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Design of Injection Moulding Tool for A Wheel Chair *Shoe Leg*

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A B S T R A C T

This work is about designing a two plate injection mold tool for shoe leg and its design. The required part study was done before the design. The part drawings are rigorously scrutinized to extract the most potential quantity of information. Solid modeling of components was carried out by UG Nx (12.0) and solid works, considering all the crucial dimension parameters. The computations required for the design was achieved by a series of calculations, with correct material choice and also the proper combination of alloys were hand-picked for the producing of mould.

Keywords: Two plate mould, Two cavity, Finger cam actuation, design calculation.

1. Introduction

Plastic may be a chemical compound material that has been an exquisite discovery by mankind. World's first totally artificial plastic was "Bakelite", made up in the year 1907, by Leo Baekeland who termed it as "plastics". This plastic has replaced the previous standard product because of its varied impressive properties like theirs typically low cost, simple to manufacture, abundant, durable, and robust for their weight ratio, electrically and thermally insulating, and proof against shock, corrosion, chemicals and water. As a result, there is an enormous growth for plastic applications that led to ascent and demand of plastic products within the quality necessities of injection moulded parts in society and worldwide market. This work involves the design, analysis, and development of 2 cavity injection moulding tools for shoe leg which is one of the important part of a wheelchair. The element chosen is used within the assembly of the wheelchair. First and foremost, many tests were conducted to see the sort of fabric used, and finally, NYLON-6 was selected and used as it is found to be the best for the functionality requirements for high production and superior quality of the component to be delivered on time.

1.1. Objective

- Study of the component details and understanding the mechanical and physical properties of the moulding materials to check its mouldable condition.
- Providing required amount of shrinkage as per the material specifications while designing using the software.
- Projecting a conceptual design to design the two plate mould.
- Design the rest of the mould parts like top plate, bottom plate, feed system, ejecting system with the proper alignment of the holes.
- Calculation of the required parameters to design the tool.
- Carrying out the mould flow advisor analysis to set injection location, confidence of fill and possible type of gates for the component.

1.2. Statement of the problem

- The component had hallowed features on either side which could not be taken care by true matching of core and cavity. Hence, to achieve that a side core was considered for filling that particular hallow portion to get the desired component.

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- Proper calculation is essential to carry out the design and development of the mould.

1.3. Scope of the project

- Design, development, and analysis of a two plate, two cavity injection molding tool for shoe leg/ washer used in wheel chair.
- Tracing the effects of parameters by liability simulations.
- Adjusting the parameters.
- Calculating the design parameters.
- Nylon-6 (polyamide) was chosen as the component's substance and the component was designed to work in a moderately stressful environment.
- Machine used is Nikitha NPM 160 for production.

2. Methodology

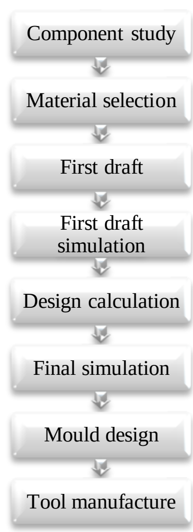

Fig.1 Flow chart of methodology

3. Component study

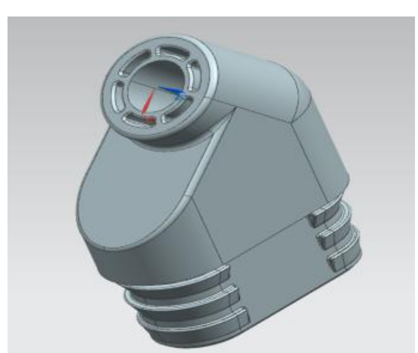

Fig.2 Shoe leg 3D mode

This component is used in the assembly of an office chair where it provides the connection between the wheel and the chair structure. This component requires two side cores for the profile it has. Necessary drafting must be provided to eject the component out, also shrinkage value must be provided alongside that based on the shrinkage factor.

