The Research on Injection Mould Design of Shell Shaped Pieces

Zhanjun Liu

Faculty of Aerospace Engineering,Shenyang Aerospace University,China

lzjlzjj@126.com

Keywords: manufacturability; cooling system; shell shaped pieces; injection mould

Abstract. It is analyzed by the technology plastics materials and molding process of shell shaped pieces, which has carried on the mold scheme demonstration and manufacturability, the forming problem of shell shaped pieces is solved, and it is designed that the main runner, cold slug well, pull rod, the runner and gate of gating system .The ejection force is calculated, and which is design of cooling system. It is given to the assembly diagram of special injection mould. Practice has proved that the shell shaped pieces injection mold structure is reasonable, reliable, good machining quality and high production efficiency.

1 Introduction

In injection molding process, the temperature of the mould of plastic affected flow melt in the mold, curing finalize the design, productivity, product shape and dimension precision, mechanical strength, stress cracking and surface quality. In order to ensure the quality of products and high productivity, mold temperature must be appropriate, uniform and stable. But what circumstances need to be cooling exactly in mold, it is with the different characteristics of the plastic varieties, products structure shape, size, productivity and the molding process of mould temperature requirements. To determine the cooling principles is as follows. The low viscosity and liquid plastic usually can use warm water to the mold for cooling, because the molding process requirements of the mold temperature is not high, and by regulating the flow of water size, it is controlled the temperature of the mold. If it wants to improve the productivity of this kind of plastic products, it is shorten by the products within the mold cooling and molding cycle time, it can use cold water to control mold temperature[1]~[4]. Because of the influence of the product geometry, all parts of the products is not necessarily equal within the mold temperature, it is often caused by uneven temperature, distribution in the molding quality is poor. That can be used to mold cooling method, the distribution of temperature is to improve the products. For small and medium-sized injection mould, plastic melt can rely on natural convection and radiation heat to the mold, but in more cases, melt in the mold mostly can only rely on cooling water convection heat conduction to spreading out. Design need to be reasonable in the mould, therefore, the cooling water channel section size and length are needed to design, in order to accurately calculate, heat transfer area is required to control mold temperature.

2 The Manufacturability Analysis of Parts

Fig.1 is shown for the shell shape, there are two aperture for 20 mm hole, which is not near the center, if it choose one hole to set center gate, which is inevitable deviation from mold cavity pressure center of injection machine, plastic flow is the long side in one direction. When using single modes, it is difficult to choose the right gate. If such mould adopts multi-point gate structure, the mould has two parting surface, the structure is relatively complex. Using the tool box sets inclined mainstream way at the top of the two square window, to get two center gate, which meets the needs of the mold two gate requirements. The material of installing parts is ABS plastics, belongs to the common thermoplastics, the forming is of good comprehensive performance, impact toughness, high mechanical strength, size stability, chemical resistance and good electrical properties, it is easy to shape and mechanical processing. Surface hardness and electrical insulating properties are balanced, in addition, their ability to resist shock is very excellent, it is larger of application temperature range,

surface quality liquidity or is good. Molding shrinkage is smaller, which is usually in the form of 0.3 ~ 0.6%. Heat capacity is low, plasticizing efficiency is high in the cylinder , rapid solidification is in the mould, the molding cycle is short, but the water imbibition content should be less than 0.3%, the requirements of surface gloss plastic parts should be long preheating dry.

The parting surface is options, due to the technical requirements of surface quality requirement, the parting surface is not set outer surface transverse.Parting surface is longitudinal Settings, by four side core working at the same time, parts are obtained by the shape.

