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Design and Fabrication of Mini Injection Molding Machine

Pratibha V Patil[1], Babu Reddy[2], Ambadas Kadam[3]
[1,2]Department of PG Studies, Department of Machine Design VTU RO, Kalaburagi-585105 India

Abstract: ***Injection molding is considered to be one of the most prominent processes for mass production of plastic components. The objective of this project is to design and fabrication of mini injection molding machine to produce the electrical holder and we reduce the machine cost by developing this machine. The scope of the studies are performed which is the study will be using a Polypropylene material reinforced with glass fibers. The project can be divided into four stages. First step is design of the mini injection molding machine and second is the preparation of the material and development of the machine, then third step is injection molding machine used to produce electrical holder. The prepared electrical holder is more cost effective compared to other conventional materials because the plastic is available in environment larger quantity only few reinforcements have to be purchased in a minimum quantity. This may not add material cost because of its minimum quantity requirement (less than 5% by weight of that material). And finally testing of the polymer composite with reinforced glass fiber. The result observed from the experiment has shown that, polypropylene thermal conductivity is decreases by adding of the glass fiber. And increase the hardness by adding of the glass fibers to the polypropylene.***
Keywords: Plastic injection molding machine, Glass fiber, Polypropylene, polymer composite

I. INTRODUCTION

Plastic injection molding is one of the most popular methods for manufacturing of plastic components. By using of the injection molding machine wide variety of products can be manufactured such as children's toys, chair caps, mobile panels, plastic cups, bottle caps, water bottles and water pipes. Plastic injection molding can also be used to manufacture larger products such as chemical drums, TV cabinets, refrigerator stands and dustbins. The one of the biggest challenging to developing the plastic injection molding machine become a completion from day by day. So that to avoid the complexity, high tolerances and better quality of the product can be obtained. The process used in injection molding is now integrated with computer control that makes the system much more efficient and make the production is better in quality.The advantages of plastic injection moulding machine process include good, surface finish of the product can be produced, less scrap and flashes are produced, and the process has relatively low labour costs. Nowadays, there are lots manufacturers to test their product so that they will improve and produce a better and, good quality of product. It is parameter because of customer, requirements, and expectations change over time besides, the manufacturer also have to shares that it will hang longer in the industry.

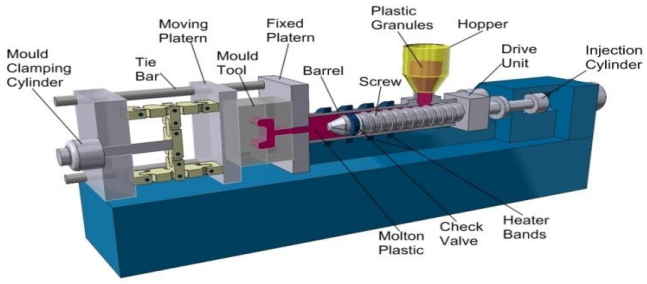

Figure1: Plastic injection molding machine

II. REVIEW

P. K. Bhartiand M. I. Khan(2010)[1] have classified the factors that affect the quality of a molded part in to four categories part design mold design machine performance and processing conditions. They have mentioned that the part design and mold design are assumed as established and fixed keeping all the aspects of injection molding. They have mentioned the main causes of defects in injection molding are mold design, machine performance, operator, type of material and working process parameters.

RadhwanHussinet al.(2012)[2] observed warpage defection plastics in guard of material PC/ABS using mold flow plastic insight. In addition to their researcher's work they have selected ambient temperature and runner size along with other six process parameters mentioned by Ming-Chih Huang. They found melt temperature to be the most contributing factor with54.22% followed by runner sizewith14.62% and ambient temperature with11.17%.

M. Kemal Karasu et al. (2014) [3] implemented single minute exchange of dies (SMED) for injection molding. They have also analyzed the progress in change overtime without SMED, with SMED and Taguchi's optimization technique empowered SMED. They have found change over time for mold is 90 minutes without SMED and 60 minutes using SMED. After implementing Taguchi method, change overtime with SMED dropped to around 40 minutes. So Taguchi empowered die exchange is less time consuming and more economic.

B. Sha, S. Dimov, C. Griffiths, M. Packianather (2007) [4] conducted design of experiments and data analysis in Micro Injection Molding (MIM). They focused on the analysis with three factors barrel temperature, mold temperature and injection velocity to find their effects on achievable aspect ratios in three different plastics viz. Polypropylene (PP), Polyoxymethylene (POM) and Acrylonitrile Butadiene Styrene (ABS).

Ahamed et al [5] have worked on Designing and optimizing the parameters which affect the molding process using design of experiment in injection molding the processing condition have critical effect on the finished molded products. The effect of various factors like Melt temperature, injection pressure, and cooling time are selected for the experiment. A Plastic product polycarbonate plastic material was taken for the experiment with optimal injection molding conditions and its tensile stress test was conducted in order to minimize defects and increase its strength.

