A PROJECT REPORT

ON

"DESIGN AND FABRICATION OF TABLE TOP INJECTION MOUDING MACHINE"

Submitted by

ANSARI MOHD IRFAN MOHD HASHIM	**18DME06**
KHAN SUFIYAN HAMIDULLAH	**18DME22**
DHANSAY SUFIYAN ABDUL SATTAR	**15ME71**
KAWCHALI SALMAN IMTIYAZ	**14ME76**

In partial fulfillment for the award of the Degree

Of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

UNDER THE GUIDANCE

Of

Prof. MOHAMMED JAWED SHAIKH

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL,

NAVI MUMBAI – 410206

UNIVERSITY OF MUMBAI

ACADEMIC YEAR 2020-2021

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL

(Approved by AICTE, recg. By Maharashtra Govt. DTE,

Affiliated to Mumbai University)

PLOT #2&3, SECTOR 16, NEAR THANA NAKA, KHANDAGAON, NEW PANVEL,NAVI MUMBAI-410206, Tel.: +91 22 27481247/48 * Website: www.aiktc.org

CERTIFICATE

This is to certify that the project entitled

"DESIGN AND FABRICATION OF TABLE TOP INJECTION MOUDING MACHINE"

Submitted by

ANSARI MOHD IRFAN MOHD HASHIM	**18DME06**
KHAN SUFIYAN HAMIDULLAH	**18DME22**
DHANSAY SUFIYAN ABDUL SATTAR	**15ME71**
KAWCHALI SALMAN IMTIYAZ	**14ME76**

To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

Prof. MOHAMMED JAWED SHAIKH
Project Guide

Prof. RIZWAN SHAIK
Prof. RAHUL THAVAI /
Project Coordinator

Prof. ZAKIR ANSARI
Head of Department

Dr. ABDUL RAZAK HONNUTAGI
Director

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL

(Approved by AICTE, recg. By Maharashtra Govt. DTE,

Affiliated to Mumbai University)

PLOT #2&3, SECTOR 16, NEAR THANA NAKA, KHANDAGAON, NEW PANVEL,NAVI MUMBAI-410206, Tel.: +91 22 27481247/48 * Website: www.aiktc.org

APPROVAL OF DISSERTATION

This is to certify that the thesis entitled

"DESIGN AND FABRICATION OF TABLE TOP INJECTION MOUDING MACHINE"

Submitted by

ANSARI MOHD IRFAN MOHD HASHIM	**18DME06**
KHAN SUFIYAN HAMIDULLAH	**18DME22**
DHANSAY SUFIYAN ABDUL SATTAR	**15ME71**
KAWCHALI SALMAN IMTIYAZ	**14ME76**

In partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering, as prescribed by University of Mumbai approved.

(Internal Examiner) **(External Examiner)**

___________________ ___________________

Date: ___________

ACKNOWLEDGEMENT

After the completion of this work, we would like to give our sincere thanks to all those who helped us to reach our goal. It's a great pleasure and moment of immense satisfaction for us to express my profound gratitude to our guide **Prof. MOHAMMED JAWED SHAIKH** whose constant encouragement enabled us to work enthusiastically. His perpetual motivation, patience and excellent expertise in discussion during progress of the project work have benefited us to an extent, which is beyond expression.

We would also like to give our sincere thanks to our Head Of Department **- Prof. ZAKIR ANSARI**, Project co-ordinators – **Prof. Rahul Thavai** and **Prof. Rizwan Shaikh** from Department of Mechanical Engineering, Kalsekar Technical Campus, New Panvel, for their guidance, encouragement and support during a project.

I am thankful to **Dr. ABDUL RAZAK HONNUTAGI**, Kalsekar Technical Campus New Panvel, for providing an outstanding academic environment, also for providing the adequate facilities.

Last but not the least I would also like to thank all the staffs of Kalsekar Technical Campus (Mechanical Engineering Department) for their valuable guidance with their interest and valuable suggestions brightened us.

ANSARI MOHD IRFAN MOHD HASHIM	18DME06
KHAN SUFIYAN HAMIDULLAH	18DME22
DHANSAY SUFIYAN ABDUL SATTAR	15ME71
KAWCHALI SALMAN IMTIYAZ	14ME76

Declaration

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

ANSARI MOHD IRFAN MOHD HASHIM	18DME06
KHAN SUFIYAN HAMIDULLAH	18DME22
DHANSAY SUFIYAN ABDUL SATTAR	15ME71
KAWCHALI SALMAN IMTIYAZ	14ME76

DATE:

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Now a day production rate of the industries has been increasing rapidly. All the industries try to achieve the maximum result and try to improve their product qualities and product functions. To improve the quality of the entire process and raw material has to be considered and their characteristics in different conditions. This will help to attain the maximum results.

The injection moulding machine is highly priced Type of machine which cost a lot of money because of this their maintenance is very important. So while testing the new composite plastic as a raw material in injection moulding machine in order to understand their characteristics, will be slightly risky because the plastic may cause the problem inside the machine because of their characteristics under different circumstances. This will damage the injection moulding machine Ultimately costing a lot of money waste in maintenance and repairing of machine. So one of the aim of this project is to check the characteristics of different types of plastic composite materials without any risk of loss of money. This machine is comparatively cheap, easy to use, low maintenance and easy to maintain.

Other purpose of this project is that, the students in colleges learns the subject and topic related to manufacturing so buying costly machine to show the actual process is not possible some times. So this project will help students to do actual injection moulding operation and learn their different operations on machine at such a low cost.

The following report contains the detail information about the project. The history, costing, components details, and the fabrication detail of this project.

Each chapters contains the important information regarding the injection moulding machine.

Chapter 1

Introduction

1.1 Background

Injection moulding is a manufacturing process for producing parts by injecting molten material into a mould. Injection moulding can be performed with a host of materials mainly including metals (for which the process is called die-casting), glasses, elastomers, confections, and most commonly thermoplastic and thermosetting polymers. Material for the part is fed into a heated barrel, mixed (using a helical screw), and injected into a mould cavity, where it cools and hardens to the configuration of the cavity. After a product is designed, usually by an industrial designer or an engineer, moulds are made by a mould-maker (or toolmaker) from metal, usually either steel or aluminium, and precision-machined to form the features of the desired part. Injection moulding is widely used for manufacturing a variety of parts, from the smallest components to entire body panels of cars. Advances in 3D printing technology, using photopolymers that do not melt during the injection moulding of some lower-temperature thermoplastics, can be used for some simple injection moulds.

1.1.1 History of Injection moulding

American inventor John Wesley Hyatt, together with his brother Isaiah, patented the first injection moulding machine in 1872. This machine was relatively simple compared to machines in use today: it worked like a large hypodermic needle, using a plunger to inject plastic through a heated cylinder into a mould. The industry progressed slowly over the years, producing products such as collar stays, buttons, and hair combs.

The German chemists Arthur Eichengrün and Theodore Becker invented the first soluble forms of cellulose acetate in 1903, which was much less flammable than cellulose nitrate. It was eventually made available in a powder form from which it was readily injection moulded. Arthur Eichengrün developed the first injection moulding press in 1919. In 1939, Arthur Eichengrün patented the injection moulding of plasticised cellulose acetate.

The industry expanded rapidly in the 1940s because World War II created a huge demand for inexpensive, mass-produced products. In 1946, American inventor James Watson Hendry built the first screw injection machine, which allowed much more precise control over the speed of injection and the quality of articles produced. This machine also allowed material to be mixed before injection, so that coloured or recycled plastic could be added to virgin material and mixed thoroughly before being injected. In the 1970s, Hendry went on to develop the first gas-assisted injection moulding process, which permitted the production of complex, hollow articles that cooled quickly. This greatly improved design flexibility as well as the strength and finish of manufactured parts while reducing production time, cost, weight and waste. By 1979, plastic production overtook steel production, and by 1990, aluminium moulds were widely used in injection moulding. Today, screw injection machines account for the vast majority of all injection machines.

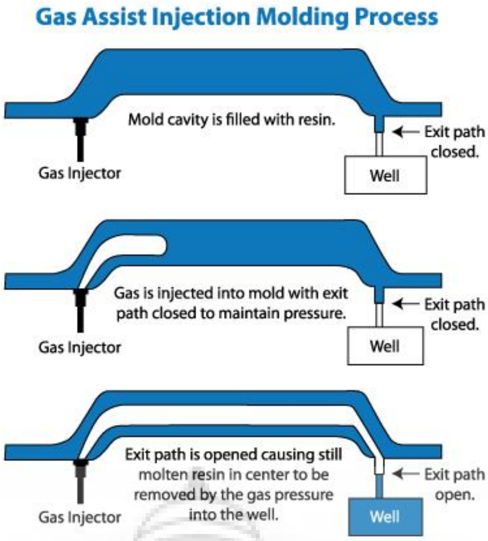
The plastic injection moulding industry has evolved over the years from producing combs and buttons to producing a vast array of products for many industries including automotive, medical, aerospace, consumer products, toys, plumbing, packaging, and construction.

