Researches and studies regarding the casting of brake drums from cast iron

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Abstract. Construction of machinery and technological equipment, but also the construction industry and household parts are the main branches using cast iron castings. This is due to the special properties of gray cast iron castings. Thanks to these properties gray cast iron is very good for casting the brake drum type. The paper presents the molding-casting technology for this type of piece, with the presentation of its advantages and disadvantages as well as the possibilities of improving the molding-casting technology.

1. Introduction
The Brake drum casting is parts of the category of railway equipment type which are cast at the Romanian foundry [1].

The piece “brake drums” is cast of unalloyed grey cast iron with lamellar graphite, EN-GJL-350, according to the standard SR EN 1561 [2].

This type cast iron is very well suited for pouring this type of casting due to its special grey cast iron properties, respectively high vibration damping capacity, excellent cutting machinability, high corrosion resistance, low fatigue strength etc. [3].

Establishing the moulding-casting technology is based on casting configuration; based on it, the pattern set is dimensioned (the pattern of casting, the cores, the core box etc.).

An important role in obtaining a quality casting is the establishing the separation plane of the mould and the casting, which is the starting point of the moulding-casting technology [4-8].

These separation surfaces may be flat, curved and concave (Figure 1), depending on the configuration of the finished piece. Thus, the separation plane for the analyzed part (Brake drum) is placed the upper part of the piece (Figure 2) [4-8].

In this case, the solution chosen allows obtaining the mould only in the lower mould part [4-8].
The following aspects to be taken account when establishing the moulding-casting technology are: establishing of the allowances (processing, technological and for contraction) as well as constructional inclinations and connections [4-7].

The dimensioning of the gating system in the present case is not necessary because it has been chosen to pour the alloy directly through the rising head (such as open rising head type) [4-7].

Industrial practice requires the use of cores as the optimal method of making of the mould. The role of the cores is to ensure the realization of the internal cavity or external configuration of the casting, to very precise dimensions. For this, besides a dimensionally correct construction, the core must resist all stresses that appear during its realization, drying and transport as well as the casting of the liquid alloy [7].

The configuration of the core and the core box for the analyzed casting is presented in Figure 3. Also, their nominal sizes are presented.
Figure 3. Configuration of core and core box

The dimensions of the mould jackets and the possibility of placement the counterweights are presented in Figure 4. The method chosen for mould consolidation depends on the method moulding and the size of the moulds [4-7].

Figure 4. Dimensions of the mould jackets and the possibility of placement the counterweights

The role of counterweights is to consolidate the two mould parts, because the liquid alloy tends to lift the upper mould part (due to the metalostatic pressure that the liquid alloy exerts). Otherwise, the
2. Analysis of defects registered in industrial practice
Performing the critical analysis on a batch of castings of the same type, such as the Brake drums, for a certain period of time, we find that the following typologies of defects have been registered (Figure 5) [9-11]:

a) blisters, caused by mould;
b) blisters, caused by metallic material in the furnace charge;
c) shrinkage cavity and micro shrinkage cavity (microporosities).

![Percentage of defects for Brake drum casting](image)

**Figure 5.** Categories of defects registered for the analyzed casting

_The blisters_ are inclusions of gas incorporated into the body of the casting (exogenous blisters), due to the gases released from moulds and cores. The formation of the blisters inside the castings occurs when gas inclusions can not be eliminated during cooling and solidification of the liquid alloy [9-11]. In case of castings there are two types of blisters namely blisters caused by mould and blisters caused by the metallic material in the charge.

_The blisters caused by mould_ are due both to large amounts of gas released from the mould and to the non-evacuated air of the mould during casting.

_The blisters caused by the metallic material in the charge_ usually appear in the entire mass of the casting and do not have oxidized surfaces. In the case of the raw casting these blisters are harder to observe (they usually occur in the cutting processing) [9-11].

_The shrinkage cavity_ is a direct consequence of the shrinkage phenomenon and occurs as holes with harsh walls due to the formation of the dendrites.

_Micro shrinkage cavity (or microporosities)_ are defects that occur when the alloy is solidified. These occur between crystalline dendrites as a result of the lack of feed of molten metal during the solidification process and are due to the large crystallization interval of some alloys. These micro-shrinkage cavity reduce the physical and mechanical characteristics of the casting and lead to loss of tightness [9-11].

Thus, out of 120 castings for a period of 3 months, 13 defect castings were registered which representing a 11% (Figure 6,7).
3. Applying technological measures to improve the moulding-casting technology of casting studied

The analysed pieces (Brake drums) cast from grey cast iron at Romanian Foundry is not of very high complexity however, due to the high demand for this type of casting, it is necessary to review the moulding-casting technology.

This is necessary because, besides this piece, the foundry also receives other commands for similar pieces, so that the reduction of defects in the moulding technology is fully justified and is directly related to the costs of the enterprise.

