Application and Notes of Super Large Single Piece Die Casting Production in Automotive Industry

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Abstract: Under the motivation of the innovation idea from a new energy vehicle company in US, and the great jobs and cooperation of several parties, a new type of Super Large Single Piece die-casting production was established, which not only reduced production costs, but also accelerated production speed and further reduced the weight of the car body. In new energy vehicles, with continued explosive growth and the demand for energy conservation and emission reduction, lightweighting of new energy vehicles has become an inevitable trend, which has also promoted the faster development of Super Large Single Piece die-casting (Giga Casting) development.

Large aluminum alloy die-casting parts such as car front underbody, rear underbody, and battery trays used to be composed of up to 70+ small parts. With this new technology, they can be produced by die-casting in one shot. It is not just to amplify all the equipment can be done, but there involves many difficulties and challenges. This article starts from the perspective of the die-casting unit, through the design and process optimization of each step, and through on-site verification, to improve the performance and production efficiency of die-casting products.

More and more motive OEM has applied the production process of the Super Large One-piece die-casting in manufacturing cars. A case study of battery tray production was carried out. Some conclusions were made in implementing the Super Large Die Casting Cell.

Keywords: Super Large Single Piece die-casting, Giga casting, battery tray, new production process for automotive.

1 Introduction

High-pressure die casting is a production method in which molten metal materials are filled into the die cavity at high speed and high pressure, and then cooled and solidified to form castings. According to the different design characteristics of the product, it is necessary to choose the appropriate die-casting production process.

The normal production process of integrated products:
Pick up → Cool → Remove the runner/overflow → Output
Now we will introduce a case of a large battery tray product (Figure 1) to demonstrate how to choose a suitable die-casting cell production process. This project verified the characteristics of the die-casting product through multiple die trials in the early stage, followed the principle of high efficiency and stability, selected the most appropriate die-casting cell production plan, and successfully achieved the expected results after implementation.

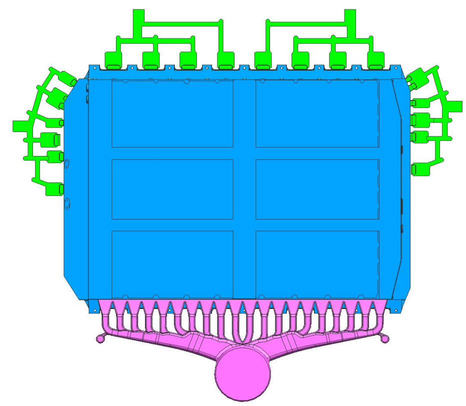

Figure 1 Large battery tray product

Product size 1800×1500×100; product basic average wall thickness 3mm; product net weight 50kg; total casting weight 100kg; heat treatment-free material C611; product deformation ≤1mm. It was produced on a LK 12000 ton die casting machine cell.

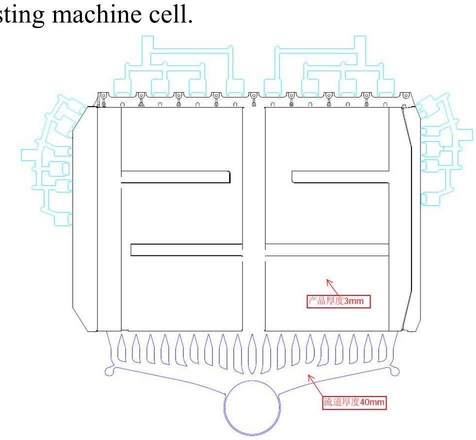

Figure 2 Size of product and runner

2 Experimental procedure

An obvious feature of battery tray die-casting parts is that the product is thin and the runner is thick (as shown in Figure 2). This feature has a great impact on the product during cooling, because the shrinkage of the runner and the product during the cooling process is inconsistent. The thick runners shrinkage is large, while the shrinkage of thin products is small, resulting in serious deformation of the product on the runner area (≥5mm). Through a CMM (Coordinate Measuring Machine), 9 positions of the product is detected, and the deformation results are obtained (Figure 3).