1.1.2 Modern Injection Moulding Technologies

1) Gas-assisted injection moulding:

In this form of injection moulding, the typical melted plastic injection is assisted by the injection of pressurised gas into the mould – nitrogen is commonly used for this process. The gas generates a bubble that pushes the plastic towards the ends of the mould; thus, as the bubble expands, different sections are filled. There are several forms of moulding used in the plastics industry that are differentiated by the position where the gas is injected when casting the polymer.

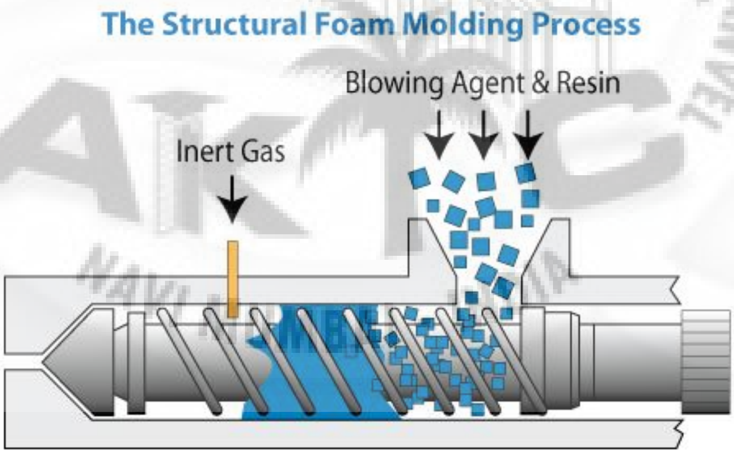
More specifically, gas can be injected through a nozzle in the machine, or directly into the mould’s cavity under a constant pressure or volume



1.1

2) Foam injection moulding:

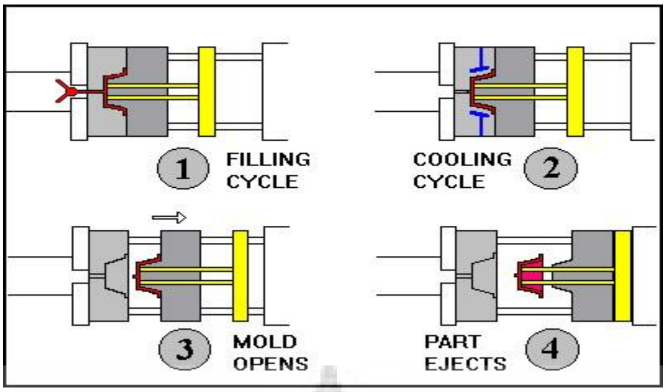
This technique provides an effective, affordable way to achieve high resistance and rigidity in structural parts. In addition to this advantage, structural foam parts have a superior thermal isolation, a greater chemical resistance, and improved electric and acoustic characteristics. This parts involve a foam core between two layers; this core is obtained by dissolving an inert gas in the resin and allowing it to expand when injecting the gas-plastic solution in the cavity of the mould. Where can we find parts manufactured through foam injection moulding? This



process is used in vehicle panels as an alternative to reduce part weight.

3) Thin-wall injection moulding:

The main technological innovation in this case is related to the end result: a section with very thin walls. The major difficulty of this process is to decide what width the wall should have to be considered to be a "thin wall". As a general rule, when component parts having widths under half a millimetre (1/50th of an inch) are manufactured, they are considered to have thin



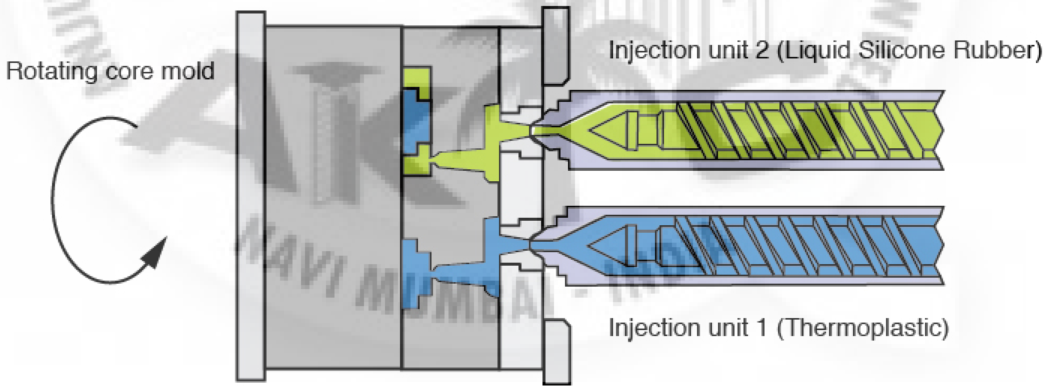
walls. The benefits associated with the reduction of the wall's width are highly appreciated and sought nowadays.

1.3

4) Multi component injection moulding:

Also known as injection overmoulding or overinjectio ,since this project involves overmoulding a hard or soft polymer over a base material (substrate), which is generally a plastic or metallic component.

Overall, this technology can be defined as the injection of more than one component or material within one same mould and as part of a single process, allowing for the combination of two, three or more materials with different colours, textures and shapes.



1.4

1.1.3 Material used for injection moulding

Thermoplastic injection molding is the most common way to manufacture parts. Thermoplastics are polymers that can be repeatedly molten or softened by heating and solidified by cooling—as a physical change rather than a chemical change that takes place during the creation of thermoset materials. It is important to distinguish what type of thermoplastic should be used for the type of product you want us to help you create. Below are the most common thermoplastics used in injection molding.

Acrylonitrile Butadiene Styrene (ABS) :

It is an opaque thermoplastic and amorphous polymer. It is a terpolymer (copolymer consisting of three distinct monomers) of Acrylonitrile, Butadiene, and Styrene. Together they create a product that is flexible and light in weight that can be molded into many items that we use in our everyday lives.The advantage of ABS is that a variety of modifications can be made to improve impact resistance, toughness, and heat resistance. The last properties of the process will influence the final product. Molding at a high temperature improves the gloss and heat resistance of the product whereas molding at a low temperature is where the highest impact resistance and strength are obtained.In addition to molded plastics, ABS is used in drain pipe systems, plastic clarinets, golf club heads, automotive parts, common appliances in a kitchen, LEGO bricks, and many other products.ABS recommended molding temperature usually are 180-230 ℃

In principle, when use the recommended melt temperature upper limit, the time of ABS plastics stay on barrel should be made as short as possible to avoid material degradation at high temperatures.

Holding pressure and time: Reasonable holding pressure and time determine directly the quality of molded plastic parts, high holding pressure will increase the density of the plastic parts, you will get less shrinkage and great surface quality. But big internal stress will be created, which endanger the part strength. So the best solution is try to use lower holding pressure as long as the surface requirement is satisfied.

1.5

Polyethylene

Polyethylene is a thermoplastic polymer with variable crystalline structure and an extremely large range of applications depending on the specific type. It is one of the most versatile and most popular plastics in the world since the 1950s when it was developed by German and

Italian scientists. The two most common types of this plastic are high-density polyethylene (HDPE) and low-density polyethylene (LDPE).

The advantages of polyethylene are high levels of ductility, tensile strength, impact resistance, resistance to moisture absorption, and recyclability. The higher the density of the polyethylene material used the stronger, more rigid, and more heat resistant the plastic is. The primary uses of polyethylene are plastic bags, plastic films, containers including bottles, and geomembranes.

- **Low-Density Polyethylene (LDPE)** is a very flexible material with unique flow

properties that makes it particularly suitable for shopping bags and other plastic film

1.6

applications. LDPE has high ductility but low tensile strength, which is evident in the real world by its propensity to stretch when strained.

- **Linear Low-Density Polyethylene (LLDPE)** is very similar to LDPE, but offers added advantages. Specifically, the properties of LLDPE can be altered by adjusting the formula constituents, and the overall production process for LLDPE is typically less energy-intensive than LDPE.

- **High-Density Polyethylene (HDPE)** is a robust, moderately stiff plastic with a highly crystalline structure. It is frequently used in plastic for milk cartons, laundry detergent, garbage bins, and cutting boards.

Polycarbonate:

Polycarbonate (PC) plastics are a naturally transparent amorphous thermoplastic. They are used to produce a variety of materials and are particularly useful when impact resistance and transparency are a requirement (ex: bullet-proof glass). Unlike most thermoplastics, PC can undergo large plastic deformations without cracking or breaks.

PC is commonly used for greenhouses, digital disks like DVDs, eyewear lenses, medical devices, automotive components, and cellular phones. Polycarbonates (PCs) are a group of tough, strong thermoplastic polymers. The molecular structure of these materials provides high stiffness, good thermal resistance, and relatively high viscosity during processing. Despite this, polycarbonates are generally easy to work with via molding and thermoforming, making them popular materials for a wide range of applications.

