NUST COLLEGE OF
ELECTRICAL AND MECHANICAL

DESIGN AND FABRICATION OF A BOX TYPE PVC WELDING MACHINE

A PROJECT REPORT

DE-40 (DME)

Submitted by

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Asst. Prof Saheeb Kiyani

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ACKNOWLEDGEMENTS

We are thankful to Allah Almighty, the most merciful for the blessings, courage, and the intellect He has bestowed us with, because of which it became possible for us to accomplish such remarkable goal. We are thankful to our parents and the family for their constant support and encouragement through each thick and thin. We are much obliged to our supervisor Asst. Prof Saheeb Kiyani for their continuous guidance and the valuable time they spent on providing us the support and encouragement through each stage. Without their efforts we would never have been able to achieve that much. Moreover, we are grateful to all our fellows, friends who supported us intellectually and emotionally. Tones of thanks to all those who contributed to it, without all that support and appreciation things would have been different. We are hopeful that this project will add value to the peoples' lives and will be developed further to adopt this technology on a massive level.

ABSTRACT

Our Aim is to Design and Fabricate a Box type PVC Welding Machine. Since Covid-19 there has been a sharp rise in the demand for blood bags and as our country is currently not manufacturing them, they are being imported. This Machine would be used in the Biomedical industry to manufacture Blood and Urine bags. It would be a fully automated Machine which would input two PVC sheets then using hot metal plates it would fuse them together. Firstly, the prototype would be produced on any feasible software then necessary analysis would be done. After the selection of suitable materials and equipment Fabrication would be done.

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CHAPTER 1: INTRODUCTION

Our aim is to design and fabricate a box type PVC welding machine. This machine would be used in the biomedical industry to manufacture blood and urine bags. It would be a fully automated machine which would input the necessary materials and produce the final required output. Firstly, the prototype would be produced on any feasible software then necessary analysis would be done. After the selection of suitable materials fabrication would be done.

The process in which the surfaces are first softened and then joined using heat is known as PVC Welding. A molecular bond is created when thermoplastics that are compatible to each other are subjected to head. This leads to formations of PVC. The surfaces must be pressed together while being subjected to heat and pressure during production, afterwards if should be allowed to cool off.

Our main aim would be to design a machine that could manufacture blood bags. The machine would input two PVC sheets and create a blood bag after fusing and welding the sheets using its hot metal plates.

1.1 Background

The main aim and objective of this project is to aid the biomedical industry. The method for fabrication that joins materials, thermoplastics, or other metals by first melting them, and then allowing them to cool down is known as Welding. This process results in fusion. There are processes that join metal at lower temperatures that include soldering and brazing, welding is different from the simply because it does not melt the base of the meta. There is a variety of PVC Welding machines available. It is an industrial special welding machine for processing PVCs (Polyvinyl chloride). Currently Pakistan is not manufacturing Blood Bags, they are imported. But their demand is increasing exponentially day by day. Due to Covid 19 Plasma transfusion escalated and their requirement further increased.

1.2 Motivation

Since our country does not manufacture blood bags, we must import it from other countries. The reason behind this project is to make a prototype blood bag Manufacturing machine for our country. Bloods bags are used for reliable production, separation, storage, and transport of blood. Blood bags are made round, this design ensures the mixing of blood and the anti-coagulants that prevent blood coagulation during process of separation and fusion. It is inevitable to manufacture PVCs as they are available globally, widely, in forms of simple machines to complete sophisticated ones. The range of simple to sophisticated forms are from cutlery to complex medical equipment or pipes being used in construction purposes.

PVC medical devices can be easily sterilized using such methods as steam, radiation, or ethylene oxide, while keeping key properties such as flexibility and resistance to tears, scratches, and kinks. Medical products and designers use PVC due to its major versatility.

1.3 Objectives

Objectives of our project are as following

- To design a CAD model of the PVC welding Machine
- To manufacture the prototype of this machine
- To manufacture the machine for manufacturing of blood bags through PVC Welding.