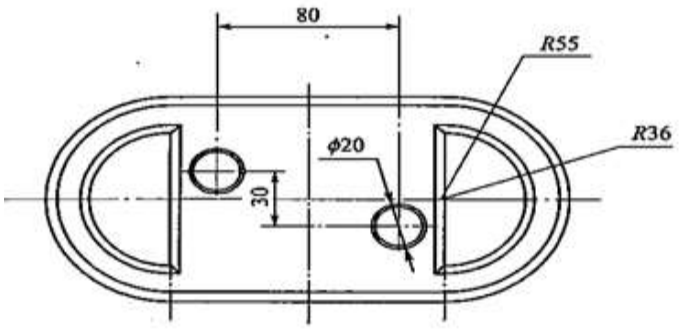

Figure 1. The plastic parts of shell shape

The parting surface is the second option. The two end of the parts are flat, according to the parting surface design principle, the parting surface design is on this plane. Because of the length of the upper and lower surface of different hole, it is obviously different package force, so to choose the parting surface on the surface. Comparing two options, one way is the part of the side core pulling, four cores are at the same time to participate in forming, the shape of the plastic parts size features ensures in good condition. By using the die blocks, and mould parts constitutes the edge part of the appearance. And the scheme of two cores is the size of non critical part, plastic flow is of a longer trip. A side core pulling is overmuch, processing complex, to make the mould the complexity, the overall increases, the second scheme is practical.

3 The Calculation of Stripping Force

Ejection force calculation is the basis of demoulding mechanism introduced, it is a very difficult to calculate the shape of complex products by demoulding force. Demoulding force is related to all thickness, the size of the products and its shape, products of ejection force formula is as follows:

$$F = \frac{2\pi rESl(f - \tan\varphi)}{(1+\mu+k_1)k_2} + 0.1A \tag{1}$$

$$\lambda = \frac{r}{\delta};\quad k_1 = 2\lambda^2 / \left(\cos^2\varphi + 2\lambda\cos^2\varphi\right) \tag{2}$$

$$k_2 = 1 + f\sin\varphi\cos\varphi \approx 1; \tag{3}$$

$$F_1 = \frac{2\times 3.14\times 2.1\times 10^5 \times {0.6}/{100}\times 16\left(0.2 - tg1^\circ\right)}{\left(1+0.35+4.5\right)\times 1} + 0.1\times 17.2 = 3950.6N$$

$$F_2 = \frac{2\times 3.14\times 2.1\times 10^5 \times 0.6/100 \times 16(0.2 - tg1°)}{(1+0.35+3.8)\times 1} + 0.1\times 17.2$$

F=3950.6+4487.6=8438.2N

4 The Design of Gating System

Main runner size directly affects the melt flow rate and molding time, because the main runner is with high temperature plastic melt, and injector nozzle is repeated contact, therefore, the main runner part is designed to remove the gate. In injection molding, injection machine mould pressure is very big, it is mainly effect on the gate set, so it doesn't usually put the sprue opening on the fixed template directly, but it is in a main gate set. Usually it is embedded mold after normalizing, such damage is in the process of mold, the use of easy is to replace or repair grinding. The sprue bushing is the use of T8A high quality materials, gate set length is fixed, mode with the thickness of the part is consistent, the mainstream way of exports face shall not be highlighted in the parting surface. In order to make the setting material pull out smoothly, the small end of the main runner diameter should be greater than the injection machine nozzle diameter, the technical parameters is of injection machine. Main runner pits is of the entrance to the spherical, radius should be greater than the injection machine nozzle radius of ball head, and to check the technical parameters of injection machine. Usually gate set in diameter should not be too big, because the main role is by bending stress, to make the gate set easily damaged, gate set diameter also should not be too large, the purpose is to make the difference in temperature between gate set, the template is to achieve the minimum. Gate set of convex shoulders must have a circular arc transition, otherwise, it tends to damage due to stress concentration in the work. R is usually about 3 mm. Main runner half of cone angle is usually 2 °~ 4 °, big cone angle can produce turbulence or eddy current, which is easy to get involved in the air. The cone angle is too small, to make mould difficulty, which also can make the mold filling of melt, flow resistance is too large. The length of the main runner is general according to the thickness of the template. In order to reduce the pressure loss, the melt filling mold is material loss, it should as far as possible to shorten the length of the mainstream way, L is generally controlled within 60 mm. The main runner outlet should be larger than rounded corners.

According to the need of cold slug, it should be in place of melt flow direction, and along the upper, which reaches the melt flow direction. In the runner, design should be considered when reducing the pressure in the flow passage of loss, and as far as possible to avoid the melt temperature reduced, it should also consider reducing the volume of flow channel. Its design principle is that the smallest distance will melt quickly in input cavity smoothly. Materials must be in the same temperature, and pressure conditions is from the gate to the cavity feed at the same time. As far as possible big flow, channel section is advantageous to the mold filling, and it ensures the enough pressure maintaining pressure, but from the perspective of saving material, sectional area should be as small as possible, larger cross-sectional area also increases the cool down.

