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TECHNOLOGICAL FACTORS OF PRESSURE DIE CASTING

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ABSTRACT: This article analyses the basic technological factors of pressure die casting. Optimal adjustment of all technological parameters of pressure die casting provides high quality of produced castings. Defects occurrence could be influenced by a die design, inlet and air vent system, cooling system, pressure machine as well as alloy and its preparation. It deals with the influence of the stated facts on the production of casting mistakes with the purpose to increase the final quality of pressure die castings.

KEYWORDS: pressure die casting, technological factors, casting defects

❖ INTRODUCTION

A high pressure die casting technology of nonferrous metals and their alloys is one of the latest ones used in foundry industry. Within a relatively short period of time, the technology has become widely used in mass production as well as a large scale series production of die castings. Die castings produced by this technology have the following advantages:

- minimum allowances on machined surfaces,
- high dimension accuracy of a complete series,
- high surface quality,
- die casting with small thickness of walls having uneven shape,
- high productivity of die castings production.

There is still more attention paid to the increase of produced die castings quality with the aim to improve their plastic properties emphasizing the ability to absorb impact and fatigue load. Such quality has to be assured with a high reliability since in the conditions of mass production only statistical methods applied to the quality control are possible. Common methods of control are not sufficient in the production process. Thus, it is necessary to apply such methods of a technological process regulation that provide the entire picture of the casting process itself as well as the inner quality of the produced die castings. This requires a fully automated die casting process and a control of keeping technological parameters of a machine in connection to the realization of a mold cavity filling with a molten metal as well as a pressure inside a die cavity during solidification [2 , 3].

❖ CHARACTERISTIC OF A DIE CASTING

Die casting is a process, in which the molten metal is injected into the mold cavity at an increased pressure up to 200 MPa. Die casting is a highly productive method of casting parts with low dimensions tolerance and high surface quality. The following parts are manufactured by die casting method: automotive connecting rods, pistons, cylinder beds, electronic enclosures, toys, plumbing fittings. The molten metal injection is carried out by a machine called die casting machine.

In the cold chamber die casting machines hydraulically operated plunger forces a molten metal to flow in the cold chamber. A principal scheme of the cold chamber die casting machine is shown in the figure 1.

When the pressure chamber is filled with a molten metal the plunger starts traveling forward and builds up a pressure forcing the metal to flow through the sprue to the mold cavity. After the metal has solidified the plunger returns to its initial position allowing a new portion of the molten metal to fill the pressure

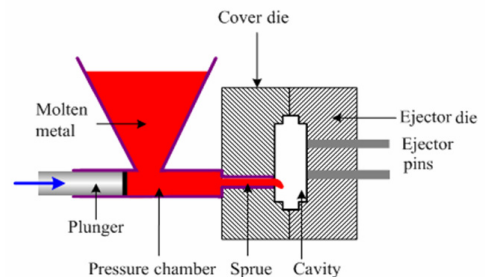


Figure 1. Die casting machine with cold horizontal chamber [6]

chamber. The mold then opens and the ejector pins removes the casting from the mold. The casting cycle now may be repeated [6].

❖ TECHNOLOGICAL FACTORS OF PRESSURE DIE CASTING

Die casting of metals is the highest technological level of metals and their alloys casting into metal molds. The quality of pressure die castings is affected by numerous technological factors, such as:

- pressing velocity during a casting cycle,
- increase pressure,
- time of filling a mold cavity,
- temperature of a cast alloy,
- temperature of a filling chamber,
- temperature of a pressure die.

Defects occurrence could be influenced by a die design, inlet and air vent system, cooling system, pressure machine as well as alloy and its preparation. The mentioned factors are mutually influenced. This refers to a complex of mutual relations between an alloy character, time of a die filling and the effectiveness of a die-casting machine, i.e. the knowledge of the principles of a complete die-casting process from the beginning of a mold cavity filling to a solidification of a casting in a die [1].

PRESSING VELOCITY DURING A CASTING CYCLE - considering the resulting quality of a casting, the most important factor of a die casting process is the velocity of a mold cavity filling which determines a filling regime and a temperature of a die casting process. A liquid alloy velocity inside the die cavity depends on the plunger velocity inside the filling chamber, hydrodynamic losses, a ratio of a slot cross section to that of the die part having a slot mouth, a die venting, etc. This velocity determines the regime of a die cavity filling, thus influencing both inner and surface quality of castings. Hydrodynamic losses are different regarding a die volume and this explains different filling regimes inside the individual die parts and in accordance with that also a non-homogeneity of the casting quality as a whole. A selection of a correct velocity of a die cavity filling depends on such factors as an alloy type, a casting complexity, a ratio of a slot area to a casting area, etc.

According to the distribution of cavity along the cut it is possible to assume the mode of filling the concrete part of casting, figure 2 till figure 4. Cavities on the figure 2 are situated in the center of casting. Their localization is interrupted by quite large stripes of healthy mass. Cavities on the figure 3 are of small dimensions, their localization is more striking in the center and they are located along half circles and along spirals.



Figure 2.

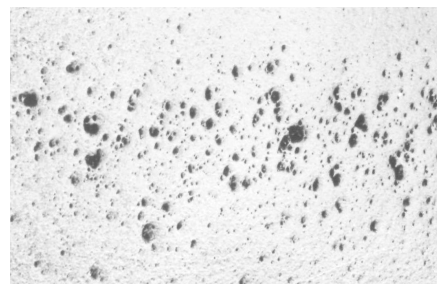


Figure 3.