Fig 1.1: PVC Blood Bag Properties

CHAPTER 2: LITERATURE REVIEW

2.1 What Is Polyvinyl Chloride (PVC)?

Polyvinyl chloride or PVC is rated as the third most common thermoplastic. PVC is made of raw materials derived from oil and salt and comes in two basic forms: rigid and flexible. PVC is made with less amounts of crude oil and natural gas that makes it more environment friendly as compared to other plastics.

2.2 Use of PVC

It is the most widely used thermoplastic polymer being used anywhere in the world. Naturally, it is brittle, and the color is white. Polyvinyl Chloride, looking at the timeline, has been known and used for way longer compared to other PVCs. It was synthesized for the first time in 1872 and was produced by Balanced Frequency or B.F. It was later produced in 1920s by Goodrich Company. Other PVCs came into existence somewhere between 1940s and 1950s. The main use is for clothes' fiber, applications in healthcare or for making signs, most of its use is in the construction industry. PVC was basically and accident. It was discovered first in 1832 and then in 1872 respectively by Henri Victor, a French chemist and by Eugene who was Russian. There is a large variety of advantages along with applications in multiple industries, whether it may be in flexible or rigid form. PVCs provide long lasting characteristics, it is economical, it is available rapidly and readily. In industrial applications, especially in areas like construction, it is the best considered option. Plastics can be melted and joined together to make one, on the condition that their properties are compatible.

Some common uses of PVCs are as follow

- Clothing
- Pipes
- Medical equipment
- Bottles
- Electrical wires

Fig 2.1: Demands of Blood Bags

2.3 Why choose a PVC welding machine?

For welding, the most suitable for numbers of different applications is the PVC. The PVC welding machines are chosen specifically due to high resistance to oil and chemical, high strength in terms of mechanical and chemical as well as fire resistance, along with this it has high durability. It is due to these reasons that industries that manufacture tents, create banners or signs use PVC as the main item for manufacture. One of the main features of PV is its weight. It is incredibly lightweight which makes it an attractive material along with the durable nature that easy adds to its attractiveness. It is utilized in plumbing or in areas of constructions along with other industrial applications. Due to its high fire resistance, thanks to its high chlorine content, it has gained a lot of popularity among a wide range of industries.

Polyvinyl Chloride is made from one of three emulsion processes:

- Suspension polymerization
- Emulsion polymerization
- Bulk polymerization

In our everyday lives, plastic is frequently thin and weak. It's designed to be torn apart, and it's easy to crush in our hands. It's no surprise that many people distrust the strength and benefits of plastic welding and ask how long the material and process will survive in contrast to a non-welded piece of HDPE (HDPE).

2.3.1 Durability of plastic welding

Plastic welding has been around for decades, and it has applications in the medical field, packaging, and the automobile industry. Its endurance is determined by a variety of elements, although in ideal conditions, it can be extremely strong and long-lasting.

When done correctly (meaning the region was prepared ahead of time), analyzed, the right welding rod was picked, and a slew of other parameters were double- and triple-checked, plastic welding can have up to 98 percent of the parent material's strength.

2.3.2 Purpose of plastic welding

It is mainly used in the automotive industry, but it is applicable in many industries. Consider the example for a bumper bar that is made of plastic. These bumper bars have a high amount of strength which is a requirement to pass safety requirements. This example illustrations the durability of plastic welding if it is used in the right places under the right circumstances.

Many businesses, particularly the automotive industry, use plastic welding. Consider how durable plastic welding can be in the correct circumstances: it's employed by professionals on plastic bumper bars, which must be extremely strong to meet safety standards.

2.4 Factors affecting strength and durability

As previously said, if done correctly, plastic welding can be robust and lasting, but a variety of factors, ranging from the material used to the welder's experience, will influence its durability. A drop-in durability expected is frequently the result of a poor or faulty welding method.

