Optimization of the casting process from environmentally friendly bentonite-based sand for efficient casting during melting in an electric arc furnace

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ABSTRACT

Foundry production is one of the most diverse industries. In the foundry, several methods are used to manufacture a part. It includes processes such as centrifugal casting, permanent casting, die casting and sand casting. The article presents the process of casting into sand molds with bentonite. In the article, the authors conducted comparative studies of the reduction of marriages by porosity. In the course of the experiments, relevant analyses and conclusions are presented.

Keywords: sandy shape, bentonite, porosity.

Introduction

Sand casting is one of the widespread technologies that uses sand as a refractory medium to increase the quality of casting. The entire production cycle of casting can be reduced to: model creation, forming and manufacturing of the rod, melting and casting, forging, testing and control. Most defects occur during the casting process. One of the sources of castings rejection is a shrinkage defect. Shrinkage is taken into account when casting cast iron and steel. It should be noted that the use of profits is justified when casting metals with a small solidification interval, because, otherwise, the metal in the main part and the profit will solidify simultaneously and the gases will not have time to gather in the place reserved for them. The metal shrinkage defect significantly affects the casting efficiency. Also, one of the problems of foundry production is a porosity defect [1-2].

The molding mixture from which the mold is obtained must have a number of properties, the most important of which is strength, gas permeability, plasticity, compactness, etc. These properties of the mixture depend both on the quality and quantity of the initial components (quartz sand, waste mixture, bentonite or clay, binding additives, water, etc.) so it depends on the method of preparation of the mixture [3-5].

A two-stage process in which quartz is wetted with a binder (non-standard and stationary state) is important for the practice of forming sand with the addition of a diluent to hang the strength in the solidified state. Sand–clay liners use expanding clay as a filler to fill sand voids and thus reduce the hydraulic conductivity of the mixture. The use of bentonite can lead to significant volume changes as a result of swelling and shrinkage. To improve compressibility and swelling, it is proposed to add a portion of clay with less plasticity than bentonite. It was found that adding less plastic soil material to bentonite reduces its amount by 60-70% for a clay content of 10-50%, respectively. It was also found that the swelling pressure and the percentage of swelling were significantly reduced [6-8].

Materials

Sand casting is one of the most commonly used metal casting processes due to its inherent advantages in production, low cost and high productivity.

The prepared molding mixture is shown in Table 1.

Table 1. The prepared molding mixture

Used sand, %	Quartz sand, %	Bentonite, %	Water, %	Flamethrower chalk, mm	Drying form° C	Keeping the form dry, s
61-66	20-22	6-7	4-5	1-2 mm	100	4-6

Research and methods

The prepared casting model (Fig.1) is installed in the center of the flask with a rod (table 2), and a laboratory-tested molding mixture (Fig.2,3,4). The mold of the flask is filled and compacted, then the second half of the flask is installed on the model and filled with a molding mixture. The mixture is compacted, then fixing pins, filling necks and ventilation ducts are mounted. Profits are set at the same time, the profit walls are made conical with a decrease in the direction of the model. Such profit generation is necessary to reduce melt shrinkage and remove gas bubbles.

The two halves of the flask are separated and the model is removed, and the mold is sent to dry for 4-6 hours at 100 ^{0}C [9-11]. The finished mold is filled with molten metal through the filler neck – casting and profit. After cooling the melt, the mold is destroyed, the part is cleaned of sand, excess metal in the form of a gate, profits, then sent for heat treatment and machining [12].

Table 2.

Quartz sand, %	Sulfite-alcohol bard, %	Bentonite, %
80 – 85	8 – 10	3 – 5

Fig.1. Casting model.

Fig.2. Test samples.

Fig.2. Strength, MA-500. kg/cm[2].

Fig.4. Moisture meter MA 150 Sartorius.

Results

Table 3. Laboratory data results.

№	Indicators	Sample1	Sample2	Sample3	Sample4	Sample5
1	Strength kg/cm^2	0,57	0,55	0,60	0,58	0,57
2	Humidity %	5,3	4,7	5,2	6,7	6,1
3	Gas permeability %	119	121	126	123	119

Fig.5. Top view of the form.

Fig.6. Bottom view of the form.

Conclusions

Based on the results obtained, the following conclusion can be drawn:

1. The configuration of the profits made by the cone-shaped allows the molten metal to be distributed more evenly over the entire height, while improving the removal of gas from it with a test tube.
2. Replacing kaolin with bentonite saves energy resources three times.
3. The addition of gil bentonite reduced swelling and thereby preserved the structural dimensions of the part.

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