Injection Mold Analysis Based on Moldex3D Car dashboard back cover Casting System

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Abstract. This paper is the injection mold design of the car dashboard back cover casting system. Two different types of gating systems for cold and hot are analysed and processed for mold structure design and problems that may arise during the production process of plastic parts. Moldex3D mold flow analysis software was used for simulation, and two different types of gating systems were analysed and compared. It is found that the advantages and disadvantages of different casting systems exist and the optimal design scheme is selected to improve the mold structure design and improve the production qualification rate of plastic parts.

1. Introduction

This mold is used to produce the rear cover plastic parts of the car dashboard. The plastic part is aesthetically pleasing and needs to carry the exterior parts of various electronic display installations of the automobile, which is strictly required in injection molding [1]. The product model is shown in Figure 1. The product dimensions in Figure 1 are 292.317x126.380x31.468(mm), the average meat thickness of the plastic part is 2.5mm, and the single cavity volume is 197.253cc. Since the wall thickness of the plastic part is thin, it is not convenient for secondary processing, so the mold design requirements are high.

Figure 1. Product model.

The mold design with one mold and two holes is beneficial to improve the production efficiency of the product. The plastic parts are made of polypropylene material (PP), which is added with 40% talc (mineral) to make up for the defects of PP material itself, low rigidity and other defects [2]. Based on

the finite element model flow analysis technology, pre-judgment can be made before the product has problems. Kesheng's Moldex mold flow analysis software can provide reliable analysis support for the accuracy of mold flow analysis [3].

2. Cold runner gating system Hot runner gating system

2.1. Cold runner gating system design

Due to the large number of meshes produced by the volume and flow channel size of the plastic part, the analysis time is long and the computer configuration requirements are high. Based on its design as a symmetrical cavity, in order to save analysis time, its single cavity is analyzed and processed. The shape of the plastic part is symmetrical, so the selected gate position is also symmetrical. The plastic part is evenly thin-walled, so the four-gate side-injection method is used as shown in Fig. 2. The pouring method is a cold runner pouring system, which uses more gates to reduce the time required for filling and shorten the molding cycle of the product. Not only can the pressure distribution pressure be even and the pressure holding time is short, and the surface of the plastic part does not have obvious mold release gate marks, which can ensure the appearance color of the plastic parts.

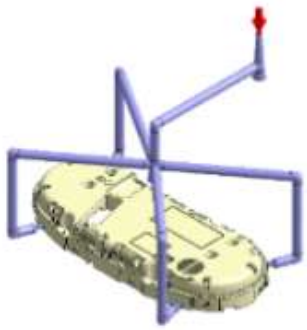
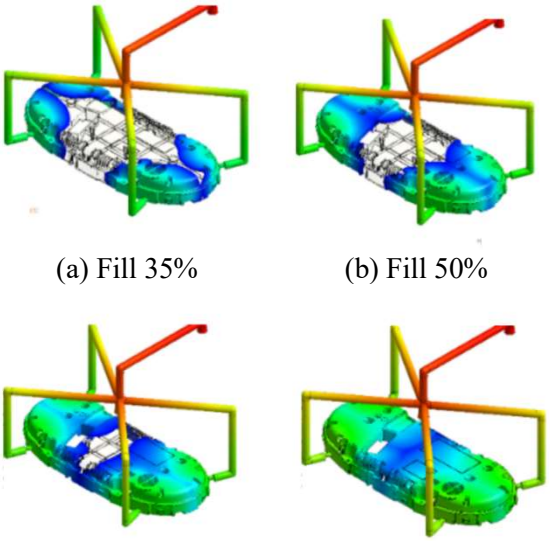


Figure 2. Four gate side glue.

2.2. Cold runner gating system analysis results

According to the results shown in Figure 3, it can be seen that when the (a) pattern is filled to 35%, the two melts at the intermediate position in the X-axis direction of the plastic part begin to merge to form a suture in the X direction;(b) When the figure is filled to 50%, the two melts in the X-axis direction have merged and flowed along the Y-axis direction;(c) When the figure is filled to 75%, the two sols along the Y-axis direction begin to merge to form a suture in the Y-axis direction;(d) The drawing is completed, and the exhausting problem should be paid attention to at the end of the filling to avoid the occurrence of cavitation.