It's possible that the improper welding rod was chosen, the area wasn't adequately prepped, the temperature was incorrect, or the material was just too weak to handle and deserve plastic welding. These are all elements that can affect the durability of plastic welding, but rest assured that when done correctly and with the appropriate materials, it is capable of handling even the most demanding operations.

2.5 Preparation of proper area

Cleaning the region properly is critical, and this will necessitate completely washing and stripping the parent material. For plastic welding to work, there must be no paint, oil, grease, or UV damage. The next step in the preparation process will be determined by the welding technique employed. For short welding runs, pendulum welding is used, while for longer runs, speed welding is used. The need of properly priming the weld ahead of time is critical to the weld's long-term resilience.

2.6 Durability test

A Rod Test Kit is used to determine the rod's durability, which is important for choosing the proper rod for the job. Welding short strips of the parent material to itself is also used in tests since it is the most compatible material. This second phase is crucial for assessing if the material is ready to be welded or if it is too low in grade to properly weld. Tensile testers are most used to measure strength, and several components in a weld are inspected to assure durability.

2.7 Widely use of plastic

Plastics are widely used due to their availability and low costs. They can also be molded easily to form different shapes and sizes. Whenever a plastic item cracks, unlike items made of glass, they can be easily recycled or repaired.

2.8 Welding Strength

Thermoplastics are known to be durable welds. The welding project and ultimate use determine the strength of the welds.

2.9 Pros and cons of PVC

Some of the basic pros and cons of PVCs are given below.

2.9.1 Advantages

PVC offers several key benefits to businesses, cementing its position as one of the most popular and commonly utilized PVCs on the market. It has the advantages of being easily available and low-cost. In comparison to other PVCs, Polyvinyl Chloride is exceptionally thick and consequently hard, and it resists impact deformation quite well. The tensile strength of polyvinyl chloride is exceptional. Chemicals and alkalis are not a problem for polyvinyl chloride. Biocompatible. Glass bottles are no longer used. The invention is environmentally friendly because it eliminates the need to wash and disinfect the glass bottles it replaces. It's simple to prepare the work surface.

Welded plastics are extremely light. One of the uses of plastic welding include creating sealings that are airtight or leak free or leak tight. Because it is robust, flexible, and weather-resistant, PVC is frequently utilized in manufacturing. PVC material and plastic will be successfully weld independent of needs. The hot air, wedge and high temperature, radio frequency welding machines will always deliver based on requirements. PVC's advantages have helped it become one of the most widely used plastics on the planet. Even if it is widely successful and popular, there are some aspects to consider when using the material.

2.9.2 Disadvantages

While PVC has a number of benefits that make it an attractive material to deal with, there are a few things to keep in mind. Poor heat stability is one of the drawbacks that must be considered while utilizing PVC. The manufacturing process adds the chemicals that are responsible for stabilizing the materials at extremely hot temperatures. When melted or burned, polyvinyl chloride generates hazardous gases. Material compatibility is quite important. Many welding techniques necessitate joint configurations that can be difficult to create. Welding is more expensive than other accessible solutions on the market. Despite various drawbacks, Polyvinyl Chloride is a great material in general. It possesses a unique combination of characteristics that make it particularly effective for make it particularly useful for the construction business. Effective navigation and compensation for use of material in the projects can be done by taking notes and accounting for material’s shortcomings.

2.10 Material for blood bags

RBCs are commonly stored in bags made of polyvinyl chloride (PVC) with 30-40 wt. percent di-2-ethylhexylphthalate (DEHP) added to make the bags soft.

2.11 PVC Welding

PVC welding is a process of connecting PVC for welding and fabrication. PVC welding can be done in a variety of ways, each with its own set of benefits and characteristics. The appropriate approach can be chosen based on the type of pipes and the industry in which they are utilized. The discrete pieces of materials that are thermoplastic, whether it may be two or more are combined or united together using heat. Heat is typically given to the edges of the PVC to melt the edges until they can be joined.

