Research Paper on "Impact of Technology Acquisition on India Manufacturing Industry"

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Abstract- Injection molded components are consistently designed to minimize the design and manufacturing information content of the enterprise system. The resulting designs, however, are extremely complex and frequently exhibit coupling between multiple qualities attributes. Axiomatic design principles were applied to the injection molding process to add control parameters that enable the spatial and dynamic decoupling of multiple quality attributes in the molded part. There are three major benefits of the process redesign effort. First, closed loop pressure control has enabled tight coupling between the mass and momentum equations. This tight coupling allows the direct input and controllability of the melt pressure. Second, the use of multiple melt actuators provides for the decoupling of melt pressures between different locations in the mold cavity. Such decoupling can then be used to maintain functional independence of multiple qualities attributes. Third, the heat equation has been decoupled from the mass and momentum equations. This allows the mold to be filled under isothermal conditions. Once the cavities are completely full and attain the desired packing pressure, then the cooling is allowed to progress.

Keywords- Injection molded

I. INTRODUCTION

A growing sector of the plastics industry, plastic injection molding is the most common process used to produce plastic parts. The process of plastic injection molding is fast, meant to produce large quantities of the same plastic product in a short time span. Nowadays, the materials used are for instance thermoplastic, thermoset, elastomer, and/or metal(s). High-performance plastics that can withstand high temperatures are replacing the metals that are traditionally used in plastic manufacturing.

Injection moulding machine offers many advantages to alternatives manufacturing methods, including minimal losses from scrap (since scrap pieces can be melted and recycled), and minimal finishing requirements. Injection moulding machine differs from metal die casting, in that molten metal's can simply be poured, and plastic resins must be injected with force . It is most common used method for mass production of plastic articles of a heated cylinder, heating the materials in the heating chamber, and forcing the molten metal into a closed mould, where the final solidification of the molten metal in form of the configuration of the mould cavity takes. The intending injection machine will be made from mild steel and medium carbon steel. It can only be used for the production of small components such as key holder, bottle cap, tally, ruler, and clothes peg. The mild steel is used for the construction of supporting plates, hopper, mainframe, mould, and platens, handle, and tie bars. This is because; they are not subjected to constant heat. It is easily weldable, and has good workability but show poor response to heat treatment. An injection moulding machine is a piece of equipment consists of two basic elements, the injection unit and the clamping unit. Injection moulding can be used with a variety of plastic resins. The chosen resins for this process are polyethylene; polypropylene, ABS, and fluorocarbons, because of characteristics of intricate shapes can easily be produced.

The advantages of small injection moulding 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.

The main aim of the research work is to design, construct and testing of small injection moulding machine while the specific objectives of the research work are to design and construct a small injection moulding machine, and testing. The scope of the work is to design and construct a cost effective and environmentally friendly small injection moulding machine for them production of small plastic articles. The project work will involve design concept, operations, design analysis that will entail design of injection plunger, motor selection, design of the handle, and the leverage on the handle of the machine. Also, assembly drawings of the machine, recommended materials and equipment for the construction of design machine will be provided to assist investors that want to venture into construction of this machine. Development of small injection moulding machine for forming small plastic articles in small-scale industries was borne out of the fact that most injection moulding machines were of big size and most small-scale industries in developing countries could not avoid buying them due to their costs. In solving this problem, there is a need to design small injection moulding machine that avoidable bysmall scale industries for production of small plastic articles, this is the rationale behind this work.

1.1 Applications

Injection molding is used to create many things such as wire spools, packaging, bottle caps, automotive dashboards, pocket combs, and most other plastic products available today. Injection molding is the most common method of part manufacturing. It is ideal for producing high volumes of the same object. Some advantages of injection molding are high production rates, repeatable high tolerances, and the ability to use a wide range of materials, low labor cost, minimal scrap losses, and little need to finish parts after molding. Some disadvantages of this process are expensive equipment investment, potentially high running costs, and the need to design moldable parts.

Most polymers may be used, including all thermoplastics, some thermo sets, and some elastomers. In 1995 there were approximately 18,000 different materials available for injection molding and that number was increasing at an average rate of 750 per year. The available materials are alloys or blends of previously developed materials meaning that product designers can choose from a vast selection of materials, one that has exactly the right properties. Materials are chosen based on the strength and function required for the final part but also each material has different parameters for molding that must be taken into account.[8] Common polymers like Epoxy and phenolic are examples of thermosetting plastics while nylon, polyethylene, and polystyrene are thermoplastic.