1.7

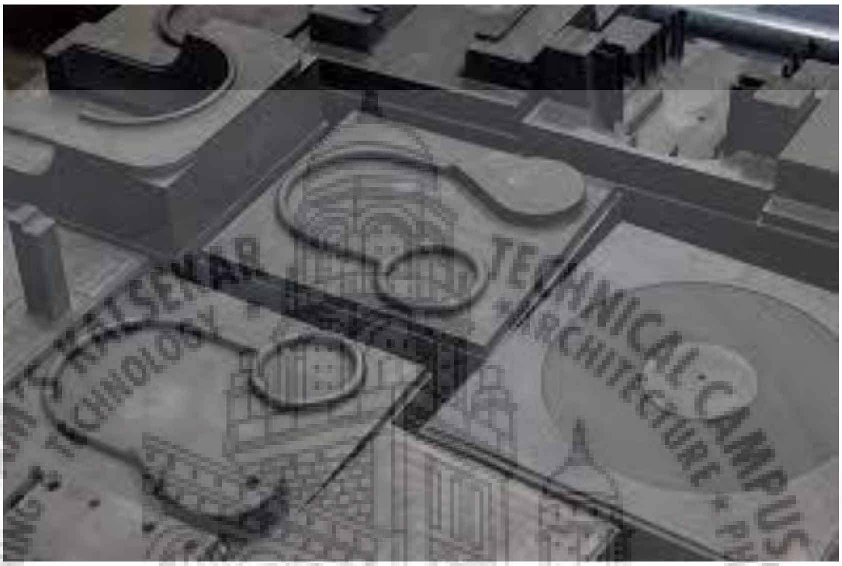
Some of the main benefits associated with injection moulding polycarbonate include:

- Excellent toughness
- High impact strength
- Excellent strength retention at elevated temperatures
- Stronger and less brittle than acrylic materials, with longer resistance to temperature extremes
- High heat resistance
- Naturally transparent (light transmission similar to glass)
- High tensile, shear, and flexural strength

Nylon

This material is used in a large range of different applications because of its electrical properties, toughness, wear resistance and chemical resistance being quite impressive. Nylon has a high level of stability (helps with strength) and is resistant to many external factors like abrasion, impact, and chemicals. This material produces plastic parts used in many industries such as:

- Medical products
- Automotive products
- Sports equipment
- Apparel and footwear
- Industrial components



1.8

High Impact Polystyrene

High Impact Polystyrene (HIPS) is a popular and tough plastic that is in the Polystyrene family. Polystyrene is brittle and can be made more impact resistant if combined with other materials (in this form it is known as HIPS). It is made from modifying crystal styrene with rubber which helps to give it many levels of impact resistance. It is low cost, has good dimensional stability and rigidity. There are FDA grades available since it is non-toxic and used as containers for many food goods.

It is highly flammable, but there are flame retardant and high gloss grades that are commonly used for injection molding.

1.9

Polypropylene

This is a very common plastic that is known for its flexibility. PP (polypropylene) is a very dynamic plastic and has been compounded for a wide range of properties. Some characteristics of this plastic are its high melting point, high resistance to stress and cracking, excellent impact strength, and do not break down easily from reactions with water, acids, and detergents.PP is safe for use as food containers because it does not leach chemicals into food products. It can be commonly found in household goods such as utensils, athletic apparel, area rugs, and automotive parts such as car batteries.

1.10

Choosing the right material for your application can result in increased performance and reduced cost. At Midstate Mold, we understand that there is no “one size fits all” solution when it comes to the production of molded plastic parts. We have been producing high-quality plastic injection parts for our clients around the globe since 1965. If you have any questions or concerns on what type of plastic you should be using, contact our team of experts who can help you every step of the way.

1.11

Melting temperature of the plastics used in injection moulding Machine.

PLASTIC MATERIALS	MELTING TEMPERTURE RANGE	IGNITION TEMPERATURE RANGE
ABS	88-125	416
NYLONS	160-275	424-540
POLYCARBONATE	140-150	580
POLYPROPYLENE	158-168	570
POLYETHYLENE	107-137	349
POLYSTYRENE	100-120	488-496
POLYESTERS	220-268	432-488

1.1.4 Applications of Injection Moulding

1) Building and Construction Tools:

While plastic injection moulding is a versatile process that has application in countless industries, it is becoming increasingly valuable to the construction industry. Some of the characteristics of custom injection moulded parts that make them suitable for construction applications include:

· High material stability

· High durability when exposed to the elements

Manufacturers use plastic injection moulding to produce a variety of affordable construction parts and products, such as hand tools, fasteners, and large and small accessories.

1.12

2) Food and Beverage:

Parts and components used in food and beverage processing facilities must comply with safety guidelines. These include FDA certification and GMA-safe compliance, to ensure sanitary product manufacturing and protect the well-being of consumers. To meet these standards, plastic injection moulded parts produced for these industries are made with food-grade materials, which are typically non-toxic and BPA-free. Components produced are,

· Conveyor system components

· Beverage filtering components

· Food and beverage containers

· Processing equipment components

1.13

3) Medical and Pharmaceuticals:

As medical and pharmaceutical products are generally tied to an individual's health and safety, ensuring quality throughout the entire manufacturing process—from the initial design phase to final inspection—is essential. injection moulded parts meet the stringent specifications of the medical industry, such as ISO certification and the use of FDA/medical-

1.14

grade resins.

4) Windows and Doors

Hole plugs, Locks and keepers, Muntin bar clips, Muntin joiners, Sash handle, Tilt latches, Vent stop, Weep covers, Window handles, Window roller assembly, Window screen corners, Window stops etc are some of the parts which are manufactured by injection moulding.

1.15

1.2 Aim and Objective:

Aim of this project is to study, Design and Fabricate a Table Top Injection Moulding Machine.

Objectives of doing this project is given as:

1) To study the working principal and process of injection moulding.
2) To reduce the cost of testing of injection moulding process.
3) To reduce the initial cost of testing table top machine.
4) To simplify the process to make it easy to understand for students and to test the quality of virgin and composite plastics.

1.3 Literature Review:

Nwadinobi, C.P., Ezeaku, I.I. and Ugwu, V: Design and Fabrication of Mini-Injection Moulding Machine for Small-to-Medium Scale Plastic Processing.

This paper presents the design process and manufacturing of plastic injection moulding machine that is inexpensive and for use in the production industry for producing small size plastic products. The components of the machine are the hopper, screw, the barrel assembly, and the injection nozzle. Temperatures of 200oC and 300oC were used to test the rate of melting of the plastic grains and their fluidity. The performance test of the machine indicated average throughput and injection efficiency, of 261.04kg/hr and 92.2% respectively at a displacement time of 0.0353hr. Therefore, this innovation is recommended for small scale plastic industries. The production cost implication of this machine considering bought out components, material cost, job cost (machining and non-machining) is approximately fifty-four thousand, eight hundred and twenty naira only (₦54,820).

Ching-Chih Tsai, Shih-Min Hsieh, Huai-En Kao: Mechatronic Design and Injection Speed Control of an Ultra-high Speed Plastic Injection Moulding Machine.

In this work they presented pragmatic techniques for mechatronic design and injection speed control of an ultra high-speed plastic injection moulding machine.

PI controller and a fuzzy PI controller are used, compared and then implemented into a digital signal processor (DSP) using standard C programming techniques.

William Liu: The microscopic features of cavitations erosion and the solution in the plastic injection moulding machines.

In this paper they discussed the failure of nozzle unit in the plastic injection moulding machines was discovered to be cavitations erosion, rather than corrosion

Three types of erosion pits in different size order have been discovered

The cavitations erosion with substituting stain less steel to aluminum has been successful.

.Lucchetta,P.F.Bariani,W.A.Knight they imposed that Recycled polymers are usually blended with virgin polymers to obtain the best trade-off between cost and low melt viscosity. A new approach to the minimization of the overall manufacturing cost.

1.4 Problem Definition

To design and fabricate a low cost table top injection moulding machine required to test the quality of virgin and composite plastic and to understand the moulding process and to test the design of moulds.

Chapter 2

Working principle, Process and Parts

2.1 Basic principle

The working principle of the injection moulding machine is similar to the syringe used for injection. It uses the thrust of the screw (or plunger) to inject the plasticized plastic in the molten state (that is, the viscous fluid state) into the closed mould cavity. The process of obtaining products after curing and shaping.