PVCs welding is achieved in three phases, surface preparation, application of heat, pressure, and cooling. Many PVCs can be welded such as acrylic or polymethyl methacrylate (PMMA), polycarbonate (PC), polyethylene (PE), polypropylene (PP), polyethylene terephthalate (PETE or PET), polyvinyl Chloride (PVC), acrylonitrile-butadiene-Styrene (ABS). Consideration includes welding equipment such as warm air welding tools, PVC welding rod, extruders etc. and then heating and cooling time, pressure. Included in most PVC welding processes are devices that hold the PVCs components together so that a complete bond can be formed as the heat is added to the weld joint. PVCs welding is used for the joining of PVCs pieces but also to repair cracks.

2.12 Basic Requirements

Translucency allows you to see layers in centrifuged bags and assess if they are full. Flexibility (low bending stiffness) so it can squeeze the bag to process. When bent to a small radius, there is no damage. Because of its heat resistance, it can be steam sterilized before use. It can't burst in the centrifuge or tear when being handled. Oxygen permeable, but not excessively permeable to water. Cost is moderate.

2.13 Welding Processes for PVCs

Welding process for joining the PVCs are a lot – few of them are listed below

2.13.1 Laser Welding or Laser Beam Welding (LBW)

This welding process, also known as Laser Beam Welding (LBW), uses a laser to attach thermoplastic parts. The application of laser beam is such that a heat source that is concentrated is produced by the laser beam, which allows for deep and narrow welds at high welding speeds. One of its numerous advantages is its speed and precision control.

2.13.2 Welding with ultrasonic waves

Ultrasonic PVC welding is a widely used technique that has been around for a long time. It joins thermoplastics using heat generated by high-frequency mechanical motion. It occurs when high-frequency electrical energy is converted into a high-frequency mechanical movement. Ultrasonic welding can be used on any PVC material. It is noted for being inexpensive, clean, and satisfying quality standards. Hot Gas Welding

A commonly used welding process for the manufacture of smaller items (heat exchangers, chemical and water tanks…), hot gas welding used a specially designed heat gun. The warm air that the gun generates softens the PVC parts to be welded and the PVC filler rod which needs to be of same or comparable PVC material. The bonding process is aided through addition of PVC material along with hot gas to weld joint.

2.13.3 Spin Welding

Spin welding uses surface friction focused on a circular weld junction to unite PVC components. By spinning one of the pieces relative to the other, it generates the heat required for the melting of the surfaces to be bonded. The two pieces are held together by a regulated force. The joint will be permitted to cool after the spinning stops. It may be used to weld large-scale PVC components and is a quick operation, although one of the sections must be circular. Container sealing is one of its applications.

2.13.4 Vibration Welding

Vibration welding, also called linear or friction welding, is when two PVC pieces are connected under pressure. The heat is mainly generated when vibration is used along the common interface. Compared to the hot plate welding, it is much faster and more accurate.

2.13.5 Hot Plate Welding

One of the oldest processes is a thermal welding technique used for joining thermoplastics. The melting process of two surfaces is done by using a heated metal plate that is used in such a way that it is placed against or near the under-pressure surfaces. It is one of the most economical and fastest method for making blood bags. That is why we use a hot plate welding machine for our project.

2.13.6 Friction Welding

Friction welding of thermos PVCs is often employed for joining injection-molded parts and was established some time ago. It uses friction to produce heat and to join two pieces together. Friction welding delivers many benefits to manufacturing and is often used in the aerospace and automotive industries in this technique to join metals and PVCs.

2.13.7 Frequency Welding

This PVC welding process, also known as high-frequency welding or radio-frequency welding, uses an electromagnetic field to join two PVC pieces. The material is heated using high-frequency electric fields, and pressure is used to soften and fuse the two materials together, resulting in a strong link. This method is used to join polyurethane and PVC. In some cases, high-frequency welding is utilized to join PVC-coated fabrics, particularly in the medical field.