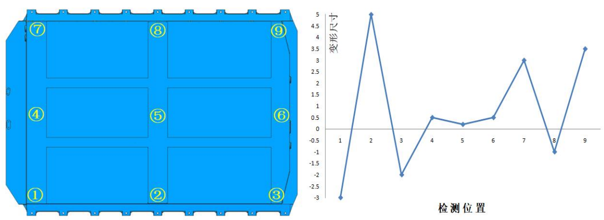

Figure 3 Deformation analysis

3 Result and discussion

In order to reduce product deformation caused by runner shrinkage, the thick runner needs to be separated from the product as soon as the casting is taken out of the die-casting die. There are currently three separation methods: Trimming by hydraulic press, Laser cutting, and Plasma cutting (see Table 1). After extensive evaluation, this project finally chose the Trim Press method to remove the runners and overflow because this method has far more advantages than other methods. This kind of production efficiency best meets our production needs.

The deformation of the product caused by the thermal shrinkage of the runner is eliminated, and the deformation is reduced from 5mm to 3mm, with the ultimate goal of controlling it within 1mm. The product itself has reinforcing rib structures of different thicknesses. During its own cooling process, the deformation caused by shrinkage is still large (Figure 4).

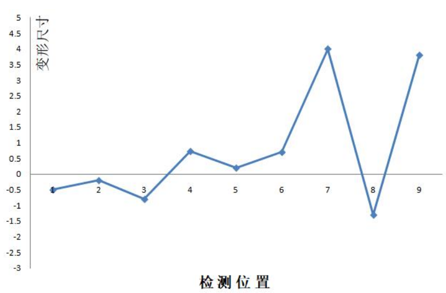

Figure 4 Deformation analysis after 1st optimization

At the beginning, it is tried to manually hammering to rectify the shape of products outside the die-casting cell, but found that it was very difficult to rectify the shape of the cooled products. The efficiency was extremely low and the workload was very large, making it impossible to achieve stable mass production. Through research, it is considered to add a shape rectify station to the die-casting cell, to carry out shape rectification when the product is still under warm status, and to perform cooling and shape rectifying at the same time. Although this solution is ideal, its specific implementation is a very big challenge. After repeated evaluation and discussion, the die-casting cell finally adopted the following production process.

picking up → punching runner/overflow → shape rectifying + cooling → output (Figure 5)

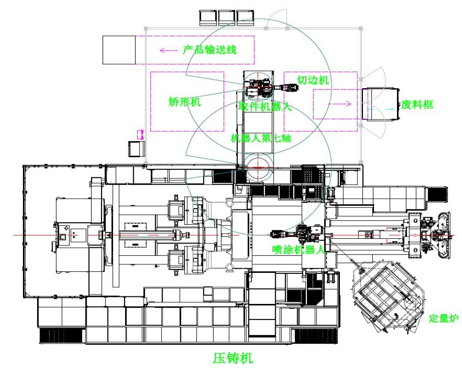

Figure 5 Final process

This solution has been verified through continuous production, and the product deformation is ≤1mm (Figure 6), which meets the processing and assembly requirements of the product.

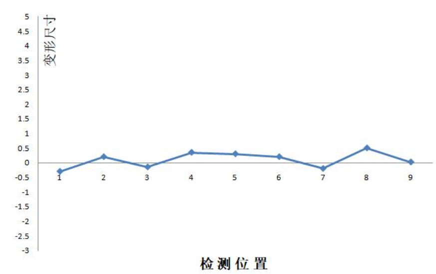

Figure 6 Final deformation

4 Conclusion

Super-large die-casting cell equipment have high investment costs (Compare to traditional assembly line with robots, the cost maybe lower). The design of the die-casting cell should follow the principle of efficiency and stability. Non-essential workstations, such as product polishing and X-ray inspection, should be placed outside the die-casting cell. Reduce the failure rate of die-casting cell production and thereby increase the equipment operating rate and thus raise the total OEE, bringing higher economic benefits to the enterprise.