Research on Cooling Technology of Rapid Die Based on 3D Printing

Hongfei Li [a], Ying Wang [b], Jinsong Li [c] and Shaoxin Feng [d]

Shandong University of Science and Technology, Qingdao 266590, China.

[a]919066567@qq.com, [b]1015561580@qq.com, [c]2315901638@qq.com, [d]961885798@qq.com

Abstract

Rapid die is a new type of moulding technology developed on the basis of rapid prototyping technology. It is a tool that uses its specific shape to form a product with a certain shape, size and surface precision [1]. The mold cooling system and the rapid system Moldflow simulation study of the test, and the traditional cooling design and 3D printing technology combined [2], to achieve all-round conformal cooling, the mold cooling more uniform, so that the quality of the injection molded parts made Well, the life of the mold is greatly improved.

Keywords

Rapid die; 3D printing; conformal cooling; molding process.

1. Introduction

Die with the shape of cooling design. Combining traditional cooling design guidelines with 3D printing technology, a conformal cooling design[3]. Moldflow moldflow analysis software is used to analyze the mold system. In the injection mold, the design of the cooling system directly affects the molding quality and production efficiency of the parts. Through the analysis of heat transfer in the cooling system of the injection mold, the heat in the mold can be known from the previous chapter. Most of them are brought out through the cooling medium in the cooling system, so the design of the cooling system has a huge impact on the mold performance[4].

2. Cooling System Design And Optimization

2.1 Study Object Test Parameter Analysis

As shown in Fig.1, the object studied in this paper is the adjustment bracket for automobile headlights, with a thickness of about 1mm, in which the product has four solid irregular column structures with a diameter of about 10mm, and the product area is approximately 8113.6mm2, with a volume of approximately 7167.5mm3, a maximum length of approximately 57mm and a width of 37mm. The mold is in the form of a mold cavity, and the injection molding material is ABS. The material has impact resistance, chemical resistance and heat resistance, the material shrinkage rate is 0.5%, and the properties of the plastic material are shown in Table 1.

2.2 Cooling System Design

During the injection molding process, heat inside the mold is mainly brought out of the mold body through the flow of the cooling medium inside the cooling system. The design and layout of the cooling system has a great influence on the molding quality and production efficiency of the plastic parts, so the design of the cooling system and Layout is a key factor affecting the molding quality and production efficiency of plastic parts. The design and optimization of the mold cooling system is

critical for plastic injection molding [5]. Conformal cooling As the name suggests, with the mold core, the shape of the cavity can be designed into a complex shape, and the diameter of the pipe can also be continuously changed. As shown in Fig.2, the use of correct scientific calculations and experimental analysis can be sufficient. To meet the requirements of the mold cooling system is to achieve the best cooling effect of the mold, thereby shortening the injection cycle of parts and improving the quality of parts.