D.Papageorgiou, et al (2013) [6] found on their study the die was made from AISIH130 steel and was intended for the production of plastic cups used for the outer closure of cylindrical aluminium cans in coffee packaging. Corrosion damage and wide crack are observed by naked eye. Design deficiency and improper cooling conditions generated a complex fatigue-corrosion cracking mechanism that lead to the damage of the die after half of its predicted service life.

III. METHODOLOGY

A. Design Concept

The design concept involves the following:

1) The maximum volume of melted material needs to fill the mold. It includes the plunger travel, barrel diameter and mass of the melt.

2) Design of barrel involves the diameter and maximum piston travel within the barrel.

3) Design for plunger.

By using below equation the diameter of the plunger can be calculated

$$V=\pi r^2 l \quad (1)$$

Where r=d/2

The equation one can be expressed as in diameter

$$V1= \pi x l x (d^2/4) \quad (2)$$

And also the volume of the melt in the barrel is obtained by using below formula

$$V2= \frac{\text{Mass of the melt (m)}}{\text{Density of the melt } (\rho)} \quad (3)$$

Therefore $v1=v2$

$$\pi x l x (d^2/4)= m/\rho \quad (4)$$

$$d^2= 4ml/\rho\pi l$$

4) Number of Teeth Required on a Plunger Rack:

The number of teeths required is calculated from below equation

Number of teeth required on the plunger rack =

$$\frac{\text{length of travel expected of plunger}}{\text{circular pitch distance}} \quad (5)$$

5) Design of Handle: In the design of the handle, the leverage on the handle (*ML*) of the machine can be Determined from below equation. $ML=mhgd1$ (6)

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6) Design of the barrel

Diameter of barrel = Dia of plunger +clearance.

B. CAD Model Procedure

First we prepare the plastic injection molding machine parts with the help of CAD software Parts are designed by the CAD software Mould is designed having the dimensions of the mould 100x100x18mm

Figure2 : Mould used in injection molding machine

Figure3 : Design and Developed Mini Injection molding machine.

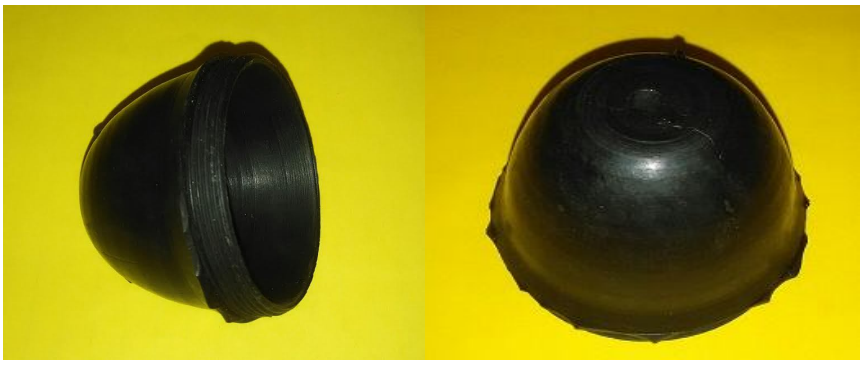

Figure 4: Electrical holder

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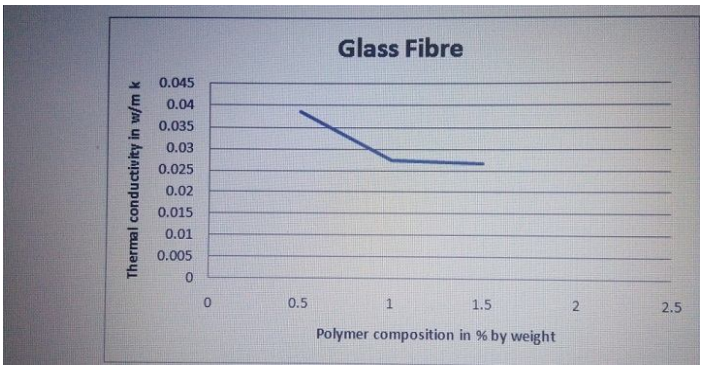
IV. RESULTS AND DISCUSSION

A. *Thermal Conductivity of Polypropylene Composite Reinforced with Glass Fibre*

TABLE I
THERMAL CONDUCTIVITY OF POLYPROPYLENE COMPOSITE REINFORCED WITH GLASS FIBER

Weight (%)	Thermal Conductivity
0.5%	0.0386 W/m K
1%	0.02727 W/m K
1.5%	0.02651 W/m K



Graph: Variation of Thermal Conductivity Vs Glass Fibre Polymer composition in % by Weight.

Thermal conductivity of polypropylene reinforced with Glass fibre decreases with increases in weight % of glass fiber this indicates that the glass fibre addition increases in thermal resistivity of the composite material and also it increases strength of the composition because of the addition of glass fibre, and also increases the hardness because of the glass reinforced fibers.

