ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Design and Analysis of Water Flow Stopper and Fabrication of Plastic Injection Mould Die

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ABSTRACT

Die Design requires thorough understanding of the subject and good perception of the possible difficulties or hindrance during the die manufacturing and operation. Since moulds have been expensive to manufacture, they were usually used in Mass Production where thousands of parts were being produced, and non-standard parts are avoided to the maximum extent and care is taken to include design considerations for safer operation.

The Project presents the Design, Analysis and Fabrication of a Single Cavity Injection Mould Die for the component "Water Flow Stopper". The Component and the Die (core and cavity) were designed in PTC CREO PARAMETRIC 3.0 software and the Mold Die is fabricated with EN 31 (steel of hardness measurement of 63HRC) material and profile of the component is machined On Mold Die by CNC milling operation. A Nickel coating is used on the Die to minimize the Corrosion effect.

The designed Single cavity Mold Die is fabricated and trial was done successfully. The components produced by using this single cavity mould Die were found to be of acceptable quality. The design is economical and flexible.

INTRODUCTION

ABOUT INJECTION MOULDING

It is hard to imagine present day human life without the use of plastics products. The products that we use or buy, day to day, many contain plastics. For small connectors to heavy automobile parts, from kitchen wear to party wear, plastics are being used everywhere. Major advantage of using plastics includes formality consolidation of parts and providing low cost to performance ratio. Knowledge of all processing methods including their capabilities and limitation are useful to process or in deciding whether a given part can be fabricated by extrusion, injection molding, blow molding, rotational molding and compression molding. So far one of the most used processes for plastics is injection molding.

THEORY OF INJECTION MOULDING

Injection moulding is the most widely used polymeric fabrication process. It evolved from metal die casting, however, unlike molten metals, polymer melts have a high viscosity and cannot simply be poured into a mould. So, a large force must be used to inject the polymer into the hollow mould cavity. More melt must also be packed into the mould during solidification to avoid shrinkage in the mould. The injection moulding process is primarily a sequential operation that results in the transformation of plastic pellets into a moulded part. Identical parts are produced through a cyclic process involving the melting of a pellet or powder resin followed by the injection of the polymer melt into the hollow mould cavity under high pressure.

Injection molding is a manufacturing process for producing parts by injecting material into a mold. Injection molding can be performed with a host of materials, including metals, glasses, elastomers, confections, and most commonly thermoplastic and thermosetting polymers. Material for the part is fed into a heated barrel, mixed, and forced into a mold cavity, where it cools and hardens to the configuration

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of the cavity. After a product is designed, usually by an industrial designer or an engineer, molds are made by a mold maker (or toolmaker) from metal, usually either steel or aluminium, and precision-machined to form the features of the desired part.

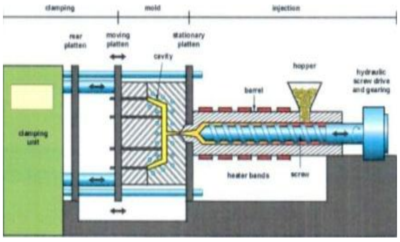

Fig.2.1.1: Injection Moulding

CALCULATIONS

MOLD WEIGHT CALCULATION

Weight = h*I*w*7.850(density) kg

Where,

h = height of Mould = 73mm

I = Length of Mould = 75 mm

w = Width of Mould = 73 mm

Weight = 68 *65 *55 * 7.85 kg

= 3.554Kg

CREATING COMPONENT

Creating component by using Part Module:

Creating the actual component by using PTC CREO PARAMETRIC 3.0 software

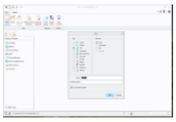

Fig.5.1.1:- Opening the part module

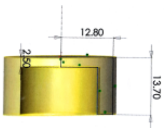

Fig.5.1.2: Revolve command using the sketch

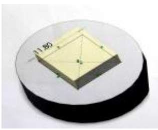

Fig.5.1.3: Extruded part of the model

Fig.5.1.4: Construction of threads by using helical sweep

Fig.5.1.5: Extrude cut of the inner hole

Fig.5.1.6: Final Component

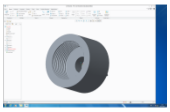

Fig: 5.1.7 Final Component

CREATING THE DIE IN PART MODULE AND ASSEMBLING

6.1 Creating Bottom Plate:

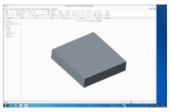

Fig.6.1.1: Bottom Plate

6.2 Creating Base Plate

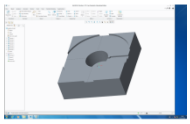

Fig.6.2.1: Base Plate

6.3 Creating Ejector Plate:

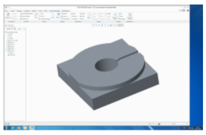

Fig.6.3.1: Ejector Plate

6.4 Creating Side Core

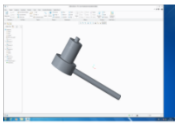

Fig.6.4.1: Creating Side Core

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6.5 Exploded View:

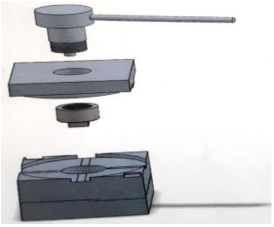

Fig.6.5.1 Exploded View

6.6 Full Assembly View:

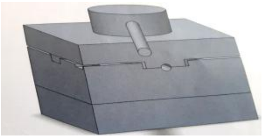

Fig.6.6.1 Full Assembly View

DIE CREATED PRACTICALLY

7.1 CAVITY:

The cavity which is in the female portion of the mould gives the moulding its external perform.
Cavity will be in fixed half

Fig.7.1.1 Cavity Plate

7.2 EJECTOR PLATE:-

Ejector plate is used to eject the product after the completion of moulding process. It is likely used at moving side of the mould.

Fig.7.2.1 Ejector Plate

7.3 SIDE CORE:

The core which is the male part of the mould form the internal shape of the moulding impression. When colour cools it will shrink on the core and remain with it as the mould opens, Core is incorporated in the moving half.

Fig.7.3.1 Side Core

7.4 FULL ASSEMBLY

Fig.7.4.1 Fully assembled

8.1.1 INTRODUCTION TO ANSYS WORKBENCH:-

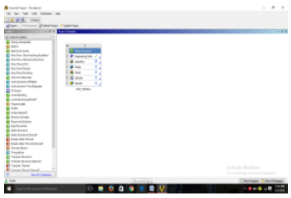

Fig: 8.1.1.a Initial screen appearance of Workbench

ANALYSIS OF WATER FLOW STOPPER IN ANSYS:

The above model (component) is converted into IGES format and imported to ANSYS Workbench. The die assembly is analyzed in ANSYS. The deformation and stresses are found out.

Parameter Used:

Young's modulus of steel (E) $=2.1*10^{11}$ N/m^2
Poisson ratio of steel = 0.3

FULL SOLID MODEL

8.2 Part imported in Ansys Workbench:

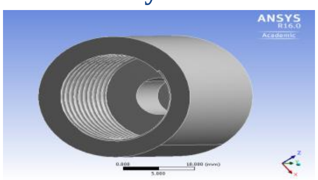

Fig.8.2.1.Imported view

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8.3 TOTAL DEFORMATION

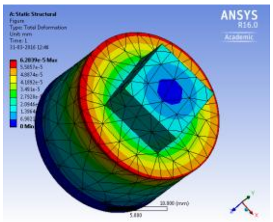

Fig.8.3.1.Total deformation

Result:-
Total Deformation = 6.2839e-5 mm

8.4 SHEAR STRESS:

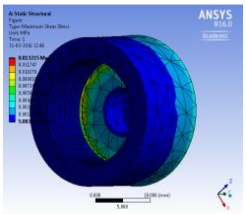

Fig.8.4.1.Max shear stress

Result: -
Max. Shear Stress = 0.013215 pa
Min. Shear Stress = 5.0831e-7 pa

8.5 EQUIVALENT STRESS

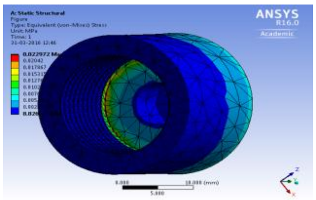

Fig.8.5.1 Equivalent Stress

Result: -
Max. Equivalent Stress = 0.022972 pa
Min. Equivalent Stress = 8.826e-7 pa

8.6 MAXIMUM PRINCIPAL STRESS

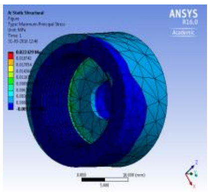

Fig.8.6.1 Maximum Principal Stress

Result: -
Max. Principal Stress = 0.022429 pa

8.7 MINIMUM PRINCIPAL STRESS

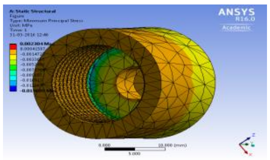

Fig.8.7.1 Minimum Principal Stress

Result: -
Min. Principal Stress = 0.002304 pa

8.8 Material Information

POLYETHYLENE

I) Density = 950 kg/m^3
2) Coefficient of thermal expansion = 2.3$e^{-0.04}$
3) Specific heat = 296J$Kg^{-1}C^{-1}$
4) Thermal conductivity = 0.28 $Wm^{-1}C^{-1}$
5) Young's modulus = 1.1$e^{+0.09}$
6) Poisson ratio = 0.42
7) Bulk modulus = 2.2$e^{+0.09}$
8) Shear modulus = 3.87$e^{+0.08}$
9) Ultimate tensile strength = 3.3e + 0.07 pa
I0) Reference temperature = 22 c
11) Pressure applied = 10 p

CONCLUSIONS

The designed single cavity mould die is fabricated and trial was done successfully.
The components produced by using this single cavity mould die were found to be of acceptable quality.
The design is economical and flexible.
It is semi-automatic hand operated mould (Hand

Mould).
The Total weight of the mould is 3.55 kg.
The total shot weight injected in the die is 5.75 gms.

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