2.2 Process

The process cycle for injection moulding is very short, typically between 2 seconds and 2 minutes, and consists of the following four stages:

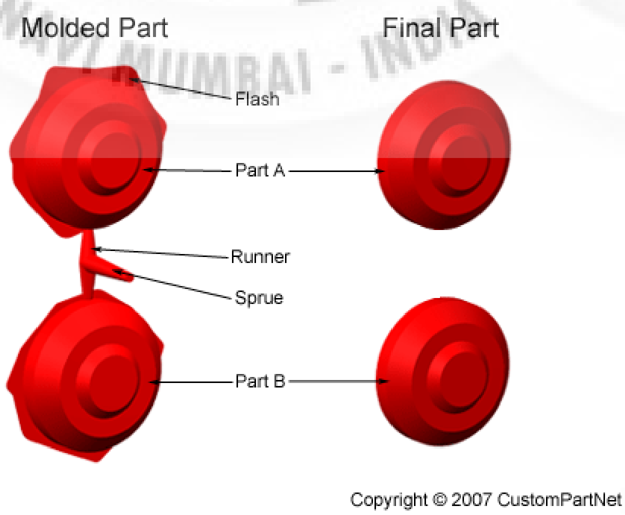
1. ***Clamping*** - Prior to the injection of the material into the mould, the two halves of the mould must first be securely closed by the clamping unit. Each half of the mould is attached to the injection moulding machine and one half is allowed to slide. The manually powered clamping unit pushes the mould halves together and exerts sufficient force to keep the mould securely closed while the material is injected. The time required to close and clamp the mould is dependent upon the machine - larger machines (those with greater clamping forces) will require more time. This time can be estimated from the dry cycle time of the machine.

Injection - The raw plastic material, usually in the form of pellets, is fed into the injection moulding machine, and advanced towards the mould by the injection

During this process, the material is melted by heat and pressure. The molten plastic is then injected into the mould very quickly and the build up of pressure packs and holds the material. The amount of material that is injected is referred to as the shot. The injection time is difficult to calculate accurately due to the complex and changing flow of the molten plastic into the mould. However, the injection time can be estimated by the shot volume, injection pressure, and injection power.

2. ***Cooling* -** The molten plastic that is inside the mould begins to cool as soon as it makes contact with the interior mould surfaces. As the plastic cools, it will solidify into the shape of the desired part. However, during cooling some shrinkage of the part may occur. The packing of material in the injection stage allows additional material to flow into the mould and reduce the amount of visible shrinkage. The mould cannot be opened until the required cooling time has elapsed. The cooling time can be estimated from several thermodynamic properties of the plastic and the maximum wall thickness of the part.

3. ***Ejection* -** After sufficient time has passed, the cooled part may be ejected from the mould by the ejection system, which is attached to the rear half of the mould. When the mould is opened, a mechanism is used to push the part out of the mould. Force must be applied to eject the part because during cooling the part shrinks and adheres to the mould. In order to facilitate the ejection of the part, a mould release agent can be sprayed onto the surfaces of the mould cavity prior to injection of the material. The time that is required to open the mould and eject the part can be estimated from the dry cycle time of the machine and should include time for the part to fall free of the mould. Once the part is ejected, the mould can be clamped shut for the next shot to be



injected.

2.1

After the injection moulding cycle, some post processing is typically required. During cooling, the material in the channels of the mould will solidify attached to the part. This excess material, along with any flash that has occurred, must be trimmed from the part, typically by using cutters. For some types of material, such as thermoplastics, the scrap material that results from this trimming can be recycled by being placed into a plastic grinder, also called regrind machines or granulators, which regrinds the scrap material into pellets. Due to some degradation of the material properties, the regrind must be mixed with raw material in the proper regrind ratio to be reused in the injection moulding process.

2.3 Parts

2.3.1 Square hollow section.

Square hollow section comes in different sizes, specifications and wall thicknesses. Its uniformity makes it predictable to use and visually appealing. It has a high weight-to-strength ratio. It's easy to bend, and because square steel tubing is inexpensive, it's cost-effective- even for large projects.

Steel tube is easily recyclable. Many projects take advantage of square steel tubing, including all types of buildings, highway guardrails and signage, support columns, trusses, bridges, heavy equipment, storage systems, and exercise equipment. A wide range of dimensions, when combined with the appropriate steel grade, ensure that the functionality and cost-efficiency of your structure can be optimised.

2.2

2.3.2 Circular hollow section.

Mechanical steel tubes are used in machined or formed parts of industrial, automotive, farm machinery, aircraft, transportation, materials handling, and household equipment. It is produced to exact outside diameter and wall thickness dimensions. Mechanical tubes are used for mechanical and light gauge structural applications.

Tubing used for mechanical and light gauge structural applications. This allows for more specific property uniformity throughout the tube compared to standard pipe or tube. While Mechanical tube can be produced to standard specifications when requested, it is often produced to "typical" properties that focus mainly on the yield strength for a precise size and wall thickness. In some applications with severe forming, yield strength may not even be specified and the mechanical tube is produced to be "fit for use". Mechanical tubing encompasses a wide range of both structural and non-structural applications.

2.3

2.3.3 Strip steel

Strip steel or cold rolled strip is a steel product that is produced from a hot rolled strip that has been pickled. The coil is then reduced by a single stand cold roll steel mill straight away or reversing mill or in a tandem mill consisting of several single stands in a series. The strip is reduced to approximately final thickness by cold-rolling directly, or with the inclusion of an annealing operation at some intermediate thickness to facilitate further cold reduction or to obtain mechanical properties desired in the finished product. High carbon strip steel requires

2.4

additional annealing and cold reduction operations. The coil is then slit to the desired width through the process of roll slitting.

2.3.4 Tubular band heater

Band Nozzle Heaters are sheathed in Brass and Aluminized Steel sheets. The heating Element (Windings) is of high quality Nickel-Chromium resistance wires. LEI band heaters

with

2.5

EXPANDABLE design feature allow the heater to be opened for installation over the Nozzle without causing internal damage to the windings. Heater Terminals are properly placed in a small terminal box so as to avoid spillages and cold spots. Heaters are provided with 1mtr long wire. Clamping action for the heaters are provided by either bent-up flanges (ears).

Applications: Extruders Nozzle Blow Moulding Machines Injection Moulding Machines Nozzles. Blow Film Dies and Various Cylindrical applications.

2.3.5 PID Temperature Controller

A PID temperature controller, as its name implies, is an instrument used to control temperature, mainly without extensive operator involvement. A PID controller in a temperature control system will accept a temperature sensor such as a thermocouple or RD as input and compare the actual temperature to the desired control temperature or setpoint. It will then provide an output to a control element. PID temperature controllers work using a formula to calculate the difference between the desired temperature setpoint and current process temperature, then predicts how much power to use in subsequent process cycles to ensure the process temperature remains as close to the setpoint as possible by eliminating the impact of process environment changes.

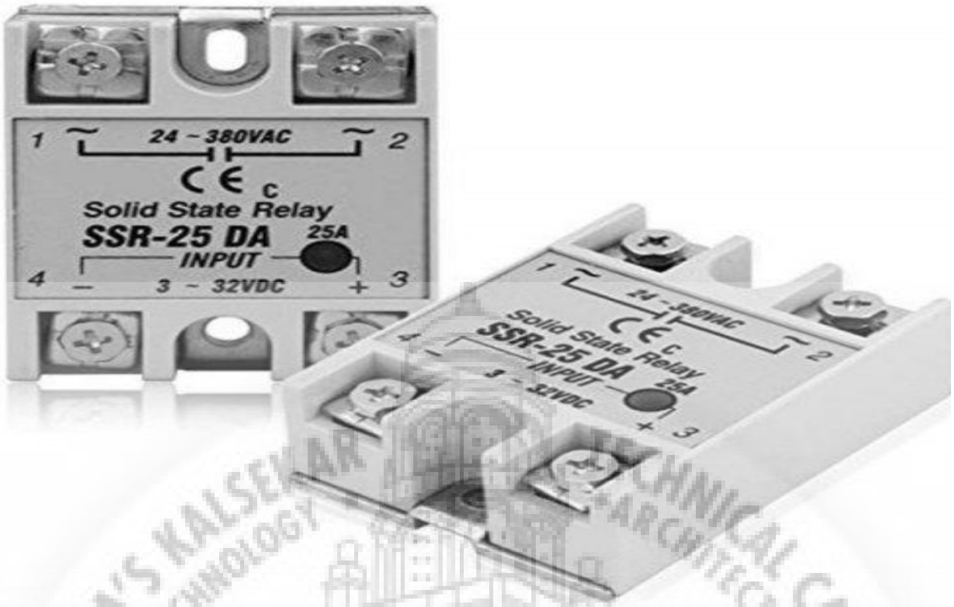
2.6

2.3.6 Solid State Relay (SSR)

A solid state relay (SSR) has no moving parts. It is a transistor activated by a small AC or DC control signal produced by the temperature controller. This type of relays can switch up to several hundred amps in less than a second. They're used for heaters with low mass like radiant heaters (but not quartz tubes and quartz lamps which require a silicone controlled rectifier) and air heaters which require very frequent power switching. Solid state relays are usually mounted on a heat sink to dissipate the heat they generate. If several of these relays are mounted in a control panel, ventilation or even cooling of the control panel may be necessary.

