MULTI CAVITY INJECTION MOULD DESIGN

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ABSTRACT

Tool Design is the process of designing and developing the tools, methods and techniques necessary to improve manufacturing efficiency and productivity. It gives industry the machine and special tooling needed for today high speed, high volume production. It does this at a level of quality and economy that will ensure that the cost of the product is competitive. Since no single tool or process can serve all the forms of manufacturing, tool designs an ever changing, growing process of creative problem solving. The plastics industry is one of the fastest growing major industries in the world. Every year there is an increase in the amount of plastics used in all types of products. These are emerging both as product innovations and as existing products converted from materials to plastics for competitive and economic advantage. These plastic components can be made by various molding processes, the process to be employed and the material to be used for the purpose entirely depends on the application of the component. Plastics did not enter our lives with the fanfare of other revolutionary inventions, but more by the process of infiltration. Plastic being the synthetic materials where at first considered to be cheap substitute for them better known and more expensive materials.We are now going to design an electrical plastic component, with its complete designing aspect, manufacturing aspect and assembling aspect. The detailed study of mold and its various parts and functions with its importance.

INTRODUCTION

Tool Design is the process of designing and developing the tools, methods and techniques necessary to improve manufacturing efficiency and productivity. It gives industry the machine and special tooling needed for today high speed, high volume production. It does this at a level of quality and economy that will ensure that the cost of the product is competitive. Since no single tool or process can serve all the forms of manufacturing, tool designs an ever changing, growing process of creative problem solving.Plastics did not enter our lives with the fanfare of other revolutionary inventions, but more by the process of infiltration. Plastic being the synthetic materials where at first considered to be cheap substitute for them better known and more expensive materials.

Plastic articles are not only replacing wood, metal and other materials but because of their particular qualities. They function better than other materials for specific process. Through the years plastics have curved the right as material themselves and not as substitute for their materials. Not only are plastics more useful, adaptable and practical than the material. They have supplemented, but uses of plastics have been found for which no other material can be used.For thermo setting the two main methods used are compression moulding and transfer moulding. In this process the thermosetting materials in powder form or pellet form is kept inside the mould and is

subjected to heat pressure. The powder melts and gets the shape of mould and get curved. Then the mould is opened and the component is ejected.Plastic is a synthetic polymer of high molecular weight. It is composed of repeating organic chemical units. Polymer is a single large molecule. It I formed as a result of the union of two or more molecules of the simpler substances.

LITERATURE SURVEY

MATERIAL SELECTION

Bill of Materials contains information regarding size of various parts as well as Various materials used for manufacturing the part. In injection mould as can be observed in Bill of Materials following materials are used due to their specific properties which are required for the long life of the tool considering the cost aspect.

M.S.:-These steels have intermediates properties to those of low carbon and high carbon steels. These steels have medium hard, not so ductile and malleable.

C%	Mn%	Si%	S%	P%	Cr%	Ni%	Mo%
0.25	0.6-0.9	0.1-0.35	0.055	0.55	0.2-0.35	-	-

EN – 31:-

C %	Mn	Si	Cr	P	S
0.9-1.2	0.3-0.75	0.1-0.35	1.0-1.6	0.05MAX	0.05MAX

These steel is plan carbon steel. This is Indian standard designation

This is mild steel having carbon of 0.40-0.50%

EN – 8:-

This steel comes under the category of Medium Carbon Steel. As Carbon percentage is less hardenability of this steel is less and hardness that can be achieved is maximum 40 – 45 HRC

C %	Mn	Si	P	S
0.3-0.45	0.6-1.0	0.05-0.35	0.05MAX	0.05MAX

OHNS:-

C %	Mn
0.90	1.60

This steel is readily available and is of low cost. Its dimensional stability as well as wear resistance is fair. Also it has good machinability. So generally it is used for making Rest button in mould.Austenitising Temperature ranges from 760 – 800 °C.Tempering temperature ranges from 200 – 220 °C. Quenching Medium:- Oil.

STAVAX :-

This is Plastic Mould Steels.These steels having excellent polishability these steels having wear resistance. Through hardening stainless steel with excellent polishability and wear resistanceHardening temperature - 1010-1050 0c .Soft anneal-890 0c.Quenching medium-oil, gas.

THEORETICAL DESIGN AND ANALYSIS

DESIGN INPUTS

Customer gives information to the marketing department regarding their requirement. Before starting the design activities following things should be make clear with the customer.

The **component related input** from the customer may be in the form of

2D Component Drawing

3D Component Model

Existing Sample of Component

The **Tool related input** from the customer may be in the form of

Type of Mould / Die

No. of Cavities

Production Rate

The **Material related input** from the customer may be in the form of

Component Material

Shrinkage

Component weight

Die Set Material

Core/Cavity Material

Aesthetic & FunctionalRequirements of Component that should be discussed with the customer are as follows

Type of gate

Location of gate

Parting Line Constraints

Ejection mark constraints

Other inputs required from the customer are as follows

Reference Information

Standard Parts

Side Core Actuation Method

Machine Specification

DESIGN PLANNING:

- Material used for the component, its applications.
- Shrinkage of the material.
- Calculate the weight of the component.
- Study the detail of the component.
- Type of mould required for the component to be produced.
- Machine available for the component.
- Injection pressure required.
- Type of runner system & gate required.
- Type of ejection system weather blade, stripper etc.
- Split and side core consideration if the component is having any groove or notch on its sides.
- Cycle time required for the component for complete fill.
- Effective cooling in a short duration is necessary.
- Cooling channels must be lick proof.
- Selection of the material for core & cavity.
- Adding of shrinkage to core & cavity dimensions.
- Parts in the assembly must not foul with each other in operation.
- The layout of the tool must not be oversized.