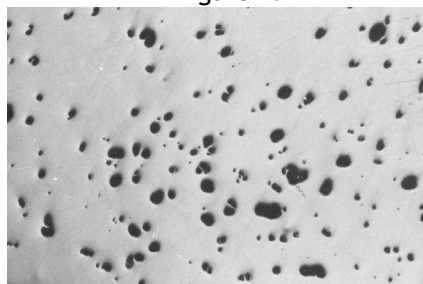


Figure 4.

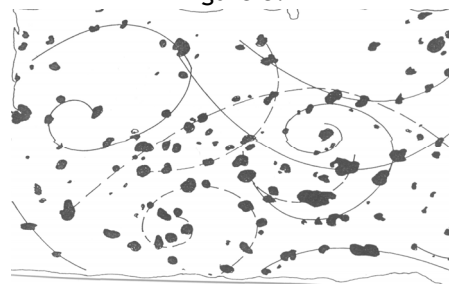


Figure 5.

The situation documented on the figure 4 is different and it seems a little bit chaotic at first sight. After studying it more carefully, it is possible to determine circles (even spirals, figure 5) of the cavity distribution whose calibre size is very wide.

Based on macroscopic analysis of selected sections of castings it is possible to obtain information about the impact of system performance to mold cavities in the casting. The figure 2 shows that this part of the casting has been filled by back turbulent asymmetric flow with a small number of larger vortices. A part of the casting documented on the figure 3 was filled by greater speed, probably by turbulent-dispersive flow of melt. The situation documented on the figure 4 could occur at melt speed, greater than in the first case, but lower than in the latter case [1, 2, 4].

INCREASE PRESSURE - is applied to replace a gravitational feeding of the melt into empty parts of a casting and to reduce accumulation and expansion of air bubbles during the casting crystallization (under the condition that there is a sufficient hydraulic connection of a die with a gating system). In order to achieve a higher increase in pressure, a multiplier is used which is a part of a casting machine.

A high hydrostatic pressure is required to overcome resistance of a solidifying metal in thin cross-sections of the formed cavity as well as the resistance of gas entrapped in a casting [1]. The pressure is transferred from a pressing plunger via a gating channel. The longer the solidification time of the gating channel, the longer the pressure operates. The process of a hydrostatic pressure transfer into the die cavity is called increased pressure. The use of thicker gating channels enables to increase pressure and feed a casting with a molten metal during the crystallization, thus removing shrinkages (figure 6).



Figure 6. Shrinkage [7]

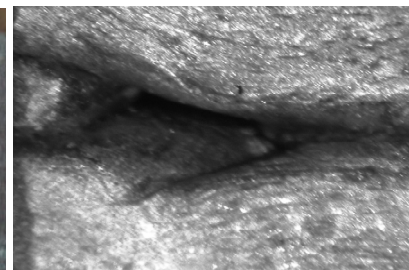


Figure 7. Cold joint

TIME OF FILLING A MOLD CAVITY has major impact on the quality of the casting surface as well as its internal soundness. Short time of filling a mold cavity doesn't permit to gases and vapors to escape from a mold cavity. Gases and vapors can be concluded in the walls of casting. This will reduce its internal soundness,

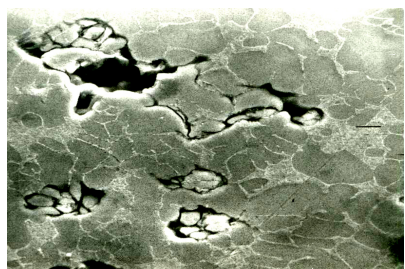


Figure 8. Internal scar

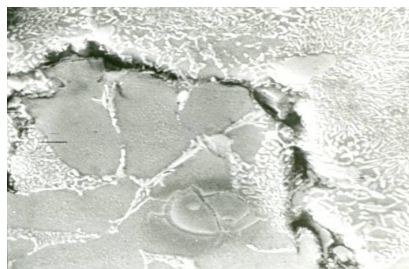


Figure 9. A detail of internal scar

although the quality of casting is good. Long time of filling a mold cavity allow to gases and vapors to escape from a mold cavity. In this case the internal soundness of casting is good, but the influence of reduction temperature alloys to the ends of streams the connection is not perfect on all points, but there are developed of cold joints (figure 7) and internal scar (figure 8, figure 9) [2, 3, 5].

TEMPERATURE OF A CAST ALLOY - The casting of very warm alloys into the cold a mold cavity causes serious strain on the surface layers of mold material. Temperature alloys for die casting has to be higher about 10 - 20 °C than the started crystallization temperature.

TEMPERATURE OF FILLING CHAMBER - the chamber is preheated before casting process than there isn't lower temperature of cast alloy before filling of mold cavity [1, 2].

TEMPERATURE OF A PRESSURE MOLD - the casting quality is significantly affected by temperature regime of mold. When the mold is cold there are created cold joints in the casting and the surface quality of casting is insufficient. When the mold is very hot, the alloys are bonded to mold and the range of bubbles and porous grows. Temperature of a pressure die should be maintained constantly approximately 1/3 of temperature of cast metal. This is achieved by thermoregulation of mold.

❖ CONCLUSIONS

Coefficient of efficiency performance of the mold cavity is a complex decision-making criterion in the phase of production and also in the evaluation of individual cycles. For the design of inlet system and casting conditions, simulation programs are used. In doing so, it is necessary to emphasize that for optimal design there is no clear answer. Establishing the conditions of casting is always a series of compromises between the demands for quality, for casting performance, for production, operational demands and other compromises, which remain the domain of design and technological experiences. The present results indicate that castings cast under pressure during solidification are characterized by better mechanical properties. The influence of the crystallization by pressure is considered very positive for its high precision and superior mechanical properties of castings.

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