Lost Foam Casting Technology and Defects Control of Box Shell Castings

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Abstract: The production of loading case shells using the lost foam process has advantages such as low molding cost, surface smoothness, and light casting weight. However, for box shell castings with complex inner cavity structures and significant wall thickness differences, there are often defects such as shrinkage porosity, sintering, and carbon defects.The box shell adopts the "two big die pieces" EPC slicing process, selects appropriate gating system, pouring temperature, foam bead density and other control measures, and the produced box shell iron castings are qualified in size and performance, and the defects such as embedded tube sintering and porosity of castings are effectively solved and mass produced.

Keywords: Lost Foam Casting; porosity; Sintering; box shell castings

1 Introduction

The lost foam casting process, also known as gasification casting or full mold casting.Compared with traditional sand casting, the lost foam casting process has the advantages of lower cost and lighter blank weight. However, lost foam casting also has limitations, as not all casting structures are suitable. Below, the author introduces a lost foam casting process for a box , as well as control measures for defects such as looseness, sintering, and carbon defects.

2 Process scheme

The material of this casting is HT200, with a basic wall thickness of 12 mm and a maximum wall thickness of 75 mm. The contour dimensions are 1040mm x 600mm x 606mm (Figure 1). Design and manufacture the lost foam casting process based on the geometric shape of the casting.

The traditional "three major molds" process for the disappearing mold of the box body, Scheme 1 (Figure 2),. Each box body is formed by three major molds, and the requirements for the molding machine and mold design are not high. However, there are many adhesive molds with large cumulative errors and low adhesive efficiency. Therefore, the characteristics of the "three piece structure" process determine that the forming process has high costs and low production efficiency of white molds.

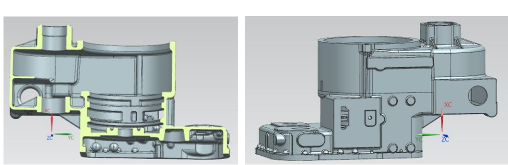

Fig.1 Product outline

The traditional "three major molds" process for the disappearing mold of the box body, Scheme 1 (Figure 2), includes molds from the end cover surface to the middle cover surface of the inner cavity, between the middle cover surface and the cylinder bottom surface, and between the cylinder bottom surface and the mating surface. Each box body is formed by three major molds, and the requirements for the molding machine and mold design are not high. However, there are many adhesive molds with large cumulative errors and low adhesive efficiency. Therefore, the characteristics of the "three piece structure" process determine that the forming process has high costs and low production efficiency of white molds.

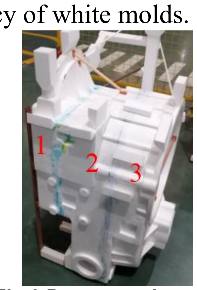

Fig.2 Process scheme 1

The author designed two process plans for the mold, Plan 2 (Figure 3): two large molds, seven small mold processes, with "cross" ribs applied to the inner hole, serving as a sprue and preventing deformation by pulling ribs. The pouring system is made as a whole mold, with stepped water inlet, smooth casting punching, and overflow risers set at the top to reduce the risk of carbon slag defects.

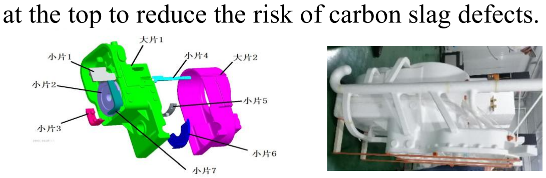

Fig.3 Process scheme 2

Weigh and compare the advantages and disadvantages of the two typical process options mentioned above: Option 2, two large mold pieces are formed, with high adhesive efficiency, improved dimensional accuracy, less occupation of tooling racks, and less space in the drying room; Considering the comprehensive quality and cost of Scheme 1, Scheme 2 is adopted for mold opening testing.

The specific parameters are: the density of pre produced foam beads in the mold is controlled (19.5 ± 0.5) g/L, and the cross-sectional area ratio of the pouring system is controlled according to the ratio of straight runner: horizontal runner: inner runner=1:5: 1.2. A section of overflow slag collection is set at the bottom of the straight runner.

The main difficulty in the process lies in the deep grooves in the inner cavity of the casting, as well as the presence of grooves on the flange surface. Both sides should be filled with sand to prevent defects such as bulging and carbon slag on the machining surface caused by loose sand filling.

3 Process testing

After determining the process plan, proceed with mold production and experimental verification, including the following steps:

(1) The mold is formed and produced by a well-known specialized mold factory in China. EPS gray iron beads are used, and the density of pre produced foam beads is controlled at 19.5 ± 0.5g/L.

(2) Two large mold pieces are glued together, and the pouring system is made as a whole. The glued efficiency is high, and the mold frame and drying room are occupied less.

(3) The thickness of the coating is controlled within (1.2-1.4) mm. While meeting the requirements of coating thickness and weight, the three coat coating process is improved to a two coat coating process, saving 30% of coating time and reducing the occupation of the drying room.

(4) Due to the deep oil pipe of the box and the bending of the valve surface oil port structure, it is necessary to use Φ 17 (inner hole Φ 12) Cold drawn steel pipes are pre embedded to create oil ducts, and coated sand is pre filled inside the steel pipes.

(5) Shaped buried boxes, are produced using ceramic sand instead of pearl sand. The density of ceramic sand is relatively lighter than that of pearl sand, and the amount of molding sand material used is reduced by more than 30%. when the box is buried and filled with sand, the foam inclines (2-3) ° to the back of the cylinder bottom to prevent the inner cavity groove from being filled with sand loosely, which may cause bulge defects.

(6) Before pouring, check to ensure that the negative pressure value reaches (-0.05) - (-0.06) Mpa.

(7) The composition before the furnace is controlled within the range of C%=3.1~3.3, Si%=1.7~1.9, Mn%=0.65~1.0, P% ⩽ 0.07, and S% ⩽ 0.1 to meet the mechanical properties and processing requirements.

(8) Pouring temperature control, first pouring temperature: 1480 ± 5 ℃, pouring time (30-40) seconds.

(9) The unboxing time after pouring is ⩾ 3 hours.

(10) By adjusting the key cylinder bottom size, center hole size and 3D scanning of castings in the foam bonding process of the control box, the casting tolerance meets the drawing requirements.

4 Defect improvement measures

(1) To address the looseness of the pump surface machining surface of castings, the sprue on the pump surface machining surface where the looseness defect occurs is moved to the non machining surface with a thin wall next to it, in order to eliminate the looseness defect caused by prolonged heating of the sprue (Figure 4).

(2) In response to the sintering defects of buried pipes, the inner hole of the embedded steel pipe remains unchanged, and the wall thickness of the buried pipe increases from 2.5mm to 4mm. Baozhu chromite coated sand is pre filled to eliminate high-temperature deformation and internal sintering defects of the buried pipe..

Fig.4 porosity defects and improvement

5 Conclusion

For the lost foam casting process of box shell castings, two large molds are used for molding, pre foaming bead density control, integral pouring system molding, and coating secondary pouring process to control pouring temperature and pouring time. Significant results have been achieved in solving the problems of loose pump surface, buried pipe sintering, and carbon slag defects in castings. The product quality meets the requirements, and mass production can achieve a comprehensive waste rate of less than 5%.