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Design of Tread Flange Injection Mold Based On Pro/E

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Abstract.In the paper, analyzing the tread flange structure characteristics ,its injection mold is designed and the maneuvering tread demolding way is applied to get out flang tread .When designing demolding parts, hydraulic pressure motor and chain-gear mechanism are used. Besides, parting plane and the forming parts can be gained automatically in Pro/E(Pro/Engineer Wildfire3.0) and standard moldbase can be achieved by EMX4.1 including gating ,cooling, and guiding system, etc. The designing ways and structure is proved rational and can be taken as reference for the similar injection mold especially for those with longer tread.

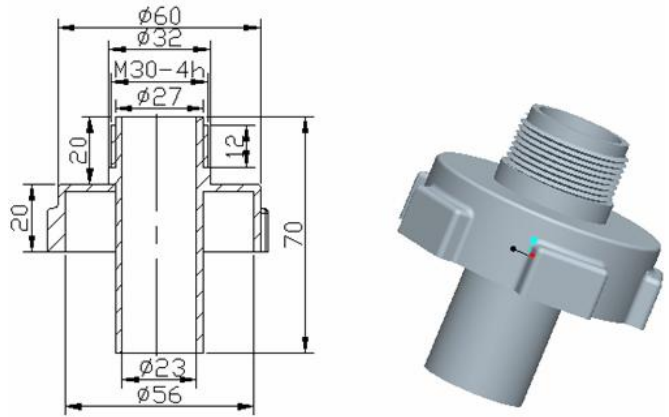
Key words: tread flange, maneuvering tread demolding way, Pro/E; EMX4.1

1. Introduction

For plastic parts, many have thread with them, and it's most critical how to design its automatic tread demolding as the tread demolding structure will effect the mold life and the plastic part quality directly . How to simplify the mold and prolong its life needs to be considered in designing. Besides, with wide application, rapid updating and high quality of plastic parts, digital designing ways such as CAD tools are used in the mold designing and manufacturing in many fields. Among those tools, Pro/E and UG are used most widely. These two softwares have become standard ones in the mold industry of many countries. In the paper, the tread flange injection mold design based on Pro/E is introduced.

2. Tread Flange Structure and Process Analysis

The tread flange's size is 60mm 70mm 20mm with 12mm external tread, and it has five pleurotus around which can prevent part from rotating in tread demolding shown in Fig.1.



(a) plastic part diagram (b)3D diagram

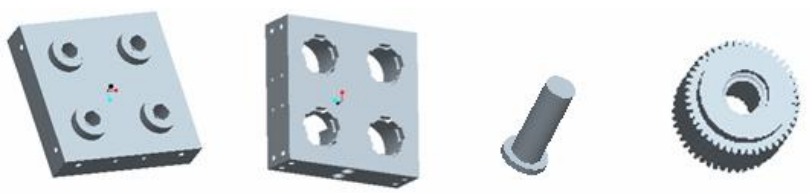
Fig.1 tread flange

Tread flange's material is PP(Polypropylene)^[1-3] with mass production. PP is a kind of material with following character: density 0.90 ~ 0.91g/cm³ , melting point 164 ~ 170 . PP also has good heat resistance, fine flow performance, less shrinkage and smooth surface.

3. the Mold Parting Plane Design

The mold parting plane is generally utilized to separate workpiece or block into mold forming parts, which is composed of a surface or several surfaces. It's important to create correct parting plane and use it to obtain mold forming parts such as cavity, core and pins in mold designing in Pro/E.

For tread flange, after using Pro/E to create its parting plane and separating workpiece with it, the tread flange mold forming parts can be achieved following in Fig.2.



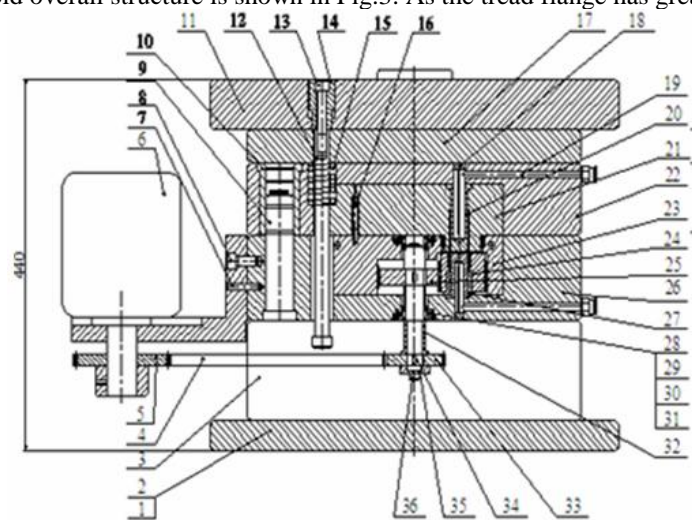
(a)fixed plate (b)mobile plate (c)mold core (d)mold cavity