MOULD CALCULATION

A) Weight Calculations :-

Weight of Component = Volume X Density

= 7.115 X 1.14

= 8.11 gram.

B) Shot capacity:-

The screw type machine is normally rated in terms of "Swept Volume" of the injection cylinder (Cu. Cms).

Machine Available is SP 80. For SP 80 Swept Volume is 100 cm3

Shot capacity (g) = Swept Vol. (Cm3) x p x C

p = Density of plastic at normal temperature (g/cm3)

C = 0.95 for amorphous materials
Shot capacity (g) = 100 X 1.14 X 0.95

= **108.3 grams**

C) Plasticising capacity:

Plasticizing rate of material B (g/hr) = plasticizing rate of

material A (g/hr) x QA/QB

A = Nylon66

B = Nylon (Material actually to be used)

Q = Thermal capacity of the material (cal/g) (Heat content)

QA = 239.4 KJ/Kg

QB = 567 KJ/Kg

Machine Available is SP 80, Plasticizing rate = 4.7 g/S

Plasticizing rate of material B (g/hr)= 4.7 X (3600/1000) X (239.4/567)

P_B= 19.844 Kg/hr

D) Locking Force Calculations:-

The clamping force required to keep the mould closed during injection must exceed the force given by the productof the opening pressure in the cavity andthe totalprojected area of all impressions and runners. Lower clamping values can be used with screw presses owing to the lower injection pressures possible with these machines.

Thin sections need a high injection pressure to fill and therefore require more clamping force. Easy flowing materials like high melt index polyethylene and polystyrene fill more readily and hence require a lower clamping force. In the case of screw injection 2/3 to 1/2 times of injection Pressure should be taken for Clamping purposes. Max. Injection pressure may be obtained from press manufacture's data sheet.

(A) Projected Area of the component = 2500 mm□

(E) Total Projected Area =5200 mm□

(F) Clamping Force = {Total Projected Area X 1/2 Injection pressure)
= 520 X 0.5 X 1500

= 39.75 Tons

(G) Locking Force= 1.2 X clamping force

(20% safety)

= 19.87 Tons

E)Determination of number of Cavities:

The number of cavities in injection moulds is determined in most cases by the machine performance, but some times by the

moulding shape or the mould locking pressure.

1)Determined by Shot Capacity:

(Based on 85% of rated shot capacity)

$$Ns = \frac{0.85W}{m}$$

Ns = No. of cavities based on shot capacity

W = Rated shot capacity for particular polymer (g)

m = Moulding weight per cavity(g)

Ns = 0.85 X 108.3 / 10

= **9 cavity**

2)Determined by plasticizing capacity:

(Based on 85% of rated plasticizing capacity)

$$Np = \frac{0.85P / T_C}{3600\,m}$$

Np = No. of cavities based on plasticizing capacity.
P = Rated plasticizing capacity for particular polymer (g/hr)
Tc = Over all cycle time (Sec.) = 4 seconds

Np = (0.85P X Tc) / 3600m

Np = (0.85 X 19.84 X 1000 X 30)/ (3600 X 10)