Table1: Component details

Component name	SHOE LEG
Material	Nylon 6
Component Volume	40.760 cm^3
Density	1.14 gm/cm^3
Type of gate	Eedge gate
Number of cavity	2
Runner system	Cold runner system
Ejection system	Pin ejection (2 no. /component)
Shrinkage	0.8-1.5%
Melting temperature	268°C
Wall thickness	3.7mm

4. Design calculation

4.1 Shot weight (S_w)

Weight of the component (wt) = Density of the material x Volume of the component.

w = 1.084 x 41.80

w = 45.31 gm

The component weight is greater than 20 grams. Hence, the multiplication factor is taken as 1.05 as per design standards

Then,

Shot weight of the component (S_w) = Weight of the component x Multiplication Factor x no. of cavities

S_w = 45.31 x 2x 1.05

S_w = 95.15 gm

4.2 Clamping force

Clamping Force (C.F) = Projected area of the component x 1/2 Injection pressure x number of cavities

$= 30.56 \times [\frac{1}{2} \times 15000]$

= 22,950 kg

C.F = 22.950 t/cavity

For two cavities (n)

C.F = 22.950x 2

C.F = 45.9 ≈46 t

Available machine is NPM 160, CF is 46 t, and hence design is safe.

4.3 Shot capacity

Shot capacity (gm) = Swept volume x Density of material x Constant

Where,

Swept volume = 391 cc

Density of material = 1.084 gm/cc

C = 0.35(crystalline material)

Shot capacity = 391x 1.084 x 0.35 = 148.34 gm

Shot capacity of machine is 148.34 gm

Since shot capacity of the machine (148.34gm) is greater than shot weight of the component (95.15gm). Hence the design is safe

4.4 Plasticizing rate

Plasticizing rate = Plasticizing rate with PS x $\frac{Q\,(PS)}{Q(\text{Nylon } 6)}$

Plasticizing rate (Pc) = 16.6 x $\frac{57}{130}$= 7.27 gm/s.

4.5 Determination of number of cavities

$Ns = 0.85 \times \frac{\text{Shot capacity of the machine}}{\text{Shot weight of the component}}$

$Ns = 0.85 \text{ x } \frac{148.34}{95.15} = 1.55$

$Ns = 1.55 \approx 2$cavities

Hence the mould can be designed to two cavities.

4.6 Working length of finger cam pin

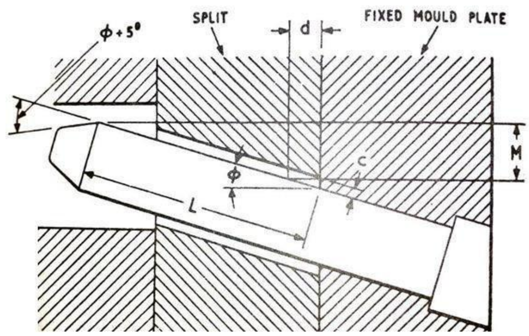

Fig.3 Cam length calculation

$L1 = \frac{M}{\sin\emptyset} + \frac{2c}{\sin 2\emptyset}$

Where,

m = movement of splits to eject the component positively = 37 mm.

$\emptyset$ = finger cam angle = 25°

c = clearance between the finger cam and hole in the splits =0.5 mm/side

$L_1 = \frac{37}{\sin(25)} + \frac{2(0.5)}{\sin 2(25)} = 88.73 \approx 90$

$L_1 = 90$ mm

$L2 = \frac{M}{\sin\emptyset} + \frac{2c}{\sin 2\emptyset}$

Where,

m = movement of splits to eject the component positively = 40 mm.

$\emptyset$ = finger cam angle = 120°

c = clearance between the finger cam and hole in the splits = 0.5 mm/side

$L_2 = \frac{40}{\sin(120)} + \frac{2(0.5)}{\sin 2(120)}$

$L_2 = 46.76$ mm

Since it is two cavities and has two side cores, to actuate it at regular intervals we have two cam rods with different lengths for proper actuation.

4.7 Runner design

Diameter of runner $= \frac{\sqrt[4]{L} \text{ x } \sqrt{w}}{3.7}$

Where,

w = weight of the component in gm = 45.31gm

L = 8.5 mm

Diameter of runner($\emptyset$) $= \frac{\sqrt[4]{8.5} \text{ x } \sqrt{45.31}}{3.7}$

Diameter of runner($\emptyset$) = 3.1 mm

4.8 Gate design

Gate width

Width of the gate (Wg) is calculated by:

Wg = $\frac{n \times \sqrt{A}}{30}$

Where n is the material constant, for Nylon n = 0.8

Wg = $\frac{0.8 \times \sqrt{15136.05}}{30}$

Wg = 3.28 mm

Gate height (h)

h = n x t

Where, n = 0.8

t = Avg. wall thickness = 3.6 mm

h = 0.8 x 3.6

h = 2.88 mm

Gate length (l)

