Numerical Simulation and Process Optimization of Electromotor Shell

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Abstract: Based on the low pressure sand casting process, aiming at the common defects of electromotor shell such as shrinkage, misrun, cold shut, pores and poor fitting of bushing, the casting process was analyzed by the MAGMA software, and process scheme were determined and verified combined with the DOE design. The results indicate that the gating system scheme of annular runner with multiple inner gates can effectively solve the shrinkage at the bottom of the casting, achieve stable filling and avoid cold isolation. The use of top feeders and side chills can effectively solve the shrinkage and loosening of other parts of the casting, and effectively solve the pores defect.

Keywords: electromotor shell; low pressure sand casting; casting process; numerical Simulation

1 Introduction

The structure of the motor shell is complicated. The side wall of the motor shell surrounds the cooling water jacket. Ensuring the sealing of the water jacket is an important technical requirement of the product, as well as the biggest casting difficulty of the product. At the same time, the shrinkage of the upper and lower end faces and side walls of the motor shell are also casting defects that need to be avoided in the process development.

This paper introduces the structural characteristics and common casting defects of the motor shell. On this basis, the casting process design of motor shell and the application of computer simulation technology in the rapid trial production of motor shell castings are discussed and shared.

2 Experimental procedure

Technical specifications for products: The main technical requirements of motor shell in this paper are as follows: the casting surface and the processed surface are not allowed to have porosity, shrinkage, cold isolation, cracks, slag inclusion and other casting defects; Mechanical properties of castings: hardness of the top flange surface ≥ 90HbW, tensile strength (Rm) ≥ 275 MPa and elongation (Aa) ≥ 2% at the sampling part of the body. Casting internal defects shall be controlled to ASTM E155 Class III; The air tightness shall meet the requirements of water test at 0.6 MPa for 10 minutes after the product is blocked, and there is no gas leakage around the water jacket.

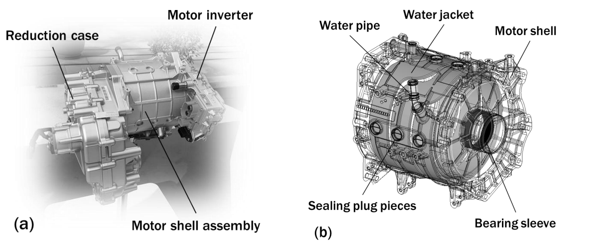

Figure 1 Motor shell in the power assembly (a) and motor shell construction (b)

Gating system design: The casting is filled with the top flange facing up, so that the area around the bearing bushing can be filled earlier during the filling process. The advantage of this is that the metal liquid in the filling is in contact with the bearing bushing, and the temperature loss is small, which is conducive to improving the fitting effect of the bearing bushing and the casting. A riser needs to be placed on the top of the casting to realize the feeding of the top of the casting. The cross runner of the casting is arranged in a ring and connected to the gate at the top of the riser through a cross structure. The inner gate is arranged in the ring runner, and the inner gate corresponds to the position of the bolt hole at the bottom of the casting. The pressure feeding eliminates the shrinkage hole and porosity defect at the bottom of the casting, and the advantage of the ring runner is to make the liquid flow in the filling process more stable and avoid air trapping.

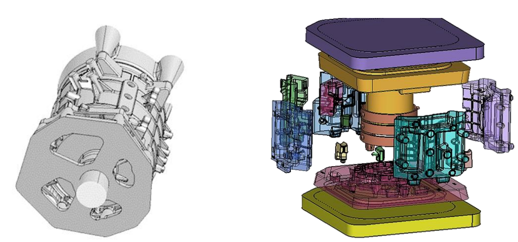

Figure 2 Gating system design and core combination modes of the mass production

For the mass production of motor shell, the water jacket core is made by hot core box, and the outer contour cores are made by cold core boxes, which is shown in Figure 2(b).

In order to avoid the casting defects of cold shut and burn on sand in the filling process, filling temperature is controlled in the ideal range of 720-740 ℃. The pressure-time curve is shown in Figure 6. The filling time is 10 s, and the pressure holding time is 210 s.

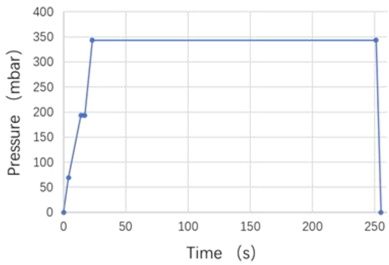

Figure 3 Pressure-time curve for pouring and solidification

3 Result and discussion

Numerical simulation:

The simulation of filling process is shown in Figure 4. During the whole filling process, the liquid metal flows smoothly without turbulence or air-entrapment. And, until the end of filling, there is no serious loss of temperature of metal liquid.

The fraction-solid field during solidification is shown in Figure 5. The metal liquid in the mold cavity is solidified in an ideal solidification sequence, and no isolated liquid region appears.

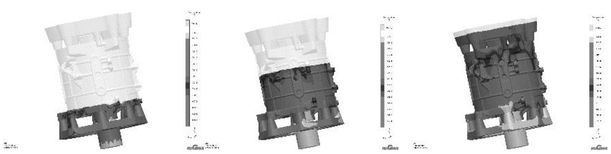

Figure 4 Simulation of filling process

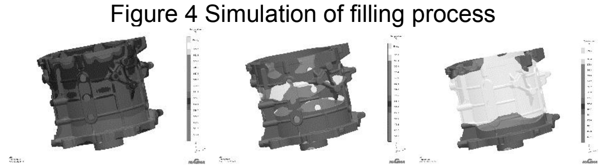

Figure 5 Simulation of solidification process

As shown in Figure 6, the shrinkage and cavity defects exist in the feeders, and there is no serious shrinkage cavity and porosity in the casting.

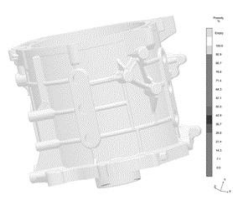

Figure 6 Simulation of shrinkage

Production: The final motor shell is shown in Figure 7. There is no casting defect in the motor shell. Through pressure leakage test to verify the product sealing to meet the technical requirements of the product.

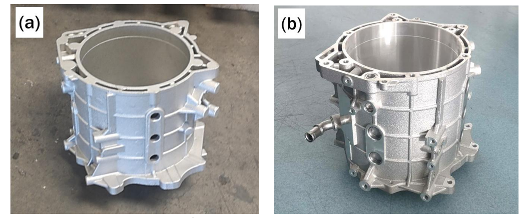

Figure 7 Motor shell of as-cast (a) and assembly (b)

4 Conclusion

(1) For the motor shell, the low-pressure sand casting process can be used for the mass production and small batch production.

(2) For the complicated motor shell, the gating system and feeding system need to be carefully thought when the casting process design.

(3) In order to avoid the appearance of casting defects as much as possible, it is necessary to make full use of simulation methods.

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