Design of Plastic Injection Mould for Plastic Bracket

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Abstract: The side core pulling mechanism of "fixed mold lifer+T-type lift guide block" is adopted for the fixed mold of bracket, and the side core pulling mechanism of "angle pin+slide" and "angle pin+slide+T-type guide block" side core pulling mechanism is adopted for the movable mold of bracket. The gating system adopts the sub-gate, the inner reinforcing rib is formed by moving mold insert, and the ejection system is the form of ejector pin + blade ejector pin. It provides a good reference for the design of similar moulds.

1. Introduction
Brackets are important functional parts. There are many side holes and inclined holes on the inside and outside surface of plastic parts, and there are many reinforcing rib structures on the inner surface of plastic parts, which is convenient for the use and installation of products, and there are many reinforcing rib structures on the inner surface of plastic parts, which makes it difficult to design the mold, and it is difficult to ejection system of the plastic parts. When designing the mold, it is necessary to design multiple side core-pulling mechanisms, and the core-pulling direction of some core-pulling mechanisms has a certain inclination with the parting surface. Thus the mold structure is complex, and it is difficult for manufacturing.

2. Plastic Parts Structure and Process Analysis

2.1. Plastic Parts Structure
The bracket structure is shown in Figure 1. It is a functional part with high requirements on precision and appearance quality. The overall dimensions are about 318mm×66mm×41mm, and the average wall thickness is about 3mm. The products are divided into left and right parts, and there are 12 side pulling of the two plastic parts, of which 6 are side holes and side grooves, 2 are side inverted buckles and 4 are inclined inverted buckles. There are 8 round small through holes on the plastic parts; and there are many ribs on the inner surface of them, so the filling resistance is large and the exhaust is difficult during the injection molding. Customers require the quality of the plastic parts to be with no molding defects. The plastic parts are made of PBT+GF30 (polybutylene terephthalate+30% glass fiber), and their shrinkage rate is 0.4%.
2.2. Technology Analysis of Plastic Parts
When the plastic parts are used, the left and right ones are used in a ratio of 1:1. According to the structure of the plastic parts, the mold is designed as one mold with two cavities (left+right). The requirements for the precision and molding quality of plastic parts are high, and the sub gate is adopted for the gating system. There are 12 side pulling on the left and right parts, of which 2 need to be designed with the side core-pulling mechanism of “fixed mold lifer+T-type lift guide block ” in the front mold, and the front mold was demoulded with fixed lifter during the first parting. The core-pulling mechanism of “angle pin+slide” should be designed for 4 inverted buckles (4 inverted buckles are formed on one slide block), and 2 core-pulling mechanisms of “angle pin+slide+T-type guide block” should be designed for the other 6 inverted buckles. 8 circular through holes on the plastic parts need to be designed with 8 front mold insert pin molding. The rib position on the upper and inner surfaces of plastic parts needs to be designed with movable mold inserts. Through the technological analysis, it can be seen that the design of lateral core-pulling mechanism, gating system and molding parts are the design difficulties and emphases of the mold.

3. Key Points of Mold Structure Design
According to the structural characteristics and application requirements of plastic parts, one mold with two cavities (left+right) and double parting surface structure are adopted for the mold. The non-standard mold base is adopted with the mold base specification of CI4590-A70-B120-C150, and the mold closing height is 476mm.

3.1. Gating System Design
There are many stiffeners on the inner surface of the plastic parts, which create great flow resistance during mold filling and make it difficult for the filling, and raise high quality requirements for plastic parts molding. Therefore, the gating system is designed as a sub gate, which is opened at surface-stiffener positions on both sides of plastic parts. Each plastic part is designed with two gates. Due to structural limitations of plastic parts, a slider core-pulling mechanism needs to be designed in the middle of the mold, and the gate needs to avoid the position of the slider. The design of gating system is shown in Figure 2.
3.2. Design of Cores and Cavities

According to the overall dimensions and structural characteristics of the plastic parts, both the molding cores and cavities are designed as an integral mosaic structure. There are 8 round through holes for molded plastic parts in the molding cavity, which have a high protruding height, and need to be designed as molding insert pins to facilitate processing and mold repair. There are 2 bosses on molded plastic parts, which also need to be designed as molding insert pins on the cavity. Therefore, there are 10 molding insert pins on the molding cavity. In order to ensure the accurate alignment of the molding cores and cavities when the mold is closed and improve the molding accuracy of the product, the tubing positions are designed on the molding cores and cavities. There are many stiffeners on the inner surface of the plastic parts, which create great mold filling resistance and make it difficult for the filling, and it is difficult to conduct forming process at the position of the stiffeners, which requires EDM (Electrical Discharge Machining). Molding inserts need to be designed on the molding core to facilitate processing and also play the role of exhaust. There are eight moving mold inserts designed on the molding core, which adopt fixing mode of hanging table and are matched with the core, and pressed firmly with B plate. The cores, cavities and molding plates are joint together through fastening of hexagon socket screws, and are fastened to B plate and A plate respectively. See Figure 3 for the design of molded components and parts.

3.3. Design of Side Core-pulling Mechanism

There are 12 inverted buckles on the left and right plastic parts, and the lateral parting and slide core-pulling mechanism are the key and difficult points in the mold design.