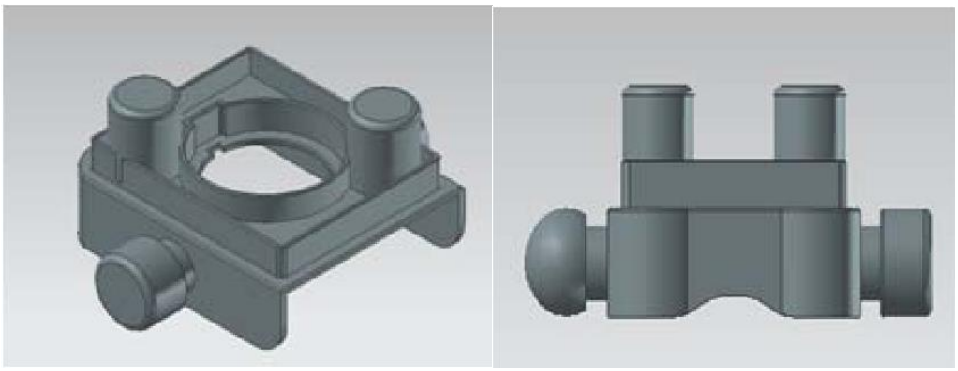


Fig 1. Car headlight motor adjustment bracket

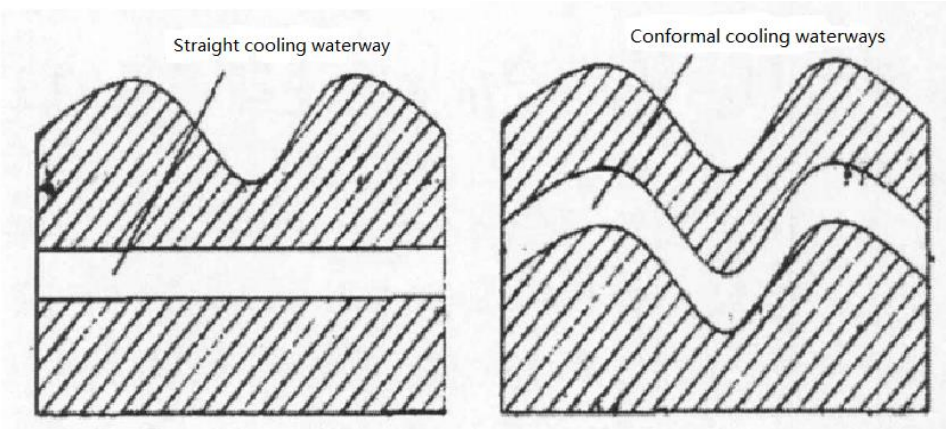


Fig 2. Conformal cooling waterways and traditional cooling waterways

Cooling pipe outlet, inlet coolant temperature requirements. General requirements for high precision plastic parts, the temperature difference is below 2 °C; if ordinary plastic parts, then the temperature difference is less than 5 °C. Especially in the case of large sizes of cavities and stencils of large plastic parts, the arrangement of cooling pipes can be changed in order to achieve cooling requirements. As shown in Fig.3.

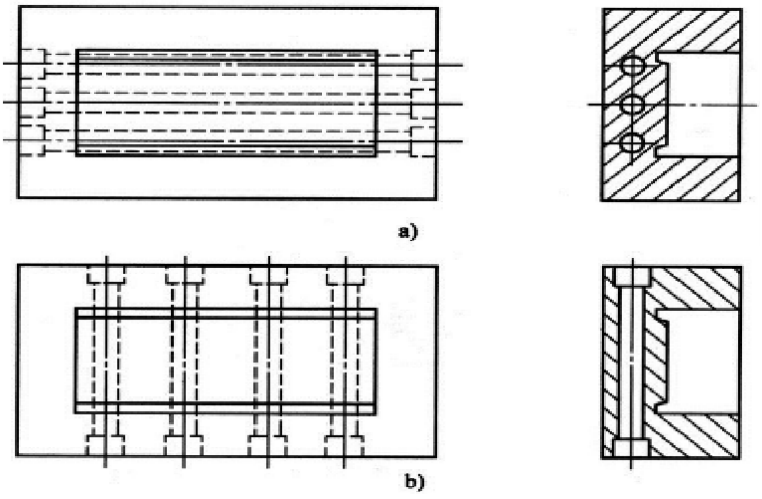


Fig 3. Cooling Pipe Arrangement Comparison

When multiple gates are used for pouring or the shape of the cavity is complex, the installation of cooling pipes should be avoided where the plastic melt meets. This ensures that there will be no melt marks at the confluence. When opening the cooling pipe, care should be taken to avoid interference with other mechanisms on the mold. The results of the design were analyzed using Moldflow's die flow analysis software, which was calibrated by the maximum temperature, minimum temperature, and overall distribution of the cloud. When cooling the design, cooling pipes can be laid out according to the shape shown in Fig.4.Within a certain range, it mainly reflects whether the cooling pipeline layout is reasonable.