Because of its low electric conductivity and polar molecular structure, PVC is ideal for this form of welding. Rapidly alternating electrical current between two metal plates produces heat. Constant pressure is applied by the plates. There are various advantages to high-frequency welding. The welding process is extremely regulated because heat is only generated while the current is on. Because the current can be directed precisely, the process does not heat up the surrounding material. This lowers the chance of the material degrading due to heat. These assets allow the plate pressure to remain constant for a longer period, resulting in stronger bonds.

2.13.8 Hot Air Welding

By pushing compressed air across electrical heat components, hot air welders generate the heat required for welding. The generated warm air is applied to the welding point, melting the thermoplastics' surface. Pressure is applied, and a weld formed when the molecules between the two surfaces intermingle and cool.

On thermoplastic materials with a thickness of 1.5 mm (1/16") or more, warm air welding is employed. Welders that can be used on the go are available. As a result, hot-air welders can make welds in a variety of shapes, including curves. It's suitable for when the welding width needs to change often or when the welding process necessitates repeated beginning and stopping.

2.13.9 Hot Wedge (HW) Welding

To deliver the requisite heat, hot wedge welding employs a heated metal wedge precisely positioned at the weld location. Two sheets of fabric are pulled across the hot wedge and then pressed down by rollers. A weld is formed when the melted surfaces come together and cool. Because there is no blowing air involved to produce flying dust and dirt, handheld hot wedge welders are widely used in field applications where materials must be welded outside on site.

PVC is no exception to the rule that all thermoplastics are good weldable. Applying enough heat to melt the PVC covering, then applying pressure and cooling to form a weld, is the welding process. Welding processes differ primarily in terms of how heat is generated and administered. Hot Air, Hot Wedge, and High Frequency are the most prevalent forms of thermoplastic welding (radio frequency). Both are safe to use on PVC-coated textiles. Which one you choose is determined on the techniques and speeds used in your manufacture.

2.14 Area of Application

Blood collection, storage, transportation, and transfusion of whole human blood and blood components in the pharmaceutical sector. PVC, TPU, EVA (Ethylene Vinyl Acetate) and PVC mixed material having 20% PVC are all suitable for processing. Medical products include urinary catheterization bags, pharmaceutical bags, nutrition bags, ostomy bags, waste liquid bags, identification bags, blood pressure bags, and a variety of other items.

CHAPTER 3: METHODOLOGY

Design and fabrication of a box type PVC welding machine by hot plate welding process. Fig 2 shows an industrial machine used for the manufacturing of PVC blood bags. It uses a powerful head where pressure can be adjusted at will, a worktable and die surface made of pure aluminum casting, better heat conduction, worktable is made of solid plywood, pole-less heating device (optional), automatic overcurrent protection device, Automatic spark protection device.