3.3.1. Fixed Mold Side Core-pulling Mechanism

There are 12 inverted buckles in the left and right parts of the support, and five slide core-pulling mechanisms need to be designed for the molding, of which 2 inverted buckles are on the side of the...
fixed mold, and two slide core-pulling mechanisms of the fixed mold need to be designed. According to the characteristics of the inverted buckle position and the overall structure of the mold, the two slide core-pulling mechanisms of the fixed mold are designed in the form of “fixed lifer+T-type lift guide block”. The guide slide seats of T-block guide slide are installed on fixed clamp plate 1. The nylon parting lock 25 is installed between A plate 4 and B plate 6, and compression spring 3 is installed between the top clamp plate 1 and A plate 4. When opening the mold, first parting is done between A plate 4 and top clamp plate 1, and relative movement occurs between the fixed mold lifter and T-type lift guide block. The fixed mold lifter along the T-type lift guide block to complete the demould of the inverted buckle of the fixed mold. When the mold opening stroke reaches 20mm, the stop screw 2 acts and the first parting ends.

3.3.2. Movable mold Core-pulling Mechanism

There are 10 inverted buckles on the sides of the movable mold, so it is necessary to design three side core-pulling mechanisms on the movable mold sides. The middle slide S1 is designed in the form of “angle pin+Slide”, and two side holes and two side inverted buckles are formed on the left and right plastic parts. The slide S1 is composed of a slide insert 21, a slide seat 19, a wear plate 5, an angle pin 22, a locking block 18 and a ball plunger 20; The top side slide S2 is designed in the form of “angle pin+slide+T-type guide block”. There are three inverted buckles in two round side holes and one inclined hole of the molded plastic part. The slider S2 is composed of a slide insert pin, a slider insert, a slider seat, a T-type guide block, a fixing block of slide insert, an angle pin, a locking block, a stop block, a ball plunger, etc. During the second parting of the mold, the slide seat drives the slide insert pin to complete side core-pulling under the action of the angle pin, and at the same time, the slide insert completes the demoulding at the inclined inverted buckle hole area under the action of the T-type guide block; The structure of ground side slide S3 is the same as slide S2, showing a symmetrical relationship. The structure of slide S2 and slide S3 is complex, and it is difficult to process and assemble them. See Figure 4 for the design of side pulling mechanism.

3.4. Design of Lifting System

There are many stiffeners on the inner surface of the plastic parts, which create great demoulding resistance, but it is impossible to design large-size ejector pins due to the shape limitation of the product. Considering the special needs of the product shape, it is designed for the mold 4 ejector pins with a diameter of 6mm, 18 ejector pins with a diameter of 4mm and 12 blade ejectors with a size of 8×1.5. In addition, the flow channel congeal material of the ejector pins are designed for 4 ejector pins with a diameter of 6mm and 1 ejector pin with a diameter of 8mm. See Figure 5 for the design of ejection system.
3.5. Design of Temperature Control System

The front mold temperature control system adopts cooling water form with “N-type + spacer”. The diameter of ordinary cooling water is 8mm, and the diameter of cooling water piping with spacer is 13 mm. There are two cooling circuits in total. The rear mold temperature control system adopts N-type cooling water form with a pipe diameter of 8mm and four cooling circuits in total. The middle slide S1 is large in size, thus it is also designed with cooling water piping. Here the N-type cooling water piping is also adopted with a pipe diameter of 6mm and one cooling circuit. See Figure 6 for the design of mold temperature control system.

3.6. Exhaust System Design

There are many stiffeners on the inner surface of the plastic parts, which create great flow resistance
and make it difficult to exhaust of the mold cavity. The mold not only uses the parting surfaces of the core and the cavity, the parting surfaces of the slide, the insert, the insert pin to assist in air exhaust, but also designs an exhaust groove with a depth of 0.5mm around the parting surface of the mold cavity. See Figure 9 for the design of the exhaust groove.

See Figure 8 for details of the mold structure.
4. Mold Working Process

After the mold is closed, the molten plastic is sent to the gating system of the mold by the injection molding machine, and the materials are introduced into the mold cavity by the gating system to fill the mold, and then the pressure is maintained and the part is cooled down. When it is cooled down to the mold opening temperature, the injection molding machine drives the mold to start mold opening. Because nylon parting lock 25 is installed between A plate 4 and B plate 6, and compression spring 3 is installed between top clamp plate 1 and A plate 4, the first parting of the mold during mold opening is between top clamp plate 1 and A plate 4. At the same time of the first parting, the fixed mold inclined lifter completes the demoulding at the fixed mold lifter of the plastic part under the action of the T-type lift guide block. After the mold opening stroke reaches 20mm, the A plate 4 stops with the function of stop screw 2, and the first parting is completed. The injection molding machine drives the mold to continue the mold opening, and the second parting is between the A plate 4 and the B plate 6, and the object stays in the moving mold to move together with the sides of the moving mold. During the second parting, the demoulding at inverted buckle area is completed under the action of the inclined guide pillar of the slide S1, the slide S2 and the slide S3 drive the slider insert to complete the side core-pulling under the action of the angle pin. In addition, the slide inserts complete the demoulding at inclined inverted buckle hole area under the action of the Guide slide block of slider block insert. After the mold opening stroke reaches the set value, the moving mold stops and the mold opening ends. The mold demoulds the product under the action of the lifting device of the injection molding machine, then the product is taken out, the mold is reset and closed for the start of next injection molding.

5. Concluding Remarks

The side core-pulling mechanism of “Fixed mold filter+T-type lift guide block” is adopted for the bracket mold fixed mold. The side core-pulling mechanism of “angle pin+slide” and “angle pin+slide+T-type guide block” is adopted for the movable mold. The sub gate is adopted for the
mold gating system. The combined exhaust system is adopted for air exhaust in the form of “movable mold insert+insert pin+parting line+exhaust groove of fixed mold parting surface”. The mold structure is quite complex. Practice shows that the mold works stably and reliably, and the quality of plastic parts meets the requirements of customers.

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