Using the anti-adherence paints to manufacturing of the moulds intended for iron castings

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Abstract. The paper presents the critical technology for obtaining of the lamellar graphite grey cast iron castings (Supporting roll type). Are presented the stages of achievement of the mould and the elaboration technology of the liquid alloy. A view to improving the qualitative characteristics of the castings and reducing the defects due to achievement of moulds it is necessary to use the antiadherence paints for moulds and cores. From the point of view of the cost the antiadherence paints belong to the expensive material category. But these expenses are done with their acquisition are amortized into account of improving the commercial aspect of the castings and shortening of the cleaning-finishing operations. Due to increase the resistance of the moulds and cores which they apply it is possible to decrease the machining allowance.

1. Introduction

In industrial practice of Romanian foundries, a particulary important role has it establishing of moulding-casting technology of the castings. Depending on the alloy that is pouring is necessary to into account certain technological aspects. Thus [1]:

- The mould must be capable to take over all the mechanical, thermal and chemical stresses to which it is subjected to the liquid alloy;
- The casting must have a commercial aspects, must be appropriate in terms of quality and advantageous in terms of price.

In these conditions the Romanian foundries places great importance on the elaboration of the liquid alloy technology, of moulding-casting technology and the materials used to achievement the moulds and cores so that the castings to obtain without defects.

Therefor the elaboration process must be carried out under normal conditions and the alloy elaborated complies with the conditions required by standard [1-4]. From the point of view of moulding-casting technology, achievement the moulds and cores must be carried out correctly using the quality moulding materials. For eliminating defects and rejects is necessary to use the refractory antiadherence paints for both moulds and cores.

In this context, the suppliers of technological materials for foundry provide an extensive range of foundry paints capable of covering all arreas of application. At present there are a great variety of products in this category with properties corresponding to technological stresses, quality requirements and customer requirements [5].

The correlation of this aspects and their implementation in practice lead to savings in Romanian companies.
2. The analysis of elaborating technology of the grey cast iron

For pointing out the aspects presented above is analyzed the moulding-casting technology for castings type “Supporting Roll”. This casting is a component of the hoist gearing of an industrial furnace door. This piece was chosen for study because it was registered a high percentage of defects for castings.

The piece “Supporting Roll” is cast of unalloyed grey cast iron with lamellar graphite, EN-GJL-350, according to the standard [1], [2]. There are analyzed 10 charges. For these, are presented the chemical compositions (Table 1), the carbon equivalent (CE) and the saturation degree of carbon (SC). CE and SC are determined using to the following relations [1]:

\[
CE = C + 0.3(Si + P) - 0.03 Mn + 0.4 S + 0.07 Ni + 0.05 Cr + 0.074 Cu + 0.25 Al \quad (1)
\]

\[
Sc = \frac{C}{4.26 - 0.3(Si + P)} \quad (2)
\]

| No. | Chemical composition, % | CE  | SC  |
|-----|------------------------|-----|-----|
|     | C | Si | Mn | P | S |     |     |
| 1   | 3.20 | 2.20 | 0.60 | 0.161 | 0.062 | 3.81 | 0.76 |
| 2   | 3.69 | 2.94 | 0.84 | 0.159 | 0.034 | 3.90 | 1.04 |
| 3   | 3.90 | 2.10 | 0.82 | 0.183 | 0.046 | 4.41 | 1.02 |
| 4   | 3.80 | 2.53 | 0.91 | 0.162 | 0.027 | 4.41 | 1.02 |
| 5   | 3.80 | 3.51 | 0.88 | 0.157 | 0.065 | 4.41 | 1.02 |
| 6   | 3.73 | 3.00 | 0.90 | 0.158 | 0.082 | 3.94 | 0.87 |
| 7   | 4.25 | 3.06 | 0.70 | 0.159 | 0.085 | 4.54 | 1.06 |
| 8   | 4.19 | 3.45 | 0.80 | 0.167 | 0.074 | 5.22 | 1.26 |
| 9   | 4.20 | 2.03 | 0.82 | 0.170 | 0.034 | 5.05 | 1.20 |
| 10  | 3.97 | 2.46 | 0.68 | 0.163 | 0.051 | 4.83 | 1.14 |

Using the data registered in the Table 2, was performed the critical analysis of the chemical composition of the 10 charges studied. Thus, conclusions were as follows [2], [4], [6], [7]:

- The influence of the carbon and silicon content

  The carbon and the silicon are the graphitizer elements with the biggest importance their variation determining the greatest changes in the structure of cast irons; in these irons the two main elements varies usually within the limits: C = 2.7...3.8% and Si = 0.8...2.5%; from the point of view of the two elements the cast irons are placed on the Fe-C diagram through the carbon equivalent CE (Figure 1) for the most part in the hypereutectic domain.

![The carbon equivalent](image-url)

**Figure 1. The variation of the carbon equivalent**
- The diagram of Figure 2 indicated that the carbon content is greater; with the increase of carbon content a decrease is recorded both tensile strength and hardness.

![The variation of the carbon content](image1.png)

**Figure 2.** The variation of the carbon content

- To increase the silicon content is recorded a decrease of the hardness and tensile strength; however, at values more than 3% Si the hardness of iron increases although the structure remains practically the same (ferrite + graphite) (Figure 3).