- Advantages over electro-mechanical relays:
- faster reaction time
- increased life time of relay and heater

- no sparking during turn on



2.7

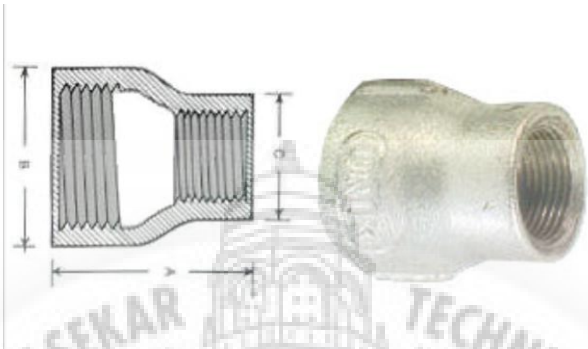
2.3.7 K Temperature probe cable

Type K Thermocouple provides widest operating temperature range. It consist of positive leg which is non-magnetic and negative leg which is magnetic.In K Type Thermocouple traditional base metal is used due to which it can work at high temperature and can provide widest 88 operating temperature range. One of the constituent metal in K Type Thermocouple is Nickel, which is magnetic in nature.A thermocouple is a device consisting of two different conductors (usually metal alloys) that produce a voltage proportional to a temperature difference between either end of the pair of conductors.Grounded type is more sensitive to temperature, can help to measure temperature fasterly.K type Thermocouple with flexible spring built in.2 terminals for easy connection.

2.8

2.3.8 Reducing pipe socket

It is a pipe Fittings which is widely used in piping and plumbing industries. The reducer sockets are generally used where pipe of two different diameters are to be connected with each other. Or in other words it is used where the diameter of one pipe has to be reduced with our affecting the connection between the two. It can be made of different materials nowadays PVC reducing is widely used. But for heavy applications GI based reducing sockets are being uaed.



2.9

2.3.9 Socket plug

It is also a pipe Fittings which is used for generally capping purpose. Whenever a flow through a pipe has to be stopped so at the other end of the pipe socket plug has to be added. This is available in different types of materials like PVC And GI. GI socket plug is widely used in heavy applications in industry while OVC based plugs are used in plumbing purposes in household.

2.10

Chapter 3

Components, Specifications, Material and Design

3.1 Components

Sr. NO	Component	Quantity	Material	Specification
1	MS square bar	1	Mild steel	120 inch × 1inch× 3mm
2	MS square bar	1	Mild steel	48 inch × 1inch × 2mm
3	MS hollow pipe (Barrel)	1	Mild steel	OD = 32 mm Wall thickness = 3mm
4	MS hollow pipe (Plunger)	1	Mild steel	OD = 28 mm
5	Reducing Pipe socket	1	GI	Length =44mm Bigger Dia = 36mm Small Dia = 30 mm
6	Socket plug	1	GI	Nominal size =20mm Length = 27 mm
7	MS Strip	1	Mild steel	12 inch × 1 inch × 2mm
8	Nut and Bolts	3	Mild steel	Length=2 inch Size = 3/8 inch
9	PID controller (REX-C100)	2		AC 100-240V 50/60HZ Detective temperature range: 0 to 400℃
10	SSR	2		Output Voltage: 24-380V AC
11	Band heater	4	Sheathed in Brass and Aluminized Steel Sheets	Watts: 85W Volts: 230V.
12	K Thermocouple Probe Cable	2	Fiberglass	Sensor diameter: 4.5mm Temperature range: 0～400℃
13	Scissor jack	1	Steel	20 ×16 × 11 cm

3.2 Specifications

3.2.1 REX-C100 Temperature Controller

1.3 Digit setup values

2.Measuring accuracy: ±0.5%FS

3.Cold-end compensation tolerance: ±2℃（can be modified by software in 0～50℃）

4.Resolution: 14 bit

5.Sampling cycle: 0.5 Sec

6.Power: AC 100-240V 50/60HZ

7.Process value (PV), Setting value (SV)

8.Output, and self-tuning can be indicated by: LED

9.PIN control (including ON/OFF, step-type PID and continuous PID)

10.Self-tuning control

11.Relay output: contact capacity 250V AC 3A (resistive load)

12.Proportional band (P): 0～full range (ON/OFF control when set to 0)

13.Detective temperature range: 0 to 400℃

14.Insulation resistance: >50M ohm(500V DC)

15.Insulation resistance: 1500V AC/min

16.Insulation resistance: Power Consumption < 10 VA

17.Service environment: 0～50℃

18.Environment with no corrosive gas 30～85% RH

3.2.2 K Thermocouple Probe Cable

1.Length: 1M

2.Sensor diameter: 4.5mm

3.Temperature rang :0～400℃

4.Internal Insulation: Fiberglass

5.External Shielding: Insulated Shielding

3.2.3 Max.40A SSR

1.Output Current: 40A

2.Input Voltage: DC 3-32V

3.Output Voltage: 24-380V AC

4.Output Voltage Range: Standard Type

3.2.4 Band Heater

1.Copper Wire 1 mtr long

2.High Quality Nickel - Chromium resistance wires

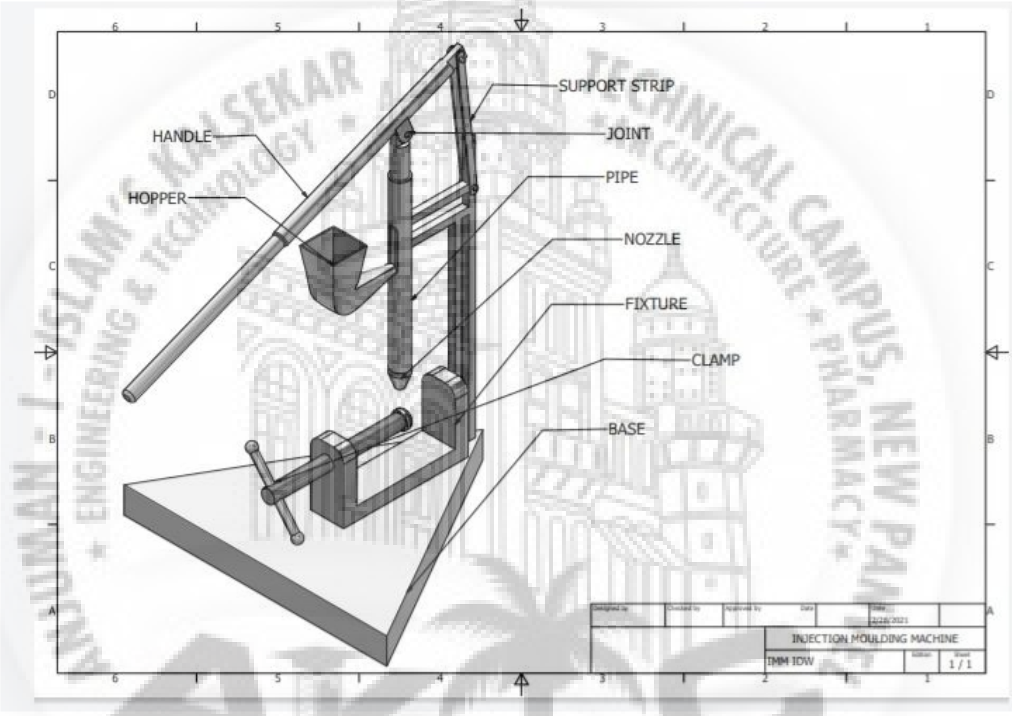
3.Sheathed in Brass and Aluminized Steel Sheets

4.Dimensions: Inner Diameter of heater: 30mm x Length: 30mm x Watts: 85W x Volts: 230V.

3.3 Design Calculations

Designing is the one of the most important and critical aspect of any project. The proper designing of the parts and components used in the any of the machine is responsible for the proper and correct functioning of the mechanism and movements of the parts. So in this injection moulding machine the designing is done on the inventor modeling software. Using a software is very beneficial because of trial and error is simpler on the software with a actual 3D design.

In this figure , the triangular base is first made on the software because the entire assembly is



3.1

attached to the base. similarly the other components are completed by drafting and assembled with each other.

Material selection:

Ms steel (mild steel) is being selected due to mainly its availability, thermal properties , physical properties and cost.

Mild steel is a type of low carbon steel. Carbon steels are metals that contain a small percentage of carbon (max 2.1%) which enhances the properties of pure iron. The carbon content varies depending on the requirements for the steel. Low carbon steels **contain carbon in the range of 0.05 to 0.25 percent**. Mild steel is a ferrous metal made from iron and carbon. It is a low-priced material with properties that are suitable for most general engineering applications. Low carbon mild steel has good magnetic properties due to its high iron content, it is therefore defined as being 'ferromagnetic'.

