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Design and Manufacture Plastic Injection Moulding Machine for Household and Small Scale Industries

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Abstract

Development of small injection moulding machine for forming small plastic articles in small-scale industries was studied. This work which entailed design, construction and test small injection moulding machine that was capable of forming small plastic articles by injecting molten resins into a closed, cooled mould, where it solidifies to give the desired products was developed. The machine was designed and constructed to work as a prototype for producing very small plastic components.

Keywords—Plastic, Design, Mould.

I. INTRODUCTION

In today's scenario recycling / recovery / management of plastic solid waste is a matter of concern. Industries are getting more interested in the field of plastic manufacturing; so, plastics have become a crucial part of lifestyle, and the global plastic production has increased immensely during the past 50 years. Uses of plastic day to day life drastically increased. Plastic do not dispose properly hence increase waste generation. Thermoplastic like LDPE, HDPE, PVC, PP, PS have certain recycle properties so it can be used for recycle plastic waste. Thermosetting Plastic are Epoxy, Bakelite, Urea formaldehyde does not have recycle property due to thermal degradation of plastic. Recycled plastic is highly used in manufacturing industries for the preparation of products. Using recycled materials is better choice for cost reduction in manufacturing industries and also helpful in reducing waste [1].

Injection moulding is the most commonly used manufacturing process for the fabrication of the parts. A wide variety of products are manufactured using injection moulding, which vary greatly in their size, complexity, and application. The injection moulding process requires the use of an injection moulding machine, raw plastic material and a mould. The plastic is melted in the injection moulding machine and then injected into the mould, where it cools and solidifies into the final part.

To design plastic components three types of designers typically interact in the development of product. Industrial designers and experts in ergonomics and aesthetics, develop quality that directly interact with the customer and provide overall form. Mechanical engineers develop the components that make up the product. Production engineer add and modify features necessary for component manufacture. The design of products requires engineers to be knowledgeable about basic quality. The processing condition relates the quality and processing parameters. Injection moulding is major net shape processes for thermoplastic polymers [2].

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The injection moulding process is primarily a sequential operation that results in the transformation of plastic pellets into a moulded part. To get polymetric components the injection of polymer melt into the hollow cavity under the high pressure produces polymetric components. Many researchers have been carried out to improve the process of injection moulding based on theoretical data. Computerbased simulation models and experimental trials. The design concept and preliminary test of the prototype were discussed and validated in terms of its performance [3].

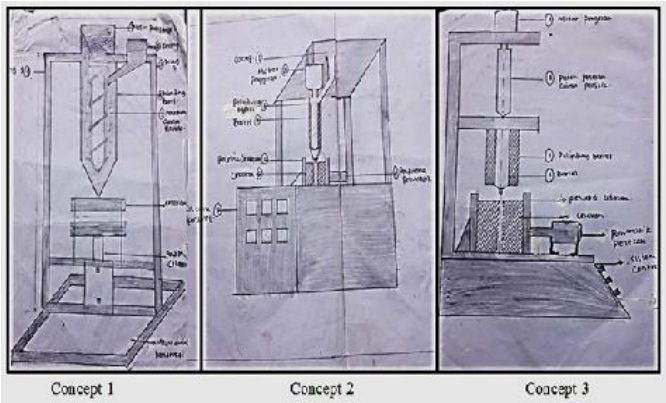
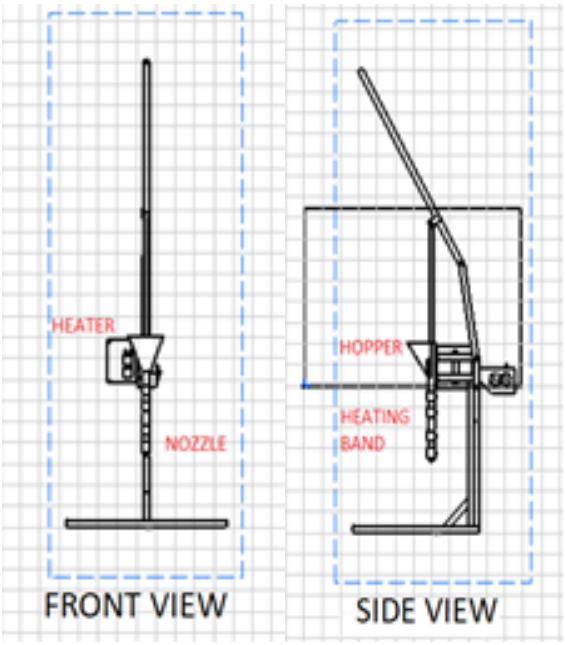


Fig. 1 Existing Machine Models

Manually operated plastic injection moulding machines are cheaper than the hydraulic machine. It is useful in small scale industries and household. The process is, material is fed into a heated barrel from the hopper, mixed and forced into a mould cavity where it cools and hardens to the configuration of the mould cavity, the features of the desired part such as simple components to complex components. Injection Moulding Process in Small Scale Industries level is becoming greater importance for the manufacturing of polymeric components in small size [4].