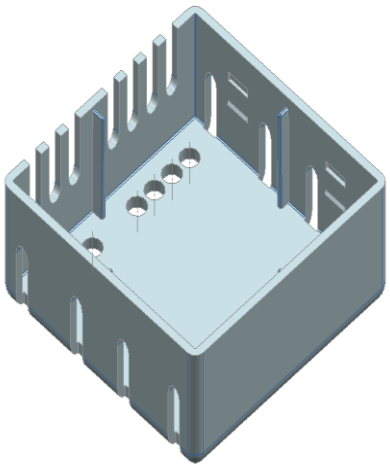
= **14cavity**

Total cost of the tool

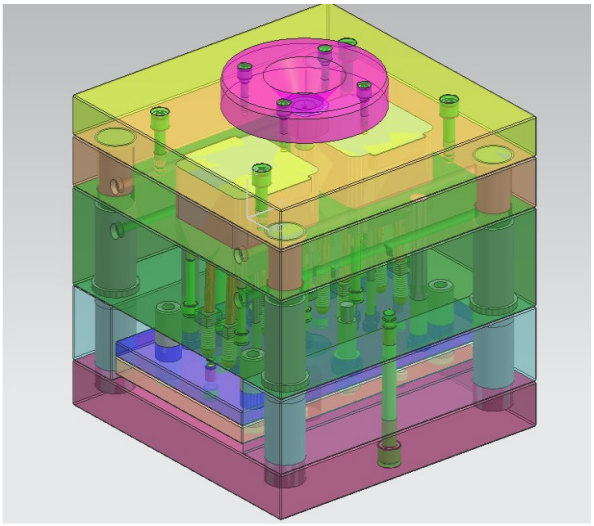
Parameter	Cost (Rs)
Total designing cost	Rs45000/-
Total raw material cost	Rs14000/-
Total premachining cost	Rs22750/-
Total precision cost	Rs71500/-
Total heat treatment cost	Rs5600/-
Total fitting assembly cost	Rs8540/-
Total inspection cost	Rs7250/-
Total Cost	Rs174640/-
Packing charges (4%)	Rs7830/-
VAT (12%)	Rs23490/-
Margin (15%)	Rs23362/-
Total cost of tool	**Rs229322/-**

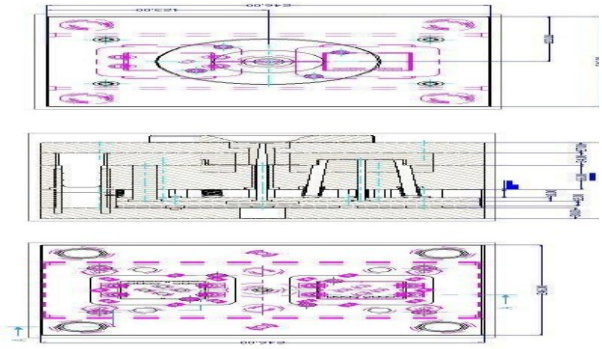
DESIGN DRAWING AND DETAILS

COMPONENT DRAWING

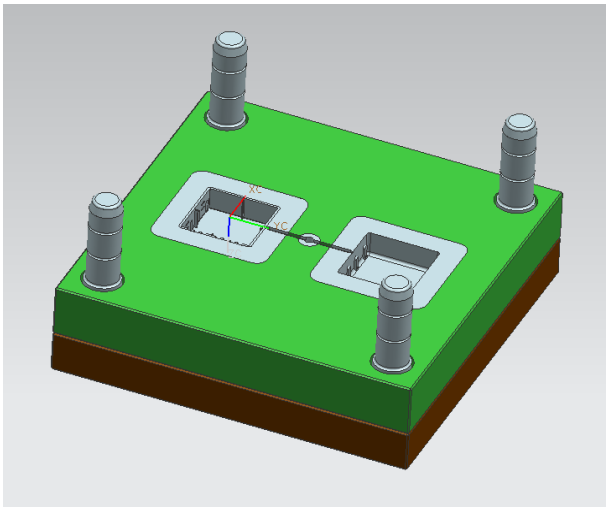


ASSEMBLY





FIXED HALF



MOVING HALF

SUMMARY

Part Name:	Panel housing
Part Revision:	1
Material Supplier:	Generic Shrinkage Characterised Material
Material Grade:	Generic PA66 (Leona)
Max Injection Pressure:	180.00 MPa
Mold Temperature:	60.00 deg.C
Melt Temperature:	295.00 deg.C
Model Suitability:	Part model was highly suitable for analysis.
Filling Analysis	sss_adv
Moldability:	Your part can be easily filled with acceptable quality using the current injection locations.
Confidence:	High
Injection Time:	0.31 sec
Injection Pressure:	23.88 MPa
Weld Lines:	Yes
Air Traps:	Yes
Shot Volume :	7.09 cu.cm
Filling Clamp Force:	2.41 tonne
Packing Clamp Force Estimate	(4.78)MPa 1.18 tonne

@20%:	
Packing Clamp Force Estimate @80%:	(19.11)MPa 4.71 tonne
Packing Clamp Force Estimate @120%:	(28.66)MPa 7.07 tonne
Clamp Force Area:	24.18 sq.cm
Cycle Time:	6.81 sec

Cooling Quality	sss_adv
Cooling Quality:	Your part will have large problems cooling and may cause problems with ejection.
SurfaceTemperatureVarianceRange	-5.06 deg.C to 2.86 deg.C
FreezeTimeVarianceRange	-1.71 sec to 0.11 sec

Sink Mark Analysis	sss_adv

RESULT

A complete mould designer must have a through knowledge of the principles of the mould making as the design of the various parts of the mold depends on the technique adopted for its manufacturer. Case studies of the various moulds of same kind have been conducted prior to the design process. Proper evaluation of the previous designs were performed and created something even better instead of simply keeping to what was done previously. The various demands of the customer were considered while designing of the tool. The final mould design is prepared after the part design has been specified and all requirements affecting the design of mould have been clarified. The outcome is a near perfect design and the trail made on the mould just about confirms it.

REFERENCES

In studying & designing of this MOULD I have get lot of knowledge from following books.

SR.NO.	NAME OF BOOK	AUTHORS
1.	INJECTION MOULD DESIGN	R.G.W.PYE
2.	MOULD DESIGN	IGTR,AURANGABAD
3.	METALLURGY	KODGIRE
4.	GD&T	RAO
5.	DESIGN DATA BOOK	CIPET