1.2 General Plastic Injection Molding Applications

- Aerospace components
- Automotive components
- Avionics components
- Cable assemblies
- Computer electronics
- Electronics components
- Encapsulations
- Engineering prototypes
- Geophysics
- Instrumentation
- Marketing samples
- Material quality testing
- Medical & dental products
- Medical laboratories
- Model shops, toys, hobby
- New product design & development
- R&D labs
- Test specimens

1.3 Problem Definition

For small scale industry the requirement of semiautomatic plastic injection machine demand with
low cost day by day increasing so there is need of solution so my project is based of design and
development of injection moulding machine for small industry
.

1.4 Objective

- Design of efficient plastic injection moulding machine
- Suitable for small part production
- Low in cost
- Take low effort to run

1.5 Plastic injection molding industry

The application of plastic injection molding is widely used in the production of plastic parts – from medical equipment to toys. In the aerospace industry and particularly the automotive industry, many parts are made with plastic injection molding. Take a moment to look around you. There's probably a plastic object nearby. Very likely made by an injection molding machine.
The injection molding industry has seen a number of changes in recent years, including faster time to market. One of the key business strategies for plastic injection molders is to work with tooling partners to decrease lead times.

1.6 Plastic Injection Moulding Process Work

The basic manufacturing process of injection molding: plastic is melted in the plastic injection moulding machine and then injected into a mold under high pressure. There, the material is cooled, solidified and afterwards released by opening the two halves of the mold. This technique results in a plastic product with a predetermined, fixed form.

To facilitate production, the parts that play a role in the plastic injection moulding process must be carefully designed. The products made by plastic injection molding machines are first designed by an industrial engineer or a designer. Then, a moldmaker creates the mold – usually from steel or aluminum. This toolmaker takes all essential conditions into account: The material that is used for the end product, the features of the product; but also the material of the mold and the properties of the plastic injection molding machine.

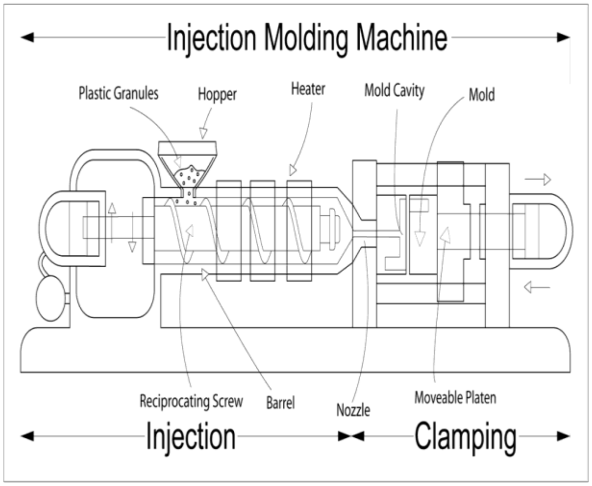

Fig.1: Injection Moulding Machine

1.7 Injection Moulding Process

To manufacture a finished plastic injection moulded component there is a process that we follow. To offer an insight for those without experience into how we achieve this we have provided a detailed breakdown of the process below:

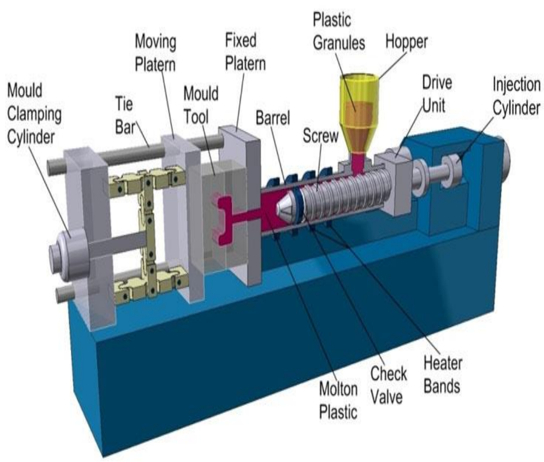

Fig.2: Injection Moulding Process

The injection moulding process

- The prepared thermoplastic is poured into the Hopper.
- The material funnels down into the screw which is heated to melt the plastic.
- The barrel is heated at staged temperatures along its length (approx. 5 zones) to allow the material to solidify and to move along the screw.
- The screw rotates which moves the material forward with the pressure and speed determined to fill the cavity efficiently.
- When the material exits the nozzle at the end of the barrel it is injected into the feed channels of the mould tool.
- The feed channels allow this material to flow into the open cavity of the mould tool which forms the shape of the finished product.
- The mould tool is held at a constant temperature to allow ease of material flow and to also draw out the heat from the product after injection, so, the material sets off to a solid form.
- After a predetermined cooling time the mould tool is opened when the moving platen carrying the ejection half is retracted.
- The mould tool opens with the product held in the ejection half of the tool.
- The ejection system then moves forward to release the product from the mould tool.
- The product is gathered in the collection box after the cycle is complete or the parts can be picked from the tool as required.