Mild steel has a carbon content of between 0.16% and 0.29 % maximum with a relatively high melting point of between 1450°C to 1520°C. Steels with a higher carbon content than mild steel, have a lower melting temperature. This high melting temperature means that mild steel is more ductile when heated, making it particularly suitable for forging, cutting, drilling, welding and is easy to fabricate.

Mild steel is not suitable for through hardening. It can be case hardened by being heated and a chemically reactive source of carbon added, the subsequent quench cycle will harden the surface layer. This outer layer, 'the case' will become hardened.Its impressive properties are responsible for a growing use in a variety of industries. Some mild steel's physical properties are as follows:

- High tensile strength
- High impact strength
- Good ductility and weldability
- A magnetic_metal due to its ferrite content
- Good malleability with cold-forming possibilities
- Not suitable for heat treatment to improve properties.

Advantages:

- It is easily available at reasonable price.
- It can be easily be welded which is very important for this project.
- It has high machinability so that different operation can be performed easily.
- High strength to weight ratio.
- Greater ductility at high strength.

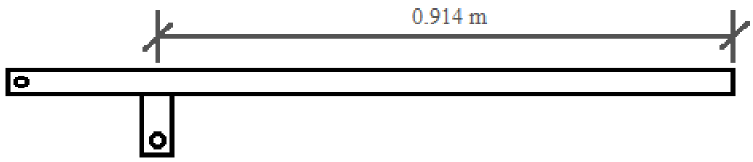
Material used:

High density polyethylene (HDPE)	Density	940 kg/m^3
	Melting point	130.8 °C.
	Temperature of crystallization	111.9 °C
	Latent heat of fusion	178.6 kJ/kg.
	Thermal conductivity	0.44 W/m°C. at °C
	Specific heat capacity	1330 to 2400 J/kg-K
	Specific heat (solid)	1.9 kJ/kg. °C.
	Crystallinity	0.6

i. Total available force:

A normal human being can easily exert a pressure of 2 kg,

$F_a = 2 \times g \times r$



$= 2 \times 9.81 \times 0.914$

$= 17.93$ Nm 3.2

ii. Force required to press the molten plastic through nozzle:

$$A \times d \left[P1 + \frac{1}{2}\rho {V_1}^2 + \rho g h_1 \right] = A \times d \left[P2 + \frac{1}{2}\rho {V_2}^2 + \rho g h_2 + \rho g f_h \right]$$

As we know,

$A \times d \times P = W$

$$w_1 + KE_1 + PE_1 = w_2 + KE_2 + PE_2 + f_h m g$$

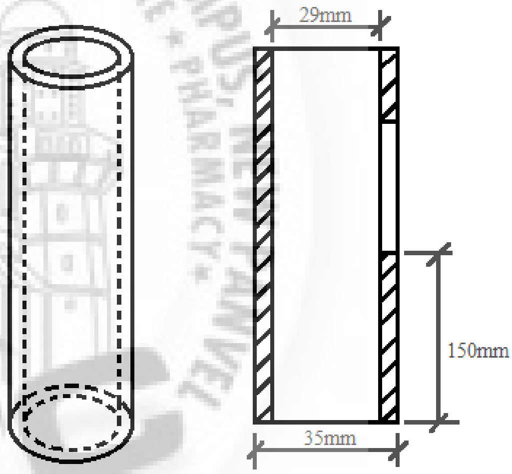
Since,

$KE_1 = KE_2$, $PE_1 = PE_2$

$$\therefore w_1 + w_2 = f_h \times m \times g$$

$$\therefore W = f_h \times m \times g \quad (equation\ 1)$$

a) mass of plastic:



$\rho = \frac{m}{v}$

$m = \rho \times v$

$m = 930 \times \frac{\pi}{4} \times d^2 \times L$

$m = 930 \times \frac{\pi}{4} \times 0.029^2 \times 0.15$

$m = 92.1\ g$

b) head loss due to friction:

$f_h = \frac{fLV^2}{2dg} \quad (equation\ 2)$ 3.3

Now to find out Darcy Weisbach factor (f),

We use Colebrook equation.

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left[\left(\frac{e}{3.7D}\right) + \frac{2.51}{R\sqrt{f}}\right]$$

e = 0.045 mm for mild steel (absolute pipe roughness)

R = 1000 (Reynolds number)

f = 0.063

putting value of "f" in equation 2,

$$f_h = \frac{0.063 \times 0.15 \times 0.1^2}{2 \times 0.029 \times 9.81}$$

$$f_h = 1.660 \times 10^{-4}\ m$$

$$f_h = 0.166\ mm$$

Putting values in equation 1,

$$W = f_h \times m \times g$$

$$W = 0.166 \times 10^{-3} \times 0.0921 \times 9.81$$

$$W = 1.499 \times 10^{-4}\ Nm$$

Now,

$W = F_b \times displacement$

$1.499 \times 10^{-4} = F_b \times 0.15$

$F_b = 9.93 \times 10^{-4}\ N$

Hence we conclude that the force available is more than the force required to operate the machine.

iii. Total barrel capacity:

$$V_b = \frac{\pi}{4} \times d^2 \times L$$

$$V_b = \frac{\pi}{4} \times 29^2 \times 304.8$$

$$V_b = 201.32 \times 10^3\ mm^3$$

iv. mass flow rate:

$Q = A \times V$ (equation 3)

Now applying Bernoulli's equation,

$$\left[P1 + \frac{1}{2}\rho {V_1}^2 + \rho g h_1\right] = \left[P2 + \frac{1}{2}\rho {V_2}^2 + \rho g h_2 + \rho g f_h\right]$$

$P_1 = P_2$ (atmospheric)

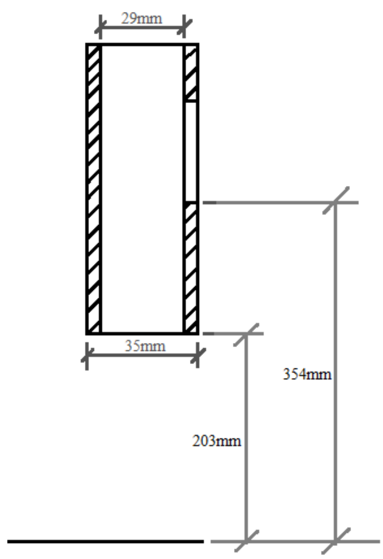
$V_1 = 0$ (initial condition)

$h_2 = 203$

$h_1 = 354$

hence we get,

$V_2 = 1.31$ m/sec



3.4

Putting values in equation number 3,

$$Q = A \times V$$

$$Q = \frac{\pi}{4} \times 0.029^2 \times 1.31$$

$$Q = 8.6528 \times 10^{-4}\ m^2/sec$$

Chapter 4

Fabrication

4.1 Frame

4.1.1 Base

One of the most important aspect of any kind of machines are the base of the machine. The base of the machine must be solid and strong enough to withstand all the stresses and forces acted on the machine. All the components and accessories are mounted on the base so the base should be balanced correctly. For fabrication of frame the important parameter is the type of material used. So for high strength and based on accessibility, we select the MS square pipe of 1 inch width and 3 mm thickness. We select high thickness which will provide the additional strength and rigidity which will required to strongly held the machine on the ground. The shape of the base is kept triangular of the size 12 inch each three sides. The reason behind selecting the triangular base over conventional square base is that, square base of 12 inch takes more floor space than triangular base and secondly having four sides the total weigh of the project will be more. Square base also requires more material than triangular base, so considering above points the triangular base is selected. The base is fabricated in following steps

1. Cutting of Ms Square pipe:

Before cutting the Ms pipe, the marking is done on the pipe. Marking of 12 inch is marked on the pipe and three sides are cut with the help of the hand cutter. There different types of methods by which we can cut the pipe of desired dimensions but we select the hand cutter for cutting because, the hand cutter is easily accessible and more effective than hacksaw.

2 .Welding :

One of the best property of the Mild steel is that it is easily weldable. It deos not requires any type of additional settings and different expensive methods to weld. There are different types of welding methods and techniques are available. After cutting the base parts all the 3 sides are weld together and form the strong triangular base.

4.1

4.1.2 Stand

Stand is vertical member of the machine which is welded to base of the machine. The entire barrel and electrical and electronic component assembly is mounted on the stand. So the stand must be strong and rigid enough to withstand and hold the components and barrel easily without and failure. So for fabricating the stand, similar MS square pipe material is taken for the stand. The size is also similar which is 1inch width and 3mm thickness. For making the stand more solid, we used two Ms square pipes. The size of the first long square pipe for stand is 1inch width × 24 inch length × 3mm thickness. Second pipe for stand is of same material and thickness but having a different length. The size are 1 inch width × 20 inch length × 3mm thickness. For cutting the pipe same hand cutter is used and for joining the stand to base similar welding process is repeated.