(a) Fill 35% (b) Fill 50%

(c) Fill 75% (d) Fill 100%

Figure 3. Fulling.

According to the distribution of the sutures in the filling result shown in Figure. 4, it is apparent that the position of the sutures is distributed in the shape of "field" in the X and Y directions, and the length is so long. The suture has a great influence on the appearance and hardness of the product, and it is easy to cause a "line" distribution on the appearance of the product and is not aesthetically pleasing, and it is easy to break at the suture during the installation process.

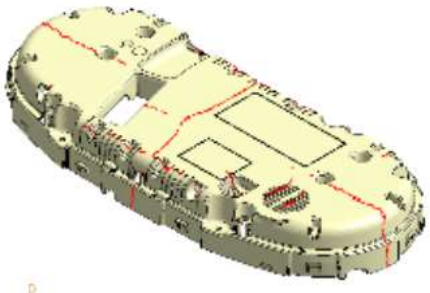
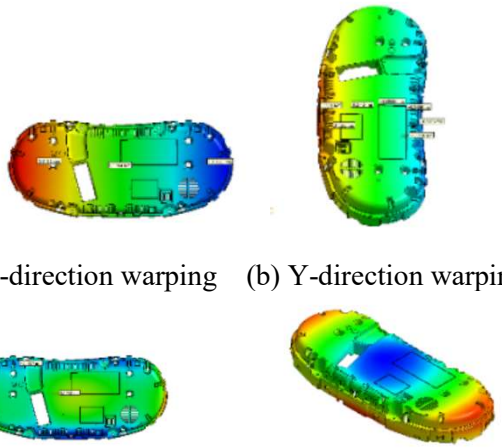


Figure 4. Sutures.

As shown in Figure.5, the warpage deformation [5] shows that the amount of warping deformation in the Y direction is large in the X direction according to the color bar value; In (a) the color bar shows the value in the X direction is -1.665mm~+1.057mm;In (b) the color bar shows the value in the Y direction is -0.773mm~+0.777mm, and the total warpage value is -0.21mm~+1.126mm, where the positive and negative values represent the direction of warping deformation. The cause of warping deformation may be due to uneven shrinkage or residual stress caused by flow, so the factors that cause warpage deformation are still uncertain, and the model needs to be verified again.



(a) X-direction warping (b) Y-direction warping

(c) Z-direction warping (d) Total warpage

Figure 5. Warpage deformation.

2.3. Chapter summary

The use of this cold runner casting system design produces a relatively long and long suture for the plastic part, which has a great influence on the appearance of the plastic part and weakens various mechanical properties of the plastic part. The reason for the large amount of warpage deformation has not yet been determined, and it is yet to be investigated.

3. Hot runner gating system

3.1. Hot runner gating system design

In this optimization design, the gating system is designed as a hot runner single gate pouring method. The position selection is biased near the center of the plastic part as shown in Figure. 6. The same is the one-module two-hole design for analyzing the single cavity. The speciality of the hot runner, the plastic in the flow channel is always in the molten state, the gate diameter can be made larger to facilitate the plastic to enter the cavity more easily, ensuring that it can fill the cavity in a short time, reducing the molding cycle of the product.

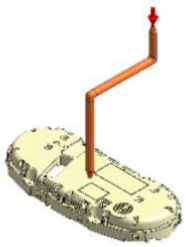
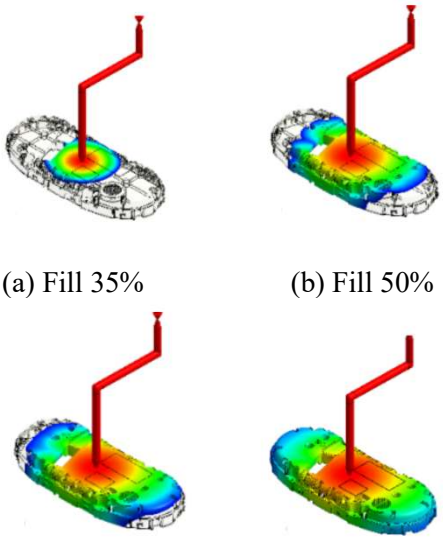


Figure 6. Hot runner single gate pouring.