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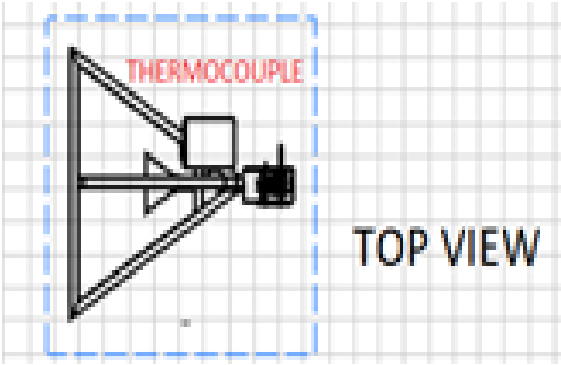

Fig. 1 CAD Model of Injection Moulding Machine

II. DESCRIPTION

The manually operated injection moulding machine is made using various components. The components are Heater, Plunger, Mould cavity, Injector, Frame, Hopper, Mounting table, Angle Plates, Barrel. The handle is used for up and down motion of the plunger which injects the plastic material into the barrel. The heating band is provided on injector and used for melting the plastic granules poured from the hopper. The plastic melts at 160-210 ° C.

III. DESIGN OF COMPONENTS

A. Design of Frame:

Frame design for safety FOR 25*25*3 L angle mild steel channel

b = 25 mm, d= 25 mm, t = 3 mm.

Consider the maximum load on the frame to be 50 kg.

Max. Bending moment

= force*perpendicular distance

= 50*9.81*450

M = 220725 N-mm.

We know,

M / I = σb / y

M = Bending moment

I = Moment of Inertia about axis of bending that is; *Ixx*

y = Distance of the layer at which the bending stress is consider

(We always take the maximum value of *y*, that is, distance of extreme fiber from N.A.)

E = Modulus of elasticity of beam material.

I = bd^3 /12

= 25*25^3 / 12

I = 32552.08 mm^4.

σb = My / I

= 220725*12.5 / 32552.08

σb = 84.76 N /mm^2

The allowable shear stress for material is σ allow = Syt / fos

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Where Syt = yield stress = 210 MPa
= 210 N/mm^2
And F.O.S. is factor of safety = 2
So σ allow= 210/2 = 105 MPa
= 105 N/mm^2
Comparing above we get,

σb<σallowi.e. 84.76 < 105 N/mm^2

So, design is safe.

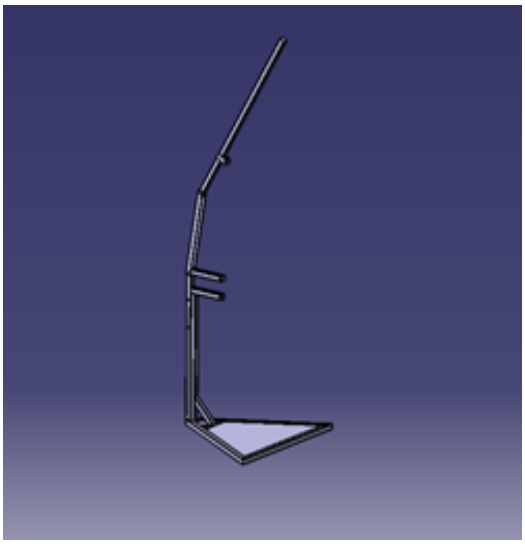

Fig. 3CAD Model of Frame

B. Heater:

Mass flow rate m=density*discharge
= 1.14*1000*2.56*10^-5
= 0.02918 kg/sec
Total Heat energy required = m*Cp*(T1 - T2)
Where,
T1= Heater temp.
T2= chamber inner temp.
Cp= specific heat of plastic
PA 6= 1.7 KJ/Kg.K.
Q= 0.02918*1.7*1000*(223-23)
=9.92KW.
Heater available in different width Heater band width=L= 80mm.
Selected material for chamber as mild steel Thermal conductivity of mild steel =43 w/mk.