II. LITERATURE REVIEW

John Wesley Hyatt(1968) Findings-developed plastic material called celluloid and entered it in a contest created by a billiard ball manufacturer. The purpose of the contest was to find a substitute for ivory, which was becoming expensive and difficult to obtain.

Alexander Parkers(1851) Findings- Celluloid was actually invented in 1851 by Alexander Parkers, but Hyatt perfected it to where it could be processed into a finished form.

Geoffrey Boothyd (2002) Finding- cost estimation at earliest stages of design.

Ching-Chih Tsai, *Member, IEEE,* and Chi-Huang Lu,(1998) Findings- The exhruder typically consists of a large barrel divided into several constant temperature zones with a hopper ***at*** one end and a die ***at*** the other Polymer is fed into the barrel in raw and solid particle form from the hopper and is pushed forward by a powerful screw. While passing through the temperature zones with gradually increasing temperature, the raw polymer is gradually heated.

The heat produced by the heaters in the barrel, together with the heat released from the friction between the raw polymer and the surfaces of the barrel and screw, causes the melting of the feed polymer, which is then pushed by the screw into the molding mechanism from the die. Generally speaking, the quality of the extrudate depends upon the uniformity of temperature distribution, magnitude of the temperature in the barrel, back pressure, and the homogeneity of the physical mixing.

III. METHODOLOGY UNDER PROJECT

3.1 Design Concept and Analysis

This design concept encompasses the following:

a) Maximum volume of the melt needed to fill the mould. This entails plunger travel (*l*), diameter of the barrel (*d*), melt density (□*m*) and melt mass (*m*);

b) Design of barrel which entails diameter of the barrel and maximum piston travel; and

c) Design for plunger.

While the design analysis entails the following units:

a) The injection unit comprises of the hopper, barrel, heater bands, nozzle, and injection plunger.

b) The clamping unit consists of the mould, platens, and the handle known as the locking device.

c) The electrical panel comprises of temperature control, contactors, thermocouple, heat resistance wire, and knob (control button).

3.2 Design calculations

In this work the complete design calculations are made. The design calculations include the calculations of the diameter of injection plunger, number of teeth required on the plunger rack, number of teeth required on spur gear (pinion), motor selection, and leverage on the handle.

These calculations are based on the mathematical equations.

3.3 Design of injection plunger

In the injection plunger design shown in Fig. 1, the volume of the melt (*V*) the plunger can successfully pushed from the barrel can be determined by knowing the diameter of the plunger. It goes thus

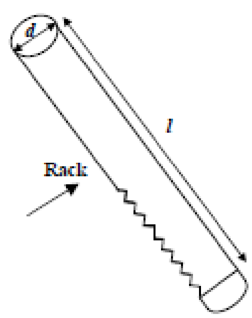

Fig.3: Injection Plunger

Using Fig. 3, the diameter of the plunger can be determined .

V=Pi.r2.l

r=d/2

The expression in Eq. (1) can be expressed in terms of diameter (*d*),

V1=Pi.d2/2. L

Also, volume (*V*) of the melt in the barrel can be obtained ,

V2=mass of melt m/density of melt q

Therefore,

V1=V2

This implies that

Pi d2/l . = m/q

Making *d*2 the subject of expression, we have

d 2 = 4m/pi.q.l

Therefore, the plunger diameter can be determined ,

d = squar root of(4m/pi .q .l)

Number of teeth required on the plunger rack

The number of teeth required is determined from E

Number of teeth required on the plunger rack= length of travel expected of plunger/ circular pitch distance

Number of teeth required on spur gear (pinion).