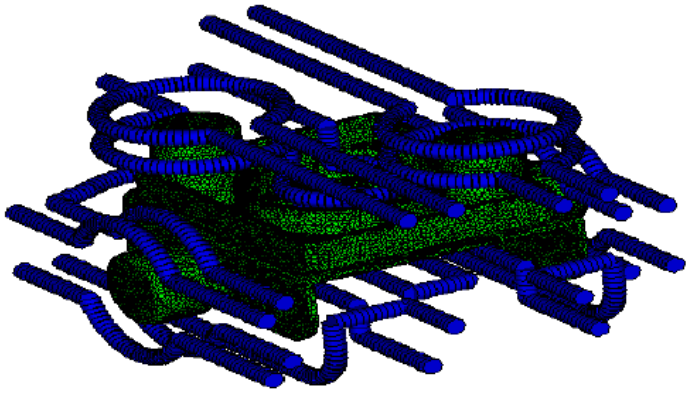


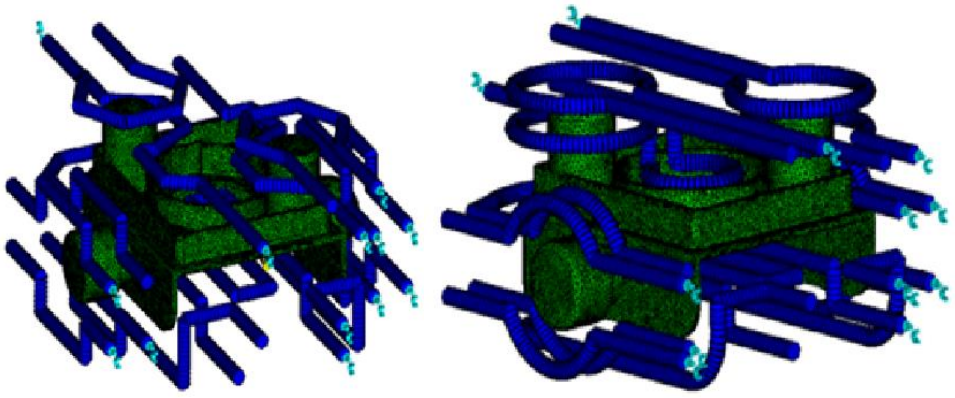
Fig 4. Conformal cooling pipe

2.3 Comparison between traditional cooling channels and conformal cooling channels

In the previous section of the experiment, the analysis was based on conventional cooling. By designing the two tests, the cooling pipe layout design of the headlight adjustment bracket shown in Fig.1 was finally obtained, as shown in Table 1. The layout analysis results. In this chapter, the design of the conformal cooling channel layout is based on the traditional cooling pipe, and the design method is based on the design method of "body to surface, surface to body" and the layout of the cooling pipe based on the experimental conclusion. Conformal Cooling Pipes Fig.5 shows the layout of the conventional cooling channels and the layout design of conformal cooling channels[6].

Table 1. Optimal layout of car headlight adjustment bracket cooling system

Cooling pipe diameter (mm)	Distance from cavity wall surface (mm)	Distance between adjacent pipes (mm)
2.5	4	6



(a) Traditional cooling layout design (b) conformal cooling layout design

Fig 5. Pipe layout design for conventional cooling and conformal cooling

In order to verify whether the design of the cooling pipe is reasonable and meets the requirements, the following analysis will be performed by the mold flow analysis software on the inlet and outlet coolant temperature and the wall temperature of the cooling pipe. The analysis results are shown in Fig.6. The result of the mold flow analysis in Fig.6 a) shows that the maximum temperature of the coolant in the conventional cooling circuit is 26.20°C, and the maximum temperature in the conformal cooling circuit is 27.19°C, which is slightly different from the conventional cooling circuit. Low, in Fig.6 b), the wall temperature of the circuit is relatively uniform with the cooling wall, because in the traditional cooling, the layout of the cooling pipe does not change with the shape of the plastic part, and the uniformity is compared with the cooling channel. Poor, conformal cooling channels are more complex than conventional cooling channels, but have high heat transfer efficiency, so the outlet temperature is higher than conventional cooling.

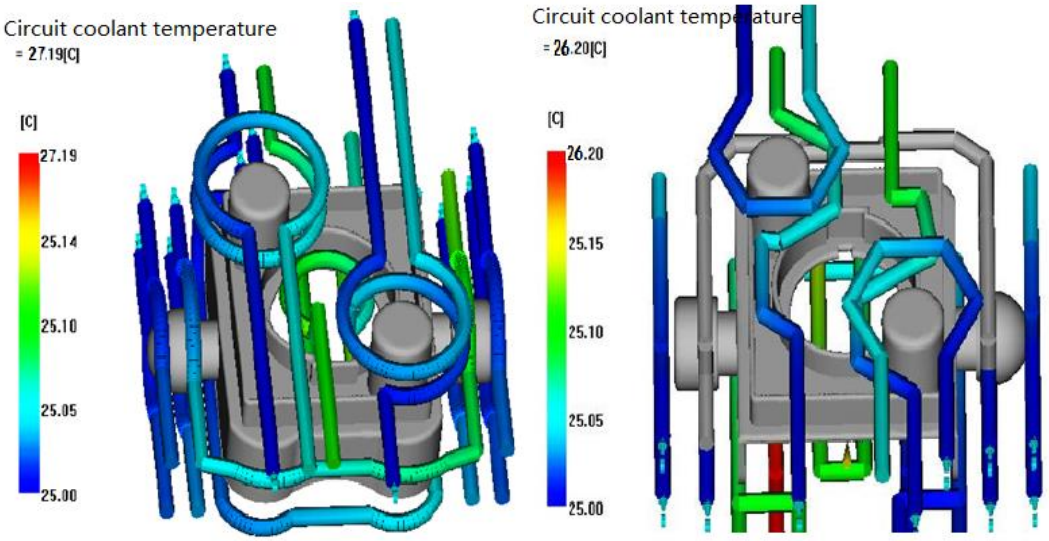
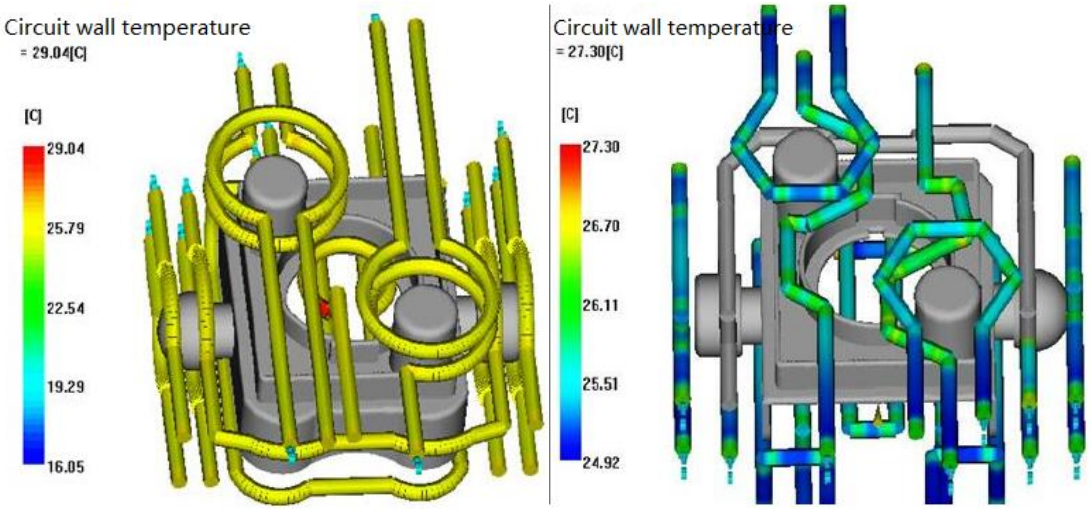