4.1.3 Horizontal support

Horizontal support is the same Ms square pipe with similar specifications. It is attached to the stand on which the circular barrel is weld. There are two horizontal support of size 1 inch width × 4 inch length × 3mm thickness. The Ms pipe is weld to the stand with the distance between the two pipe is 2 inch. At the other end of this horizontal support circular hollow pipe called barrel is weld. This support provide the stability to the barrel because it is welded to it.

4.2

4.2 Barrel

Barrel is the circular hollow pipe which perform two most important function of the machine. Barrel is hollow because raw material like plastic is heated inside the it and other than that it also carries injection nozzle at other end. The material for barrel should have height melting point because the outside surface of the barrel is always heated to a high temperature. So while selecting the material this parameter should be noted. The material selected for barrel is mild steel because of its excellent heat transfer capability and height melting point. Also the cost of the mild steel is low. The availability of the mild steel hollow pipe is excellent. The external diameter of the barrel is 35mm with 3mm thickness. For our machine the length of barrel is 16 inch. The inner surface of the barrel must be clean and smooth since the plunger is to be slided inside the barrel.

Cutting of the barrel:

The circular barrel is cut with the help of cutting machine. 16inch length is marked and cut by the machine. Both ends and inside of the barrel is clean with cotton cloth so we can obtain smooth clean surface. After cutting the barrel it is weld to the horizontal support. The 4inch rectangular slot is made on the barrel by which ram material like plastic is supplied inside the barrel for heating and melting of the plastic. After cutting of the slot sharp edges of the slots is made smooth with the smooth file by filing operation.

Welding of the barrel:

The barrel with the slot having on the top front side of the barrel is welded to the other end of the horizontal support. During the welding operation the perfect alignment and straightness of the barrel is maintained for proper functioning of the press mechanism.

4.3

4.3 plunger and Handle:

In injection molding machine the liquefied plastic comes through nozzle with the help of some compressing mechanism. This mechanism either aid by hydraulic system or pneumatic system. But in small scale, rack and pinion or hand press manual mechanism is used. The plunger is the element which will slide inside the barrel and compressed the molten plastic to flow through nozzle. Plunger should have high melting temperate. Because of the heat produce inside the barrel may increase the thermal stresses on the plunger so the plunger should be able to withstand these thermal stresses. Material for plunger is again Mild steel. Plunger should be solid to compress the plastic through nozzle. But the problem is if we use the solid plunger of required size the total weight of the project will be more or it may create imbalances in the machine. So to avoid this problem we used hollow Shaft of outer diameter 28mm. So to perform like solid shaft, the end of the Shaft is filled and the end surface is made plane. The movement of plunger is done with the help of handle

. Handle is the element which will provide the force on the plunger to force the plastic through the nozzle. The size of the square plunger is 48length × 1inch width × 2mm thickness. The length of the handle plays a vital role in the machine because the pressure and force depends upon the length of the handle. The handle act as lever which will reduced the efforts and increase the force by increasing the length. the other end of the plunger is attached to the handle by means of nut and bolts. A hole is drilled on the top of the plunger through which bolt is passed through the metal strip attached on the handle. A similar hole is drilled on the metal strip to fastened the plunger with the handle. One end of the handle is drilled also which will be fastened to strip of 8 inches on both sides and the other end of the two strips are attached to the horizontal support. Due to this arrangement the handle can be freely operate by hand and can move in upward and downward position. The upward and downward movement of the handle

4.4

will cause the plunger to slide inside the hollow barrel freely and of the plastic is fed to barrel the plunger will apply the pressure and forces the plastic to flow through nozzle. The entire handle and plunger assembly can be detached with each other which will help in easy maintenance and transportation of the machine.

4.4 Nozzle:

The basic function of the nozzle in the injection moulding machine is to connect the barrel to the mould and form a seal between the barrel and the mould. It also injects the molten plastic into the mould by fixed flow rate which depends on specifications of each nozzle. These are basic types of nozzle available for injection moulding machines such as simple nozzle, hydraulic shut off nozzle, spring shut off nozzle and reverse paper nozzle. Shut off nozzle is widely used in injection molding machine but the only problem is it is used for high volume of production. So at small scale shutt of nozzle cannot be used and also it is expensive. So we need a nozzle type element which works more or less lika a nozzle and it cost less and works satisfactorily.

4.5

For this project, we replace the shut off nozzle with socket and plug arrangement. The socket provides the smaller variation in the area like a nozzle. the end of the socket the plug in attached which has the screw and fitted into the socket. The screw pair arrangement provides the proper sealing thus performs and fulfill the purpose. The end of the socket in rectangular shape and it doesn't have any hole through which plastic can be flown. So first square head of the plug is converted into the conical shape with the help of lathe machine. The purpose of this taper shape is that, this shape will help in mating with the mould completely. After the outer shape hole is required a small through hole with small diameter is drill on the face of the plug and finally the plug is tightened with socket and the nozzle is completed.

4.6

After completing the arrangement of nozzle the nozzle is welded at the end of the barrel so the barrel and nozzle part becomes single piece. During the welding of the nozzle extra care is taken for proper alignment and straightness of the nozzle for the correct and efficient flow of the molten plastic in the mould.

4.5 clamping arrangements:

It is used for the clamping and maintaining the position of mould with respect to nozzle tip. There are different types of clamping devices are available but we take the different approach in the clamping of die. We use scissor jack for clamping and maintaining the position while also applying a sufficient pressure. The scissor jack is used for lifting the cars so it is very strong and easy to use. Scissor jack can be move and down with the help of screw thread. So by applying a very less effort we can operate the jack.the die opening and nozzle tip is made align with each other and with the help of scissor jack the die is clamped on the nozzle.

4.7

Scissor jack is fitted on the base of the project.

4.6 Electrical and Heating system:

Heating is the most crucial part in the injection moulding machine. Heating process of any injection moulding machine should be easy efficient and rapid. The machine should attain the melting temperature of the plastic raw material used during the process. In our injection moulding machine the heating is achieved with the help of band heater, PID controller, thermostat and temperature sensor. Band heater is the hand band type element which is wrapped around the barrel. Once the electrical supply starts the abnd heater starts heating the barrel. For controlling and maintaining the temperature of the barrel PID controller and thermostat is used.

4.8

The melting temperature of the plastic will be set on the controller once electrical supply starts the PID controller start increasing the temperature of the band heater. After achieving the desired temperature. The thermostat sends the signal and further heating is stopped and it manages the desired temperature. The temperature sensors sense the actual temperature on the barrel since they are attached to barrel and the actual temperature will be indicated on the controller.

4.7 Circuit Diagram and electrical connections:

We have Rex C-100 PID temperature controller which has the total 6 pins. The pins are namely pin 1, pin 2, pin 4, pin 5 and pin 9 and pin10. We also have the Solid state relay SSR with connection to PID temperature controller. The SSR is the electronic switching device that switches ON and OFF when an external source is across its terminals. SSR has 4 pins namely pin 1 and 2 on top side and pin 3 and pin 4 on bottom side. We also have band heater and k thermocouple probe.

Connections:

PID temperature controller (REX C-100):

available connections: pin 1 and 2, pin 4 and 5, and pin 9 and 10.

Solid state relay SSR

Available connections: pin 1 and 2, pin 3 and 4.

1. At the pin 9 of PID temperature controller we connect blue terminal of k probe thermocouple as shown in the connection diagram.

2. Similarly at the pin 10 of the PID temperature controller we connect red terminal or wire of k probe thermocouple. This thermocouple will measure actual temperature.