3.2. Hot runner gating system analysis results

According to the filling results in Figure 7, compared with the four-gate side pouring method, there is no fusion of the melt in the single gate, and the single gate pouring in the cold runner system may cause the flow to be delayed or short-shot due to insufficient injection pressure.In the hot runner system, there is almost no pressure loss between the pressure at the pouring surface and the gate pressure, and the injection pressure is ensured.

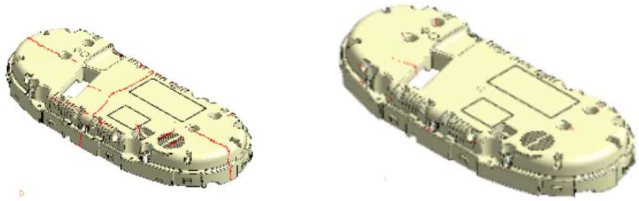


(a) Fill 35% (b) Fill 50%

(c) Fill 35% (d) Fill 50%

Figure 7. Fulling.

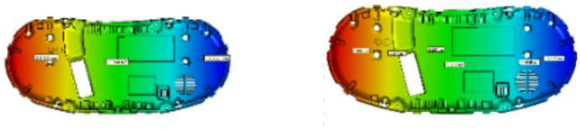
As shown by the suture in Figure 8, longer and more sutures than those produced by the four-gate side infusion pattern (a); The single sprue (b) is used to produce a much smaller number of sutures, and most of the sutures are produced at the holes. The reason is that the melt is "divided" by the hole. Since the hole of the product is mostly ventilated and the area is not large, the length of the formed suture is short, which has little effect on the strength and quality of the plastic part.



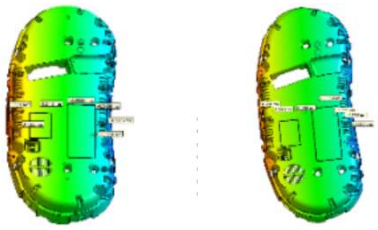
(a) Four gate side pouring (b) Single gate pouring

Figure 8. Sutures.

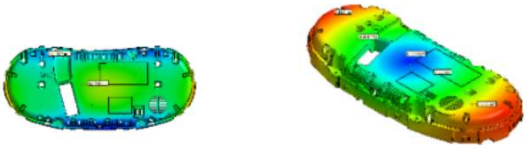
The X direction and the Y direction which are large for the warpage deformation value are shown in the comparison chart of Figure 9 (The left picture represents the pouring of the four gate side, the right picture represents the single gate pouring, the following is simplified in the left figure on the left). It can be seen that the left figure of the figure (a) shows that the warpage value in the X direction is -1.665 mm to 1.057 mm, and the value in the right image is -1.1171 mm to 1.207 mm. The left graph of Figure (b) shows that the warpage value in the Y direction is -0.773 mm to 0.777 mm and the value in the right graph is -0.857 mm to 0.845 mm. The left graph of Figure (c) shows that the total warpage value is -0.21mm~1.126mm and the value shown on the right is 0.005mm~1.219mm. There is no obvious improvement, and the value of the amount of warpage is almost close.



(a) X-direction warping



(b) Y-direction warping



(c) Total warpage

Figure 9. Warpage deformation.

4. Conclusion

The above various conditions are summarized into the comparative analysis table of Table 1. It is concluded that there are no short shots and flow hysteresis for the filling results in the two different infusion systems; The suture line of the four gate side pouring is obviously more than the single gate pouring and the length is long, which is easy to cause quality problems such as the rigidity of the plastic part; There is no significant difference between the two pouring systems on the warping deformation, and the main factor causing the warping deformation is caused by the uneven shrinkage of the plastic in the plastic part.

Table 1. Comparative analysis table.

Name		Four gate side glue	Hot runner single gate pouring
Filling result		No short shot No flow lag	No short shot No flow lag
Sutures		More Longer	Less Caused by a hole
Warpage deformation	X-direction	-1.065mm 1.057mm	-1.171mm 1.207mm
	Y-direction	-0.773mm 0.777mm	-0.857mm 0.845mm
	Total warpage	-0.21mm 1.126mm	0.005mm 1.219mm

Based on CAE analysis, it is possible to simulate and analyze the problems generated in the production process before the test, and optimize the problems generated. Reduce the rate of failure in the production process, avoid unnecessary waste, save production costs, and increase revenue.

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