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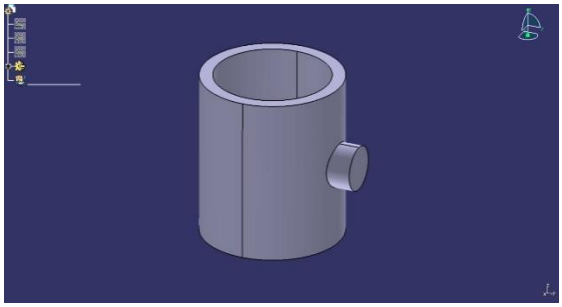

Fig.4CAD Model of Heater

C. Design of Shaft:

Generally hand can lift 25kg =250 N

$$\tau = \frac{16T}{\pi d^3}$$

$$\therefore T = \frac{\pi \tau d^3}{16}$$

$$\therefore force \times dis\tan ce = \frac{\pi \tau d^3}{16}$$

$$\therefore 250 \times 250 = \frac{\pi \times 41 \times d^3}{16}$$

$$\therefore d = 20mm$$

So, the diameter of shaft is 20 m.

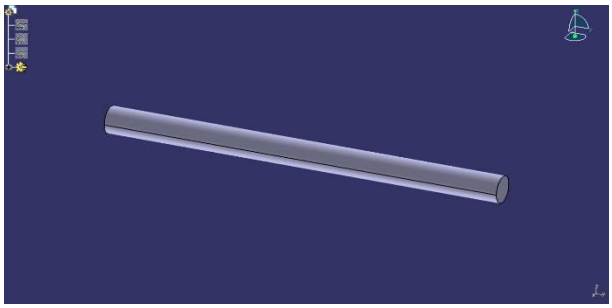

Fig.5 CAD Model of Shaft

D. Welded Joint:

Checking the strength of the welded joints for safety

The transverse fillet weld welds the side plate and the edge stiffness plates,

The maximum load which the plate can carry for transverse fillet weld is,

P = 0.707 x S x L x ft

Where,

S =thickness

L = contact length = 25mm

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The load of shear along with the friction is 50 kg = 500N.
Hence, 500 = 0.707 x 3 x 25 x ft
Hence let us find the safe value of 'ft'

$$\text{Therefore ft} = \frac{500}{0.707 \times 3 \times 35}$$

ft = 6.73536 N/mm^2.

Since, the calculated value of the tensile load is very smaller than the permissible value as ft=56 N/mm2.
Hence, welded joint is safe.

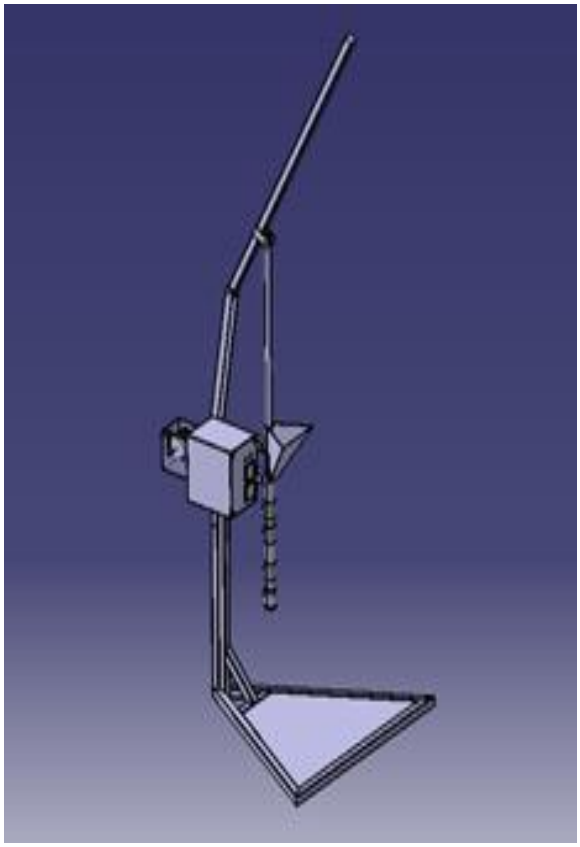

Fig.6CAD Model Assembly

IV. RELEVANCE

The important factors like quality, production and that raw material are becoming expensive and the cost of the energy is also increasing. The strategies of the mould design not only just aim at cost reduction but also at consumption and emission throughout the entire life.

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V. MOTIVE

Now days the plastic bottles, supporting frames etc. are normally used. After using these plastics are disposed of. They take lot of space and as it is this increases pollution. Hence this can have to be recycled taking in consideration and environmental concerns Plastics crushed can be melted and can be used to produce different kind of product but it is an extremely hard work. Hence, we need a simple machine which will reduce the human efforts and low cost

VI. SUMMARY

The manually operated machine is suitable for small scale industries and household. It reduces the cost. It is more eco-friendly as compare to other machines. It is easy to operate. The weight is less and it is portable.

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