3. We connect the pin 4 of the PID temperature controller to the pin 3 of the solid state relay (SSR) with the red wire.

4. Similarly we connect the pin 5 of the PID controller to pin 4 of the SSR with the blue wire.

5. We Connect pin 1 of the PID controller to the live of 220v ac power supply with yellow or brown wire.

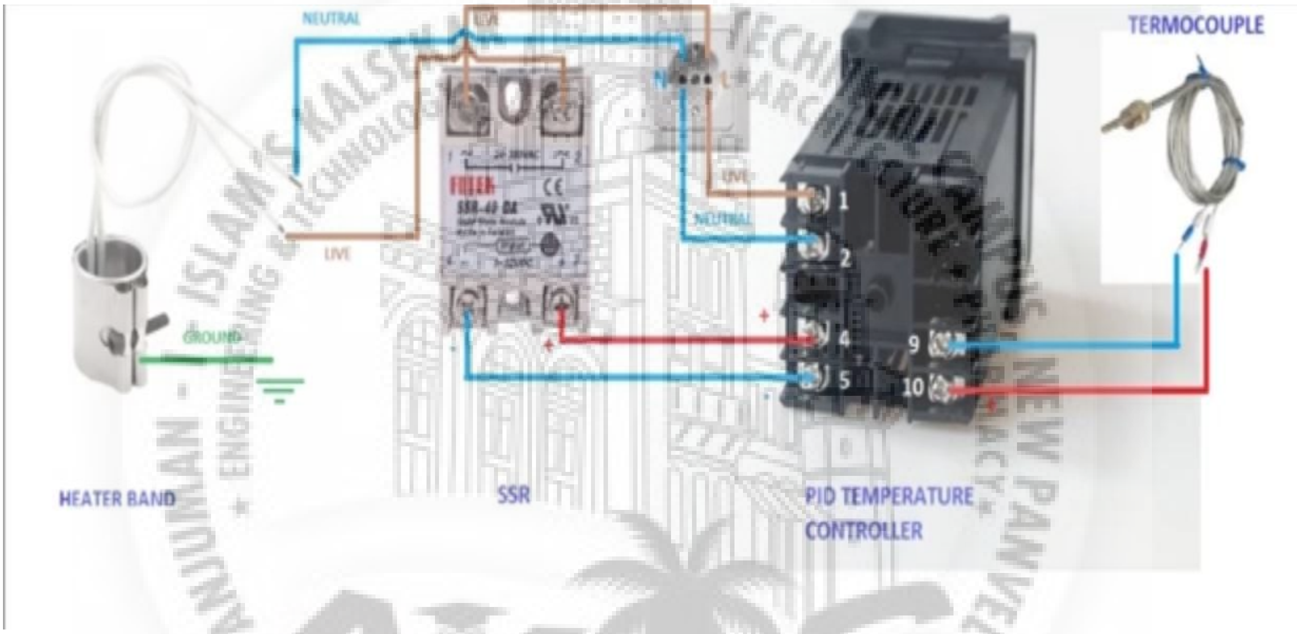
6. We connect pin 2 of the PID controller to neutral of the Ac power supply with blue wire.

7. We connect pin 1 of the Solid state relay SSR to the live of the 220v Ac power supply with the help of Brown or yellow wire.

8. We connect the one wire of the Band heater to the pin 2 of the solid state relay SSR with the brown or yellow wire.

9.we connect the other end of the band heater to the neutral pin of the main supply.

By these connections our entire electrical and electrical system is connected with each and ready perform the required functions.



4.9

4.8 Procedure to operate the machine:

The following steps is required to operate the machine in a proper way,

- Before starting the heating system, first check all the electrical connections and take the necessary safety precautions.
- Plug in the PID controller to the 220 V AC supply and switch on the supply.
- Turn the machine ON and set the temperature depending upon the melting point of the plastic, and type of plastic used.
- When the temperature is increasing make sure to lower the handle.
- The band heater near the nozzle should be set higher temperature than that of upper band heaters because to melt the complete plastic granules.

- When the actual temperature around the barrel reaches to desired set temperature, now the plastic should feed to the barrel through hopper.
- After putting the plastic, wait for some times until the plastic is completely melted inside the barrel.
- So before injecting the plastic, the mould should be place according to the nozzle opening.
- Mould should be placed on setting mechanism which will press the die against the nozzle opening.
- After setting the die, the plunger must bring down in rider to apply the pressure on the molten plastic which will flow through the nozzle.
- The plastic will flow into the mould and take its shape after solidifying.
- After that move the plunger higher. Release the die and take off the product after cooling down.
- Similarly the process should be repeated for another product.
- After the process is done, the plunger should be move up and down to remove the remaining plastic in order to avoid the choking of barrel and nozzle.
- Turn off the PID temperature controller and switch off the electrical supply.
- Unplugged the machine safely and the process is done.

Chapter 5

Cost report

5.1 Cost details:

Sr. NO	Component	Quantity	Material	Specification	cost
1	MS square bar	1	Mild steel	120 inch × 1inch× 3mm	650
2	MS square bar	1	Mild steel	48 inch × 1inch × 2mm	200
3	MS hollow pipe (Barrel)	1	Mild steel	OD = 32 mm Wall thickness = 3mm	100
4	MS hollow pipe (Plunger)	1	Mild steel	OD = 28 mm	150
5	Reducing Pipe socket	1	GI	Length =44mm Bigger Dia = 36mm Small Dia = 30 mm	55
6	Socket plug	1	GI	Nominal size =20mm Length = 27 mm	30
7	MS Strip	1	Mild steel	12 inch × 1 inch × 2mm	30
8	Nut and Bolts	3	Mild steel	Length=2 inch Size = 3/8 inch	32
9	PID controller (REX-C100)	2		AC 100-240V 50/60HZ Detective temperature range: 0 to 400℃	3600
10	SSR	2		Output Voltage: 24-380V AC	-
11	Band heater	4	Sheathed in Brass and Aluminized Steel Sheets	Watts: 85W Volts: 230V.	2400
12	K Thermocouple Probe Cable	2	Fiberglass	Sensor diameter: 4.5mm Temperature range: 0～400℃	-
13	Scissor jack	1	Steel	20 ×16 × 11 cm	700
	Total				7947

Chapter 6

Conclusion

6.1 Conclusion

Due to its low cost, this working model can be successfully inducted in small scale molding units and can be used to manufacture small plastic component at an acceptable cycle rate within an effective cost component.

A mini injection moulding machine for Plastic Processing was designed and fabricated which melts and injects (pressurizes) molten materials into mould cavities with ease. This machine is primarily for testing the quality of composite plastic and for testing the mould design. This machine is inexpensive and can be used as learning equipment in school or laboratories and also could be used in the production industry for producing small size plastic products. The components design of the machine was properly undertaken and fabrication followed by assembling of the parts.

6.2 Future scope

- Manual mechanism can be replaced with hydraulic or pneumatic system.
- Different clamping assembly can be used to increase the clamping force.
- Stroke length of plunger can be increased to increase the barrel capacity.
- More heat bands can be attached to reduce the heating time.
- Cooling system can be attached to cool the mould in machine only.
- Fully automization can be achieved.

References

- Ching-ChihTsai,Shih-MinHsieh,Huai-EnKao.“
  Mechatronic design and injections peed control of an ultra-high speed plastic injection molding machine "in mechatronics Volume 19(March2009).
- William Liu.
  “The microscopic features of cavitation erosion and the solution in the plastic injection molding machines "in Engineering Failure Analysis Volume36, (January2014).
- Ego Muller, Rainer Schilling. “Improvement of Injection Moulding Processes by Using Dual Energy Signatures "in Procedia CIRP Volume17 (2014).
- A.G.Gerber,R.Dubay,A.Healy.
  “CFD-based predictive control of melt temperature in plastic injection molding "in Applied Mathematical Modeling Volume30, (Sep.2006.
- Harold, F. and Giles, J.R. (2005) Calculations of Output in Different Sections of the Extruder in Extrusion, the Definitive Processing Guide and Handbook; New York: Williams Andrew: 80- 81.
- Jassim, M., Abdulkarim, J., Darewan, A., Zryan, O.A., Khelan, O.A. and Mohammed, H.H. (2016) Design and Fabrication Recycling of Plastic System; International Journal of Scientific & Engineering Research, 7 (5): 1471-1480.
- study & review of design and manufacturing of vertical injection moulding machine prototype parts m
  Shoeab Sheikh, Dr. Prashant Sharma Department of Engineering, College of Dairy, Food Science & Technology (MPUAT).
- PLASTIC INJECTION MOULDING MACHINE
  Gaikwad Mahesh Digamber, Sharif Mohiuddin Akbar2, Dhomase Datta Govind3, Ravale Shivshankar Ashokrao4 ,Mr. Bidve Mangesh Angadrao5,Mr Devshette Ashish Rajkumar.
- Kwong, C.K.; and Smith, G.F. (1998). A computational system for process design of injection moulding: Combining blackboard-based expert system And case-based reasoning approach. *International Journal of Advanced Manufacturing Technology*, 14(4), 239-246.
- Niebel, B.W.; Draper, A.B.; and Wysk, R.A. (1989). *Modern manufacturing Process engineering*. Mcgraw-Hill Book Company, Singapore, 435-437.
- Lindberg, R. A. (1990). *Processes and materials of manufacture*. Prentice- Hall of USA, Inc., New Jersey, 247-250.

- Netstal, C. (1978). Instruction manual for injection moulding machine. *Netsal Machine and Foundry Limited*, Switzerland, 36-60.

- Design and development of injection moulding machine for manufacturing maborator
  R A Siregar[1], S F Khan[2] and K Umurani

links

- Web link
  www.unikpipe.com/pipe-fittings/index.html
- Working priciple
  https://www.ssmachinery.com/Guide-to-the-working-principle-of-injection-molding-machine/
- process
  https://www.custompartnet.com/wu/InjectionMolding#:~:text=The%20injection%20molding%20process%20requires,solidifies%20into%20the%20final%20part
  Steel parts
- http://www.sunnysteel.com/square-hollow-section.php#:~:text=Square%20hollow%20section%20comes%20in,effective%2D%20even%20for%20large%20projects