Thus, according to the data registered in the industrial practice, it can be said that the casting in green-sand moulds (although it is economical) can not be used for the casting of high-rise parts. The explanation of this is the following: after filling the mould, the liquid alloy exerts on the walls of the mould a metallostatic pressure. This pressure is even greater as:
- The casting height is higher and
- The specific weight of the cast alloy is higher.

Casting in green-sand moulds is also limited by the fact that immediately after casting there is an excessive increase of moisture of the moulding sand at a certain distance in the wall of mould. The consequence of this phenomenon is the decrease of the resistance of the moulding sand in this layer.

The current technology of obtaining these castings presents some inconveniences, namely:
The use of an inappropriate moulding mixture lead to occurrence of the blisters
The use of an inappropriate moulding mixture lead to damage cores and moulds
Due to the fact that the mould are of the green-sand mould type, there is the possibility of the occurrence of the micro shrinkage cavities and of the pores (due to the moisture absorbed by the molds during their stationing up to the casting of the liquid alloy)
Uncorrelation of casting parameters (speed, temperature, duration) lead to inappropriate solidification of the liquid alloy.

In order to remove these defects, it is necessary to apply technological measures to prevent their occurrence, respectively:

1. In order to improve the quality of castings and to reduce the defects due to the non-drying forms, it is necessary to use the anti-adherence paints with self-drying for moulds and cores [12], [13]

The main advantage of self-drying paints is their stability over time and, on longer storage, the accumulated substance at the bottom of the container can be easily homogenized by mixing. In term of costs, anti-adherence paints belong to the expensive materials category. The cost of purchasing these types of paints are amortized due to [12], [13]:
- Improving the commercial aspect of castings;
- Shortening cleaning and finishing operations;
- The decrease of the mechanical processing allowances (due to increased resistance to the surface of the cores and moulds to which they apply);
- Fuel economy;
- Elimination of the need to neutralize the gases that are released from the dryers.

Industrial practice indicates that in most foundries in industrially developed countries over 70% of foundries use self-drying paints in the manufacturing processes of castings [12], [13].

2. Modification of the recipes of the mixtures used and replacement with self-hardening mixtures (these are recommended to be used together with anti-adherence paints) [14]

The self-hardening mixtures are a very varied group of mixtures due to the different binders used [14]. In 1970 it began the assimilation of the cold-hardening mixtures based on synthetic resins for the manufacture of cores and moulds used for the casting of pieces (from cast iron and steel) [14].

These mixtures have a number of advantages compared to cold-hardening mixtures based on sodium silicate. These advantages relate to:
- The castings surface quality,
- Easily shaking-out of cores
- The possibility of regenerating the used moulding mixture.

However, it is still continuing to discuss about the dangers of using furanic/phenolic resins (and other resins) on humans and the environment (due to the noxious substances they release).

Besides the above, the process of using the cold-hardening mixtures can also be applied under cold weather conditions when the temperatures in many foundries are negative [14].

3. Covering the shrink head with the mixtures, in order to guide the solidification

Elimination of the shrinkage cavities is achieved through a judiciously designed technology and by strict compliance to it. For this purpose is performed the sizing of the rising head in accordance with the data registered in industrial practice. In addition, for the analyzed casting, the cover of open rising head (after casting) with exothermic mixture is used.

This is actually a method of heating the rising head and uses a special material, respectively a exothermic powder [14].

The exothermic mixture, upon contact with the liquid metal, ignites and the heat ceded increases the time of liquid storage of the rising head, guiding the solidification.

4. the correct correlation of the casting parameters (speed, temperature, duration);
5. the correct management of the technological process of molding-casting.
4. Conclusions
As a result of the decline in demand for castings in the last decade, the vast majority of surplus production capacities are focused on the production of unique and small series parts. In these conditions the preponderance of the castings belongs to the production department, equipped with equipments and universal machines which are based on technologies that easily adapt to the market requirements [14].

The criteria for choosing one or other moulding-casting technology include mainly quality and price, which in fact determines competitive opportunities of the internal and external markets. But, these criteria are necessary but not sufficient.

Thus, in the current stage of the casting production the ecological criterion is extremely important because, without taking into account the volume of gases emanating from casting, cooling and shaking-out of the castings, no technology can be used [14].

Through a series of simple, practical and easy to implement measures applied permanently, spectacular reductions in consumption per ton of casting are achieved, with positive implications for costs.

These include:
- correct management of the elaboration process of the liquid alloy;
- maintenance of foundry installations and equipments (especially mixers);
- correct correlation of casting parameters (speed, temperature, duration);
- sand temperature control and sand parameters control
- the correctness of the moulding process.

Similarly, on a permanent basis, a particularly important role must be accorded to customers / beneficiaries' requirements regarding the provision of castings that correspond technically and quality standards.

These technological measures, which modify the molding-casting technology of the parts, can lead to a decrease in the quantity of rejected castings, so that the rejects registered in the industrial practice do not exceed 4.5% of the total good cast parts. These aspects lead implicitly to important business savings.

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