B. *Hardness of Polypropylene (PP) Composite Reinforced with Glass Fibre*

TABLE II
HARDNESS OF POLYPROPYLENE COMPOSITE REINFORCED WITH GLASS FIBER

Weight (%)	Hardness
0.5%	67
1%	69
1.5%	72

Hardness of polypropylene reinforced with the glass fibres is increases the hardness in weight % of the glass fiber this indicates that the glass fiber addition increases the hardness and also the strength of the polymer.

V. CONCLUSION

A. Injection molding is the one of the most important of various types of plastic products can be manufactured.

B. Now all electrical components are made up of nylon polymer is very costly and time consuming to produce the components. So that here we are used PP having low cost and reinforcement with the glass fibre will reduces the thermal conductivity and increases the hardness and strength. Cost and processing of the component is also easy and takes a less time to produce the components.

C. Heater is attached to the plastic injection moulding machine only so that the other separate heating equipment is not necessary it

reduces the cost of the machine and requires a less space for machine.

D. Due to low cost, this project will be designed and manufactured and this project can be used for small scale industries to produce a small plastic part such as chair caps, bottle caps, children toys, key holders, cups and electrical holders.

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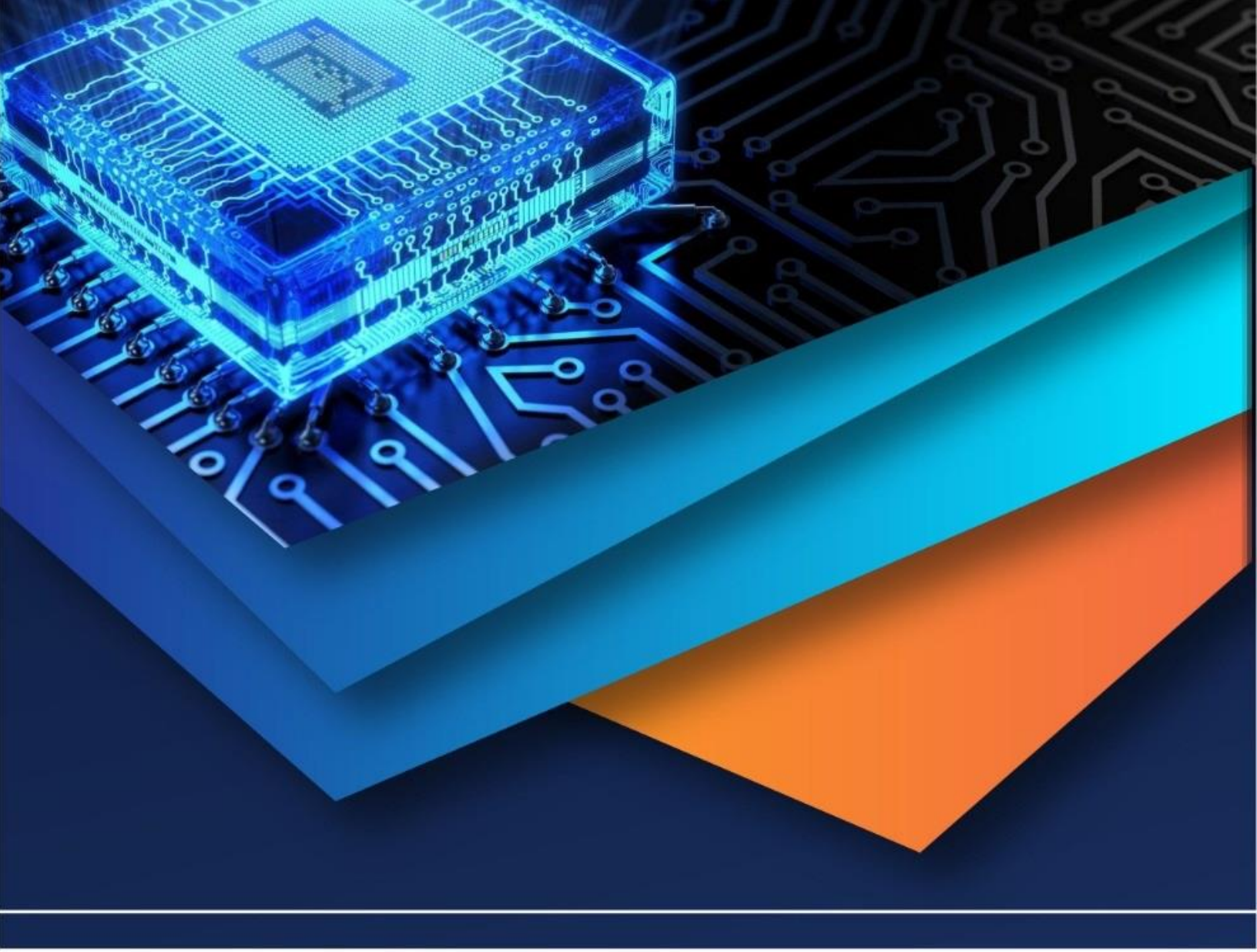

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