The cross section is shape of the runner. In the design, flow channel is to reduce the pressure loss of flow passage, and hope to flow the less surface area, therefore, available, cross section area is of flow channel, and the ratio of the circumference is to represent the port efficiency. Circle and square are the highest efficiency. Due to the parting surface shape is as the plane, trapezoidal section flow channel can be used. Because the plastic melt flow is in the passage, it will be formed in the flow channel of wall solidified layer. This layer heats insulation effect, it makes the melt that department is in the center of the flow channel. Therefore, in the center of the runner, gate is located in the center of straight line[5].

5 The Injection Mould Design of Shell Shaped Pieces

In the shell shape parts of Fig.1, injection mould is using double mainstream way to this kind of mould structure design, which can make the center gate molding use the hole, it is not near the center of continue,

plastic injection mould structure is shown in Fig.2, injection mould is using double straight mainstream way to two mainstream way entrance center distribution on the circumference of a circle, the mainstream way condensation is used inverted cone pit type to pull material structure by pull bushing, which is released by the push rod. Mould is used in the XS-ZY-250 type injection machine, the positioning pore diameter of injection machine mould is 125 mm.

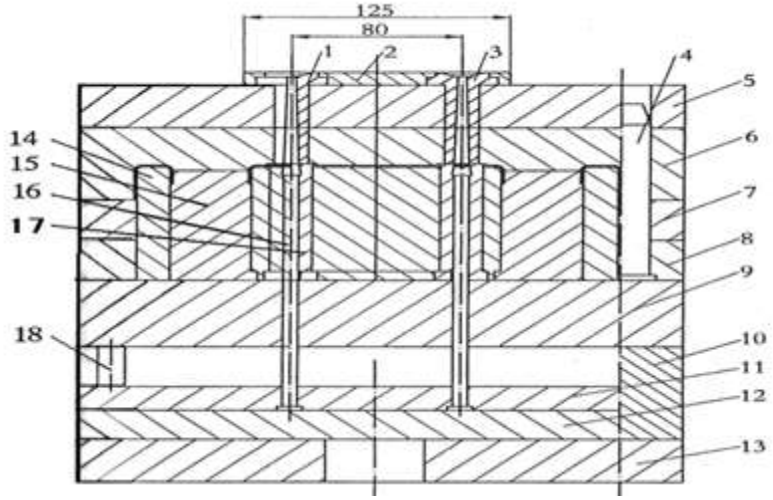

Figure 2. Injection mould structure

The section size of distributary channel mainly depends on the size of the plastic products, mould structure and processing of plastic types. In general, the increase of product size is wall thickness, because the melt is in the big cross section, small flow channel section flows in the runner when the resistance is small, therefore, large cross section flows, channel can promote the mould filling process. If shunt way is longer, the process is longer, plastic viscosity should be smaller.

6 Conclusions

It is analyzed by the technology plastics materials and molding process of shell shaped pieces, which has carried on the mold scheme demonstration and manufacturability, the forming problem of shell shaped pieces is solved, and it is designed that the main runner, cold slug well, pull rod, the runner and gate of gating system .The ejection force is calculated, and which is design of cooling system. It is given to the assembly diagram of special injection mould. Practice has proved that the shell shaped pieces of injection mold structure is reasonable, reliable, good machining quality and high production efficiency.

References

[1] Feng. Jing , The Mixture of The Multimode System Reliability Growth Model,Computer Application Research Supplement, pp.60-61,(2003).

[2] Xu. Yuxiu, Complex Mechanical Fault Diagnosis Method of Fractal and Wavelet, Mechanical Industry Publishing House,Beijing, pp.24-25,(2005).

[3] Weng. chaoxi, Reliability Growth, Science Press, Beijing, pp.130-131,(1993).

[4] Guofang, Reliability Data Collection And Analysis, National Defence Industry Press, p22,(1995).

[5] Wen.WeiDong, Prediction model based on the fuzzy reliability, aircraft engine, Beijing, pp.322-323,(2003).