which during the short period of time sufficient compression are not fully taken by venting form system. Depending on the nature of the vent system and piston compression force in the filling chamber, the pressure in the mold cavity is increasing during the first stage of compression to the value of 0.3 MPa. In other phases of compression, these values may be doubled or even tripled.(fig. 1a) Venting the mold cavity by gas and air diversion gas using vacuum causes a reduction in back pressure in the mold cavity. In this way antipressure rarely exceeds 0.02 MPa [1,2].

The principle design of degassing pressure form is shown schematically in Fig. 2, where with the help of valve the valve suction device is formed, which has to within a few milliseconds, when the casting process takes place, drain away air and gases from the mold cavity. Exhaustion lasts throughout the molding cycle [3].

THE METHODOLOGY OF EXPERIMENTS AND EQUIPMENT

For the realization of experiments the compressed casting machine FRECH DAW125F was used, designed for casting non-ferrous metals with a vertically arranged filling chamber and degassing of the pressure casting mold was realized by a vacuum device FONDAREX. Analysis of the impact of degassing the pressure molds on casting porosity has been observed on the cast on Figure 3.

Figure 3. Analyzed Casting

The tested analyzed casting is made from an alloy ZnAl4Cu1, whose chemical composition responded to EN 1774 and is listed in the table 1.

Table 1. Chemical Composition of the Experimental Cast of the Applied Alloy

Chemical composition of the experimental cast of the applied alloy - % of elements content					
Al	Cu	Mg	Cr	Ti	Pb
3,9	0,8	0,05	-	-	0,001
according to EN 1774					
3,8 – 4,2	0,7 - 1,1	0,0035 - 0,6	-	-	max. 0,003
Chemical composition of the experimental cast of the applied alloy - % of elements content					
Cb	Sn	Fe	Ni	Si	Zn
0,002	0,001	0,001	0,001	0,01	95,225
according to EN 1774					
max. 0,003	max. 0,001	max. 0,02	max. 0,001	max. 0,02	the rest

Porosity analysis was performed by the indirect method of verification and the volume density of the samples. For this analysis was used Mettler Toledo scales PG203-S. The measured values were then calculated density cast by the relation:

$$\rho = \frac{m}{V} \qquad (1)$$

ρ – density [$kg.m^{-3}$], m – mass [kg], V – volume [m^3]. Subsequently, the calculated density values were determined by casting % porosity castings analyzed according to the relation:

$$porosity = \frac{density of the alloy - measured density of the alloy}{density of the alloy} * 100\% \qquad (2)$$

During the casting process in a vacuum and without vacuum there were constant technological parameters on the pressure casting machine FRECH DAW125F:

- *time of increase pressure: 1,5 s,*
- *increase pressure: 16 MPa,*
- *temperature of alloy: 434 °C,*
- *velocity of I. phase: 0,12 $m.s^{-1}$*
- *velocity of II. phase: 1,2 $m.s^{-1}$*

ANALYSIS OF THE ACHIEVED RESULTS

The measured values of the analyzed samples porosity cast without degassing and with vacuuming of pressure molds are shown in Table 2. Graphical process of the porosity dependence of the samples cast in a vacuum and without vacuum is illustrated in Figure 4.

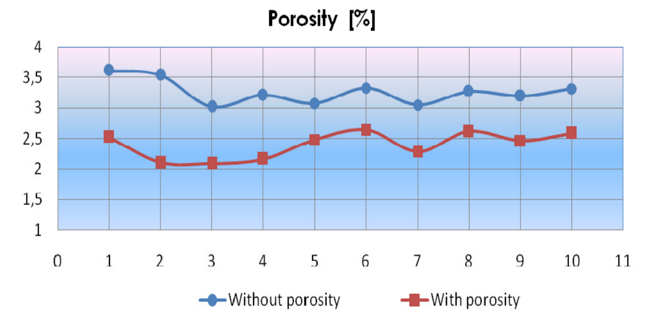

Figure 4. Graph of Porosity Values

Table 2. The measured mass and density and calculated porosity

No.	Mass [g] Without vacuum	Mass [g] With vacuum	Density [kg/dm³] Without vacuum	Density [kg/dm³] With vacuum	Porosity [%] Without vacuum	Porosity [%] With vacuum
1	23,776	23,918	6,458	6,531	3,612	2,522
2	23,948	23,991	6,463	6,559	3,537	2,104
3	23,901	23,951	6,498	6,56	3,015	2,090
4	23,830	23,942	6,485	6,555	3,209	2,164
5	23,842	23,931	6,494	6,534	3,075	2,478
6	23,782	23,981	6,477	6,523	3,328	2,642
7	23,837	23,958	6,496	6,547	3,045	2,284
8	23,816	23,910	6,481	6,525	3,269	2,612
9	23,806	23,935	6,486	6,535	3,194	2,463
10	23,854	23,952	6,478	6,527	3,313	2,582
Min.	23,776	23,910	6,458	6,523	3,015	2,090
Max.	23,948	23,991	6,498	6,560	3,612	2,642
Average	23,839	23,946	6,481	6,539	3,259	2,394

CONCLUSIONS

The distribution of total volume of pores in the cross section of the casting depends on the conditions of implementation of the mold cavity. By the turbulence of the melt, air and gases are entrained from lubricants and mold forms system, they are not sufficiently vented and subsequently they are being closed to the wall casting. By the application of degassing pressure form are air and gases vented into the vacuum tank unit with a positive impact on minimizing the porosity of castings.

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