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Magnesium Alloy Wheel Structure Design and Wheel Casting Process Performance Analysis

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Abstract: Recently, as the automotive industry is increasingly demanding on energy saving and environmental protection, people are paying more attention to the lightweight design and comfort of automobiles. Casting is a very important part of wheel manufacturing. Casting method includes centrifugal casting, sand casting, high pressure casting, low pressure casting and so on. In this research, magnesium alloy wheel casting numerical simulation was carried out. Analysis of casting process was researched based on finite element theory, filling and solidification data at the end of the simulation were obtained for guidance of produce.

Key words: Magnesium alloy wheel, casting process, finite element method.

1. Introduction

With the development of the world, there has been a growing focus on environment and energy issues. Magnesium alloys are the lightest metal structural materials used in the aircraft and automobile manufacturing industries. Therefore, reducing the weight of automobiles has a great impact on the environment and energy, and the lightweight of automobiles has become an inevitable trend [1-5]. The research on magnesium alloy wheels is of great significance.

Wheels are important to vehicles. Because it not only bears the weight of the whole vehicle, but also the rotating tire bears the horizontal force and the impact force from the road surface [6-8]. Wheels directly affect the overall driving stability and smoothness of the car.

There are many ways in casting wheels [9-16]. This research study talks about sand casting. The advantage of sand casting is that clay is rich in resources and cheap. The mold has a short cycle, high work efficiency and wide adaptability.

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The disadvantage is that castings are prone to defects such as sand washing, sand inclusion, and porosity, so in this research, we analyze wheel casting process performance. Based on this research, we can let the study of wheel casting process be more useful.

2. Materials and Method

2.1 Lightweight Design of Wheel

When designing wheel, two major factors must be considered, such as safety and engineering standards. The wheel mainly consists of rim and spokes. The wheel are specified in standard. In this research, the market is the target to design a lightweight vehicle wheel. The wheel model is lightweight while satisfying the safety as Fig. 1 shows.

Fig. 1 Wheel model.

The relevant parameters of the material az91 are as follows Table 1:

Table 1 The properties of magnesium.

Material properties	Magnesium (AZ91)
Specific heat (kJ/(kg·k))	1.02
Coefficient of thennal expansion (μm/(m·k))	26.0
Poisson ratio	0.35
Yield strength (GPa)	0.16

3. Wheel Casting

In wheel casting, the sensor is set up in the wheel to get the relevant casting information. Number of grids: grid size is 2, the total number of grids is about 10 million.

Because of sand casting, it is sufficient to set the thickness of the sand layer directly.

In the simulation, four test points at the wheel model, at the rim and spoke junctions, at the top of the rim are selected to record the evolution of the temperature in the whole process. Fig. 2 below shows wheel casting sensor.

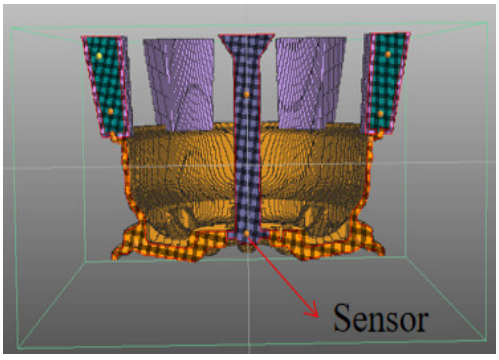

Fig. 2 Wheel casting sensor.

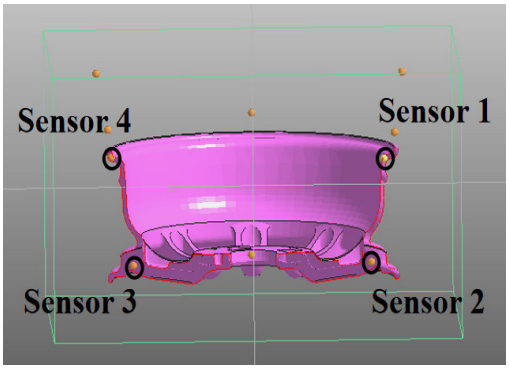

Fig. 3 Wheel casting sensor related to rim.

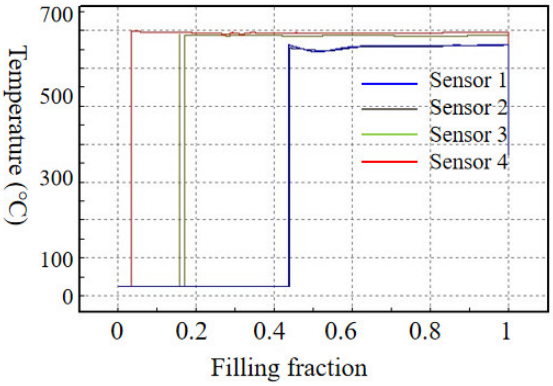

Fig. 4 Wheel casting filling fraction.

In the simulation, four test points were analyzed to obtain the whole process. Fig. 3 shows wheel casting sensor related to rim. Fig. 4 shows wheel casting filling fraction. The alloy temperature at the bottom of the rim is about 700 °C, the temperature difference of the alloy between the top and the bottom of the rim is about 50 °C.

During the process of filling, when the front metal reaches the middle of the spokes, the flow velocity will slow due to the existence of the scoops, which makes the shrinkage defects. During the process of solidification, using suitable casting sensor can obtain wheel casting process in filling fraction.

4. Conclusions

Casting of magnesium alloy wheels is a complicated process. Through the simulation in the casting process, a rational casting model is established for the casting process. The rationality of lightweight design of magnesium alloy wheels and casting model were verified. By simulation analysis of the wheel casting, the distribution data of different parts of the wheel at different times were obtained. The actual casting of the wheel is simulated, and a good casting model is obtained, which is very meaningful for the engineering.

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