The number of teeth required on the spur gear is determined

Number of teeth required on spur gear = pi . diameter of pitch circle / circular pitch distance

Motor selection

The angular velocity can be determined ,

W =v/r

While the number of revolution (*N*) can be determined

N= 60w/2.pi

In addition, the torque (*T*) of the motor can be determined ,

T =Frs

Likewise the power (*P*) can be determined ,

P= Tw

Design of the handle

In the design of the handle, the leverage on the handle (*ML*) of the machine can be determined ,

ML=Mhgd1

Assembly of machine

The procedures for assembling the machine are as follows:

- fixing the main frame,
- position the supporting plates and bolt them together with the tie bars,
- bolt the barrel to the supporting plate 2,
- mount the plunger assembly through the supporting plates 1 and 2 to the barrel,
- positioning of the driven unit to the plunger assembly: the driven unit are spur gear, the reduction gearbox and electric motor,
- mount the handle (locking device) through the supporting plate 4 to the platen, and
- install the mould to supporting plate 3 and the platen.

3.4 Working drawing

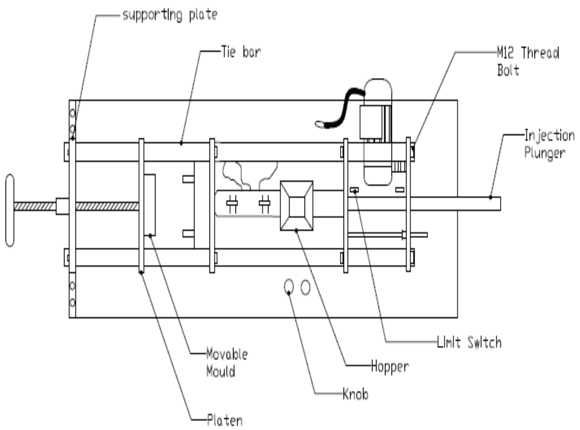

Fig.4: Plan View of the Constructed Injection Moulding Machine

3.5 Materials selection

Materials are selected based on designed and metallurgical properties of the materials such as machinability, formability, weldability that greatly influence the construction methods and other

joining methods. Other factors considered are cost of the materials; and mechanical properties of the materials.

Materials

The following materials used in the construction of this machine are medium carbon steel used for injection plunger, barrel and nozzle. Mild steel was used for hopper, supporting plates, tie bars, platen, mould, bolts, and main frame. Other materials used are thermocouples, limit switches, knobs (control button), bolts, and 4-core flexible wires, heat resistance wires, and contactors, red and light green paints.

3.6 Equipment

The equipment used are as follows: electric motor, other such as mainframe is cut into sizes using oxyacetylene gas welding, facing operation mould, barrel, injection plunger, and handle were faced using the lathe machine., drilling operation, milling operation, and tapping operation using drilling machine, milling machine and tapping machine respectively. Components such as the drilling operation on the lathe machine were performed on the components such as the mould, barrel, tie bars, and the supporting plates. Milling operation was carried out on the barrel, and the spur gear teeth. Tapping operation was also carried out on the tie bars. All the general finishing operation was carried out on the machine such as grinding of all rough edges using a hand grinding machine. Cutting saw or frame cutting were used for cutting the various metals into sizes and required shapes. Metals such as the supporting plates, platen, tie bars, barrel, injection plunger, and hopper were cut sizes using manual hacksaw.

3.7 Operation procedure

The operational principles of this machine are as follows: switch on the heater for one hour, and set the electric controllers to the desired temperature, and fill the hopper with materials (highdensity polyethylene and master batch). When beginning to inject the molten resins to the mould, make sure the mould is close and there are two limit switches that determine the stroke of forward and backward movement of the injection plunger [4]. That is, when the injection plunger reaches the maximum forward stroke predetermined for the particular mould, a limit switch will be actuated and this will stop the electric motor movement. The same way goes to the backward stroke and this determined the amount of molten resins that goes into the mould. If the mould functions properly, the finished product will fall out of the mould on its own.