![The variation of the silicon content](image2.png)

**Figure 3.** The variation of the silicon content

- The influence of the two elements (Si, C) is to be regarded and according to the ratio of their concentrations. Thus, the increase of the carbon and silicon contents (respectively the increase of SC) leads to increasing the quantity of graphite and the ferrite in the structure and thereby to the decrease of mechanical properties (R and HB). The variation of the saturation degree of carbon is presented in Figure 4.
The influence of the manganese and sulphur content

- In grey cast irons, usually the manganese content varies within 0.3...1.5%, and the sulphur content within 0.03...0.15%; of the diagrams in Figure 5 and Figure 6 is observed that the two elements comply with these limits at the charges analyzed;

- The influence of the manganese and sulphur content on the structure and properties of grey irons depend largely on the ratio of their values; to the grey irons with low content of manganese sulphur occurs for the most part in the form of eutectic or sulphides rich in iron (Fe, Mn)S and to the irons with high manganese content - in the form of sulfides rich in manganese (Mn, Fe).

- In the grey cast irons manganese content at values over 0.3% manages to neutralize the sulphur action.

**Figure 4.** The variation of the saturation degree of carbon

**Figure 5.** The variation of the manganese content
The variation of the sulphur content

The influence of the phosphor content
- In the grey cast irons the phosphor content varies between 0.1…1.5% not exceeding 0.3% in all cases (Figure 7); this element favors the process of graphitization (as silicon) and is almost entirely in the form of eutectic phosphorous (Fe-C-P);

The variation of the phosphor content
- The phosphor content affects the mechanical properties of iron through structural changes which it produces, respectively: graphite finishing, increasing the proportion of pearlite, formation of the eutectic phosphorous (a constituent with high hardness: 500…600HB and fragile: \( R = 30…70 \text{ N/mm}^2 \), which has great influence on the properties of cast iron).

Following this analysis resulted that elaboration is carried out in normal conditions, without any deviations too great of the chemical composition from the standards. The variations in chemical compositions of the charges are insignificant in the technological point of view and, generally, comply with the requirements of the beneficiary.

2. The analysis of moulding technology for obtaining the parts of type Supporting roll
Due to the defects registered in industrial practice was analyzed the moulding-casting technology of this type of casting: it started from the finished piece design (Figure 8), was making the technological drawing and the wooden pattern (Figure 9) and then they were achieved and assembled the two mould-part for casting of the liquid alloy [1], [3], [8-10].
The most frequent defects for this type casting were adherences. *Adherences* (*D 221*) is defects that appear on the casting surfaces due to the following causes [11], [12]:

- The improper achievement of the moulds;
- The use of improper moulding sands;
- Non-use of refractory paints for the mould and core surfaces;
- The refractory quality is improper.

A method of prevention of appearance of the registered defects to moulding is the use of the antiadherence paints for moulds and cores [9].

### 3. The analysis of moulding technology for obtaining the parts of type *Supporting roll*

The refractory antiadherence paints used in foundry are coating materials that are applied to the surface of the moulds and cores. Their role is to smooth the porous surface of moulds and cores in order to ultimately obtain castings with surfaces as clean, aesthetic and without defects. The basic components of foundry paints are refractory materials finely ground. The refractory paint layer acts as insulation protecting the moulds and cores against the thermal and/or chemical action of the molten metal [5].

With time, the foundry paints were transformed from simple materials (mono- or two- component) in complex products that contain material systems with synergistic action. Following the development and continuous change of the binders system, the foundry paints go through significant changes so that they correspond to the new stresses. This is achieved by using of new refractory materials and testing of new products in the laboratory and industrial scale [5].

The main criteria for choosing the sorts of the antiadherence paints are the cast-alloy type and the castings weight. The paints can be used to protect the moulds and cores achieved by various technological methods of moulding. But, it must be provided that the moulds and cores are dry after painting [13].

**For mould:**

For casting studied (*Supporting roll*) is recommended the use of antiadherence paint that requires drying, KGS-type. For this type of paint are specified the following characteristics [13]:

- The refractory material is composed of quartz and graphit
- Humidity of powder – max. 4%
• Density – 1380-1430 kg/m³
• Viscosity – max. 18 s
• Stability – max. 97%
• Film resistance to abrasion – max. 2 kg/mm

are delivered in the form of powder compositions which contain all the necessary components; to be use in foundry, the powdery paints are dissolved in water up to obtain the necessary consistency.

The main advantage of powders consists in the possibility of long-term storage of them. The duration guaranteed by the manufacturer is 12 months, but industrial practice shows that the powders do not lose the properties even longer storage durations [13].

➢ For core:
For painting by immersion of the core is recommended to use the paint KGS-1-type due to the following advantages [13]:
- viscosity - 14-15 s
- Thixotropic properties
- Ensure the formation of a homogeneous film on the surface on the core

It is necessary [13]:
• In the process of painting by immersion the cores are maintained into the paint maximum 5 s in order to prevent the excessive increase of their humidity.
• The drying of the core takes place at temperatures of 150-200°C for not destroy the binder of paint (by burning).

To increase the effectiveness of the drying process and prevent potential overheating, the drying chambers must by provided with fans (recirculation and exhaust air) [13].

5. Conclusions
Preventing the formation of adherences and obtaining of plane surfaces are achieved by the use the refractory paints. The refractory paints are applied to the surface of the moulds and cores, in order to achieve a refractory layer to the contact surface of the mould with the liquid metal. They must be fluid and dense to form a continuous layer, thinly and evenly on the surface of the mould and core.

Regarding of the cost, the antiadherence paints belong to the expensive material category. These expenses are done with their acquisition are amortized taking into account the following advantages:
• Improving the commercial aspect of castings;
• Shortening the cleaning-finishing operations for castings;
• Decreasing the machining allowance due to increasing resistance to surface of the moulds and cores that apply;
• The possibility of long storage in safe conditions;
• Quality / price ratio for this castings is a sure guarantee of obtaining a important economic effect to users.

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