Fig 6. Temperature difference between inlet and outlet in traditional cooling and conformal cooling



Circuit wall temperature

Fig 7. Analysis results of conventional cooling and conformal cooling pipes

2.4 Comparison of analysis results

Comparison of mold temperature analysis results In the cooling system, the mold cooling temperature is the most important factor that reflects the molding quality and molding efficiency of plastic parts [7], through the comparison of the mold temperature of traditional cooling and conformal cooling in Fig.7. It can be seen that the maximum temperature of the mold in the conventional cooling is 39.56°C, while

the maximum temperature of the mold in the conformal cooling is 30.22°C, which is an increase of 24% compared with the conventional cooling.

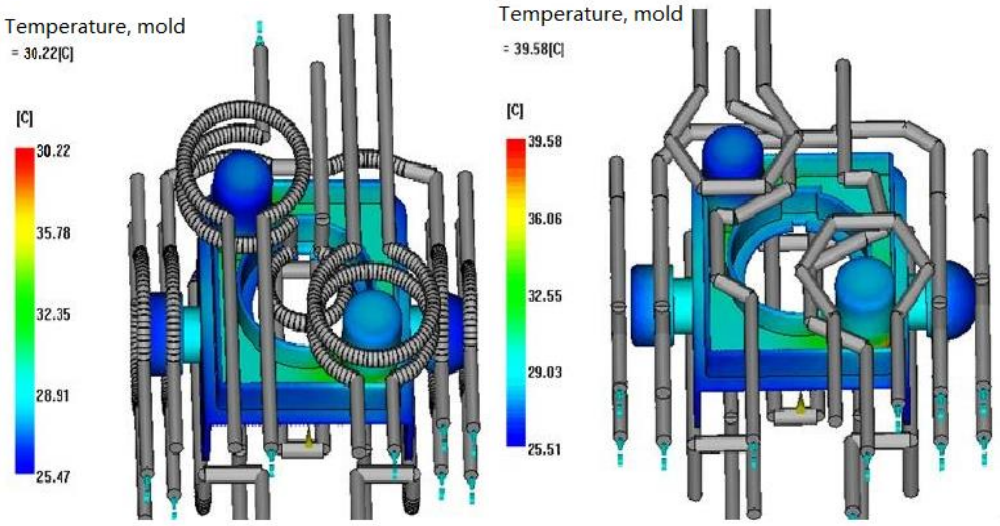


Fig 8. Mold temperature under conventional cooling and conformal cooling

3. Conclusion

In this paper, the design and optimization of the injection mold cooling system are studied. Based on the traditional cooling design, the design method of conformal cooling is proposed. For the layout of the cooling pipeline, Moldflow software was used to analyze the test results through visual comparison and range analysis. The optimal value was obtained and the cooling efficiency of the mold was improved. And compared with the traditional cooling analysis, after the test comparison, with the shape of cooling is better than the traditional cooling.

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