Fig.2 the mold forming parts

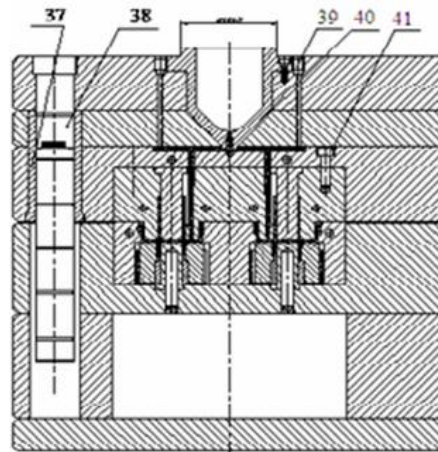
4 the Injection Mold Design

4.1 the Mold Overall Structure

The mold overall structure is shown in Fig.3. As the tread flange has greater total



(a) main view



(b) left view

1- movable base plate 2- Screw 3-supporting plate 4-chain 5- Sprocket I 6- hydraulic Motor 7-pin 8- Screw 9- Guide column 10- guide sleeve 11- fixed base plate 12- Determined distance pole 13- Screw 14 fixing plate 15- Spring 16-closing mold tool 17-resisting

plate18-seperating watar plate19-up mold core 20-water mouth21-fixed plate22-fixed mold plate
23-movable plate 24 screw core25-gear26-movable mold plate 27- Sleeve 28-bearing 29-bearing
cover 30-seals31-Seal adhesive32- Sleeve2 33-Sprocket 34-Key 35-briquetting 36-screw4 37-
Guide column38- guide sleeve 39-Gate sets 40-pulling pole41-screw4

Fig.3 overall structure of the mold

length and longer external tread, some difficulty will confront in its designing and manufacturing , among which separating mechanism according to distance and auto tread demolding must be resolved in designing .

4.2 Injection Machine Selection

With calculating tools in Pro/E , the tread flange's total volume including gating system and the plastic part itself can be calculated as 111.822 cm³. Apart from that, considering clamping force and opening stroke, the injecting machine G54-S200/400 is selected, whose Specifications is following:

Rated injection volume/cm³ : 200-400

Screw diameter/mm : 55

Injection pressure/MPA : 109

Injection stroke/mm : 160

Clamping force /KN : 2540

Maximum molding area/cm² : 645

Maximum die plate stroke/mm : 260

Maximum die thicknessmm : 406

Minimality die thickness/mm : 165

Sprue circle radius/mm : 18

Sprue diameter/mm : 4

4.3 the Maneuvering Tread Demolding Structure Design

There are three common methods for tread demolding: manual tread demolding , forcing tread demolding and auto tread demolding. For those plastic parts of high quality with mass production, auto tread demolding ways which include maneuvering demolding, half- sliding demolding and combined mold demolding can be applied. In the tread frange mold, maneuvering tread demolding is selected.

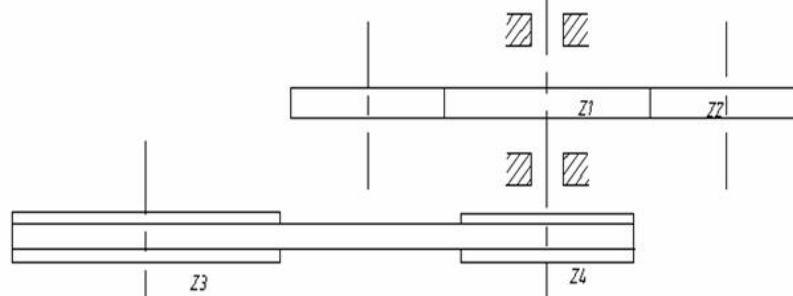
The maneuvering tread demolding has the advantage of high efficiency and steady, and in designing, its feasibility, stability and wearing property must be considered seriously and resolved successfully.

AS the tread flange has greater total length and longer external tread, when maneuvering tread demolding , if the traditional rack and pinion is applied, problems must occur in designing and manufacturing as its opening distance is too long. So in the mold, hydraulic pressure motor and chain-gear mechanism are selected in demolding agency. Compared with electric motor, hydraulic pressure motor is more steady , lower noise, and stepless speed regulation. And compared with belt drive, chain drive has

nonslipping with good transmitting ratio, small tension, and small load played on axis. Now hydraulic pressure motor and chain-gear mechanism have become a more popularized thread demolding agency.

4.3.1 the Transmission Mechanism^[4] Design

The main chain-gear transmission diagram in the mold is in Fig.4.



z1:tooth number of driving gear z2:tooth number of driven gear
z3:tooth number of driving sprocket z4: tooth number of driven sprocket

Fig.4 chain-gear transmission diagram

(1) The gear parameter design

In the moldbase of tread flange, the center distance between two gearing shafts is 120mm, and the main gear parameters are following:

Diametrical pitch/mm: 2.5

Tooth number: $z_1=28$, $z_2=20$

Pitch circle diameter/mm: $D_1=70$, $D_2=50$

Gear width/mm: $B_1 = 20$, $B_2=30$

(2) Bearing selection

Axis with parts on it is located by bearing and bearing cover in axial and radial directions for the stability.

According to the force loaded on the axis ,the deep groove ball bearing 61805 is selected in the design.

(3) Chain transmission parameter

According to reference^[5], the plastic part enveloping force can be calculated as following: $F=28.1\text{KN}$.