L = h + (Wg/2)

= 2.88 + (3.28/2)

L= 4.52 mm

4.9 Design of guide pillars& guide bush

Diameter of guide pillar = $4+0.06\sqrt{(axb)}$

Where,

a = length of core plate = 300 mm

b = breadth of core plate = 250 mm

$d_{gp} = 4+0.06\sqrt{(300 \text{ x } 250)}$ = 20.43≈21 mm

d_{gp} = 21 mm

For convenience of fabrication and installation, a 21 mm diameter guiding pillar was used.

Collar Diameter of guide pillar = diameter of guide pillar + [2×t (thickness assumed as 2 mm)]

= 21 + (2×2) = 25 mm

Guide bush

Internal Diameter = 21 mm (diameter of pillar)

Outer Diameter = 21 + (2 X thickness)= 21+ (2 X 4)

Outer Diameter of guide bush = 29 mm

Collar diameter of guide bush= Outer Diameter of guide bush + (2 X thickness)= 29+ (2 X 6)

Collar diameter of guide bush = 41 mm

4.10 Mould cooling

Heat to be transferred from mould per hour (Q)

Q = n x m x Q_{Nyl}

Where,

Q=Heat to be transferred per hour (cal/hr)

m =Mass of the plastic material injected into the mould per shot (gm) = 95.15 gm

n = number of shots per hour (42shots/hr)

Q_{Nyl} = Heat content of plastic material, for Nylon 6=130 cal/gm

Q = 42x95.15 x 130

Q = 519519 cal/hr

It is found in practice, that approximately 50% of total heat input is carried out by the water-cooling systems in moulds. Hence the amount of heat removed by cooling water is,

Q = 0.5 x Q

= 0.5 x519519

Q = 259759.5 cal/hr

Weight of water to be circulated

$$M = \frac{Q}{S \times (Tol - Til) \times K}$$

M = Mass of the water to be circulated (kg/hr)

Q= heat to be removed from die (cal/hr)= 259759.5 cal/hr

S = specific heat of water (1kJ/kg^{0}C)

K = 0.65 (direct cooling) constant

(Tol – Til) = difference between outlet & inlet of water= 5 °C(assuming)

$$= \frac{259759.5}{1000 \times 5 \times 0.65} = 80 \text{ kg/hr} = 1.85 \cong 2 \text{ L/min}$$

5. Discussion

From the above design calculations following details are assumed for manufacturing the tool:

- Total weight of single component with feed system is 45.31 gm.
- Minimum machine tonnage required is 46 t, any machine having more than that can be used here.
- Total Weight of material required per hour is 7.27gm/s and machine plasticizing capacity for PA is 16.6 gm/s, hence machine selection is safe.
- Shot capacity of the machine (148.34 gm) is greater than shot weight of the component (95.15 gm). Hence the design is safe and the Component can be carried out without any restrictions.
- Based on shot capacity, clamping tonnage and plasticizing capacity number of cavities are selected as two.
- Amount of water circulated per hour to dissipate heat is 2 l/min.

References

Neeraj Kumar Jha and P. V. Ramana "*Design Methodology and Analysis of Double Cavity Metal-Plastic-Insert Injection Molding Die for Push Board Pin*" ISSN 2277 – 3916 CVR Journal of Science and Technology, Volume 14, June 2018.

P D Kale,P D Darade and A R Sahu "*A literature review on injection moulding process based on runner system and process variables*" iCADMA 2020 IOP Conf. Series: Materials Science and Engineering 1017 (2021) 012031 IOP Publishing doi:10.1088/1757-899X/1017/1/01203.

Juan M. Jauregui-Beckera, Guido Tosellob, Fred J.A.M. van Houtena, Hans N. Hansenb "*Performance evaluation of a software engineering tool for automated design of cooling systems in injection moulding*" Procedia CIRP 7 (2013) 270 – 275 Forty Sixth CIRP Conference on Manufacturing Systems 2013.

Kiran Tom Thomas and Ramesh Babu K1"*conceptual design of two plate injection mould tool for five pin daimler regulator*" ISSN 2278 – 0149 www.ijmerr.com Vol. 3, No. 4, October 2014.

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