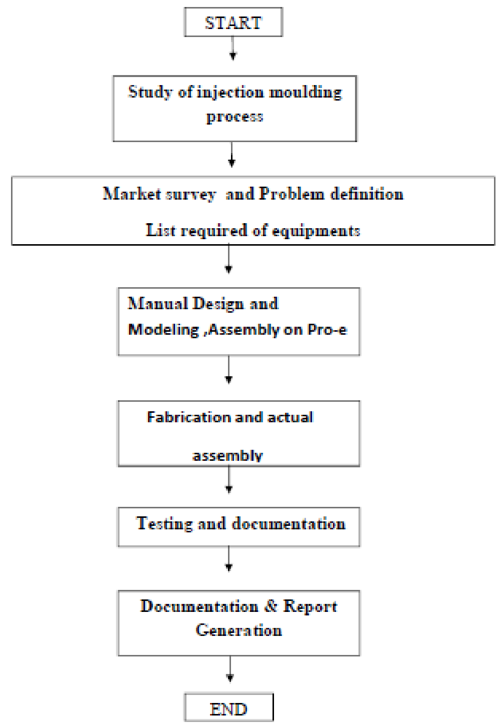

Fig.5: Flow chart of Injection Moulding Machine

IV. CONCLUSION AND FUTURE SCOPE

4.1 CONCLUSION

Injection Molded Plastic Market size was calculated at over 100 million tons in 2015 with growth forecast at more than 5% CAGR up to 2023.

MEA Injection molded plastics market size, by application, 2012 - 2023 (USD Million)

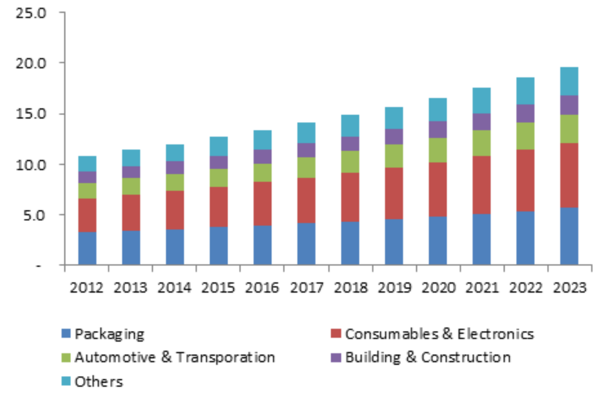

Fig.6: MEA Injection molded plastics market size, by application, 2012 - 2023 (USD Million)

Global plastic packaging demand was more than USD 285 million in 2015 and is projected to exceed USD 425 million by 2023. Growth in demand for processed food, consumer goods and beverages boost the packaging industry growth. Key polymer properties, durability, temperature resistance, corrosion resistance and ability to withstand wear & tear may drive demand in this segment.

Injection Molded Plastic Market, By Raw Material

Polypropylene (PP) injection molded plastic dominated the demand and was valued at over USD 72 billion in 2015. Rise in PP demand in automotive, packaging, and electrical & electronics industries owing to corrosion resistance & electrical insulation are among favorable factors to

Injection Molded Plastic Market, By Application

Consumable & electronics application demand was worth over USD 66 billion in 2015. Electronics industry expansion accompanied by cost effective electrical appliances availability were considered to be the stimulating factor to pave injection molded plastic market growth. Rise in demand for food processors, microwave, television, laptops, mobile phones, and refrigerator owing increase in disposable income and purchasing power created more opportunities and enhance market growth.

Injection Molded Plastic Market, By Region

North America, with dominant U.S. injection molded plastic market demand, is set to grow at more than 4.8% CAGR up to 2023. Rise in food & beverages packaging demand owing to increase in processed food & alcohols demand coupled with building & construction expansion are expected favorable factors to drive demand.

Latin America expected growth rate at above 4.6% up to 2023due to abundant fossil fuel raw material availability and government support to initiate FDI in Brazil and Columbia.

Competitive Market Share

Global injection molded plastic market share is highly fragmented due to presence of numerous players and unorganized sector. Major participants include ExxonMobil, BASF, Dow, Huntsman, Eastman, INEOS, SABIC, Magna International, Newell Rubbermaid, Beckton Dickinson, and IAC group.

This Paper will be designed and constructed for the small-scale production of small plastic articles. Hence, it can be recommended for small-scale investors that are willing to produce small
plastic articles such as key holders, clothes pegs, flat rulers, bottle covers/caps and tally.

4.2 Future Scope

Plastic injection Moulding Industry Is Now Facing The Very Heavy competition; most of the plastic injection moulding companies is working on mercy profits and low technologies. Speed Up all The Moulding machines. Forth Is Point You Need To Be Sure That Your Machines Are Suitable For High Speed running¬Even If Your Machine Are High speed, but if you are in shortage of automation system in your injection moulding plants, then you need a lot of labour to pickup the moulded plastic components from the machine and you need to stack or collect them before packing. In the Project We Have Used Manual Plunger arrangement for pressing them often plastic instead of that we can have hydraulic arrangement for the automatic control that will reduce production time.¬Also for the batter and quick heating to melt the plastic insulation can be done which will reduce the heatloss.

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