Considering the enveloping force on the core coming from the plastic part, the chain 16B in GB/T 1243-1997 is selected whose tensile load is 60KN and pitch 25.4mm with single row and short pitch.

The parameters of the Sprocket in the mold is designed as: $z_3=54$, $z_4=20$.

(4) The transmission ration calculation

As the total thread's length is 12mm, and thread pitch is 1.5mm, so the thread number can be calculated as 8.

The formular of overall ratio is next:

$$i=(z_2/z_1)(z_4/z_3) \quad 0.26 \quad (1)$$

In the formula, the meanings of z_1, z_2, z_3 and z_4 are shown in Fig.4. It can be illustrated from the formula (1) that in order to pull the thread out of the core

thoroughly the gear must be driven by the hydraulic pressure motor to work at least 32 rounds.

4.3.2 Hydraulic Pressure Motor Selection

Considering the plastic part previous enveloping force , and after composite calculating, the hydraulic pressure motor NmH1-163 is selected ,whose Specifications are next:

Rating torque/ n.m: 225
Wept volume/ ml/r: 64
rated pressure/ mpa :25
rated torque/ n.m: 472
speed range/ r/min: 15-1500
weight/ kg: 20

Besides, in order to protect the thread from being broken, it is better to run the hydraulic pressure motor slowly.

4.4. Separating Mechanism According to Distance and Mold Working Process

Three plates mod is adopted shown in Fig.3, in which the hydraulic pressure motor and chain-gear mechanism are used to realize auto thread demolding. The mold primary working process is as following: at first, after mold being closed and cavity being filled fully, the parting plane I opens and the pin point gate separates from the plastic part under the action of spring 15 ; secondly, with the help of the die locker 16, the parting plane II can be ensured to be opened before the parting plane III, as a result cooling slag of the runner can be get out; finally, under the action of separating mechanism, movable mold can be separated totally from fixed one and then the cooled plastic part will be removed from core in movable side by motor-chain-gear mechanism .

5. the Moldbase Design

Most of injection moldbase have already been standardized. From standardized moldbase loading, sliding-block creating to casting system designing, and from ejecting mechanism to cooling system, all of them could be achieved in standardized moldbase. EMX(Expert Moldbase Extension)4.1 is such a tool ,which is a plug-in belongs to Pro/E and can be used to design standard moldbase parts such as mold plate, sliding block, pin and cooling system and so on. Besides, emulation of mold opening and interference checking can also be realized in EMX 4.1^[6,7].

The moldbase main designing steps in EMX4.1 are as following:

- (1) Assemble the forming parts such as mold core , cavity and sliding block into the moldbase so that EMX4.1 can identify them;
- (2) Definite mold subassembly including moldbase type selection, the mold plate dimension, mold layout, locating ring and sprue bush;
- (3) Design the gating system. The sprue runner, sub-runner and gate can be

- quickly achieved in EMX4.1 using standard runner tool;
- (4) Design sliding block mechanism including outside core-pulling and inner side core-drawing mechanism;
 - (5) Design ejector mechanism. As the hydraulic pressure motor and chain-gear mechanism are used to realize auto thread demolding, ejector mechanism needn't be designed in the tread frange mold;
 - (6) Design cooling system. After cooling waterline has been drawn in the cooled parts, cooling system can be gained automatically using EMX's gating tool.
 - (7) Assemble moldbase. Assemble all the parts achieved previously to the moldbase, shown in Fig.5.

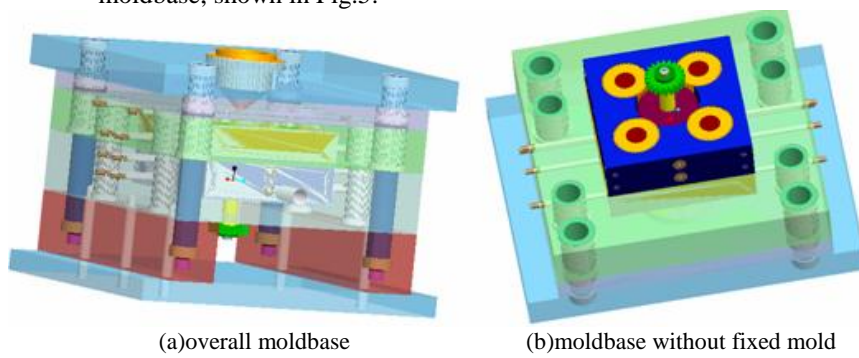


Fig.5 moldbase

6. Conclusions

(1)In the mold, the hydraulic pressure motor and chain-gear mechanism are applied to realize maneuvering thread demolding successfully. Compared with other mechanism, this kind of mechanism can work accurately and stable for demolding, with low noise, good quality and high efficiency.

(2)The CAD technology has been used in the mold and moldbase design by means of Pro/E and EMX4.1, thus the cycle of developing a new part can be shorten rapidly and the mold costs in designing and manufacturing can be reduced greatly.

The maneuvering thread demolding way and CAD technology in the mold designing can be considered as a successful example for other similar mold with tread structure.

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