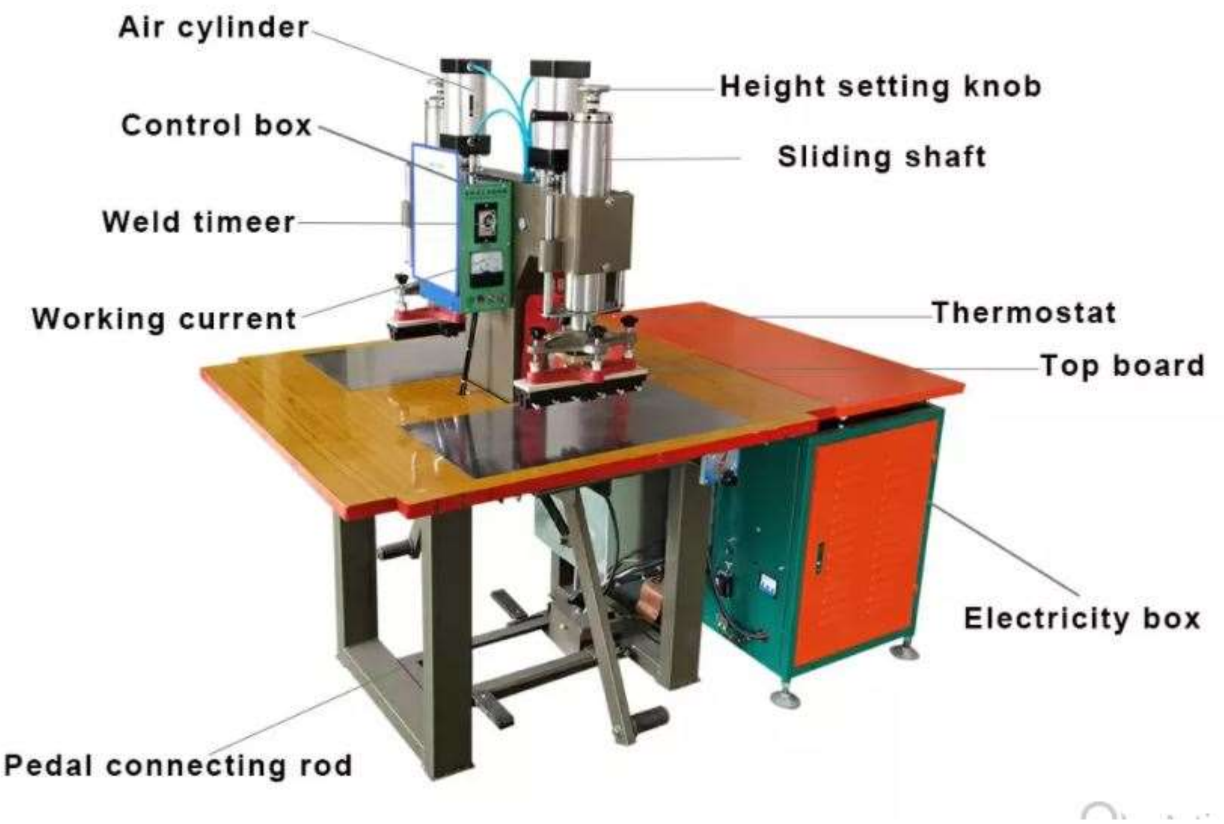

Fig 3.1: Industrial PVC Welding Machine

3.1 Formation of blood bags from the PVC welding machine

A blood bag system is a biomedical device for collecting, storing, transporting, and transfusing human blood and blood components. A single or several bags relate to tubes, needles, needle covers, clamps, and other components. The PVC material used in the Blood Bags is compatible with blood. Blood bags can effectively replace glass bottles for the collection, storage, transportation, and transfusion of blood and blood components since glass bottles require extensive cleaning, washing, and autoclaving operations and are susceptible to breaking at any time.

The usage of disposable bags in the future reduces the risk of contamination. The blood bags are made of biocompatible PVC that has been mixed with the appropriate chemicals. The formulation is used for making sheets, tubes by extrusion and other components like transfusion ports, clamps, needle cover etc. by injection molding. The bags are fabricated by high frequency welding technique. The bags are sterilized after the anticoagulant is filled. The inspected bags are foil packed and cartooned.

The following major steps are involved in the manufacture of blood bags system:

3.1.1 Compounding

The PVC material is also compounded with several additives like Pizers, stabilizers, lubricants etc. The formulation is also used for making bags and tubes.

3.1.2 Extrusion

To turn the Pectized material into sheet form, the compounded PVC is extruded through a die. After slitting, the extruded sheet is trimmed to the desired size and transferred to the welding area. The donor and transfer tubing are made of PVC composites that are extruded. Before being delivered to the welding section, the tubes are printed and cut to length in line.

3.1.3 Molding

The components like transfusion port, needle cover, clamp etc. are produced by injection molding. A drying oven dries and cleans the component ultrasonically. The needle is fixed in the needle holder.

3.1.4 Welding

A method called as high frequency welding is used to create the blood bags. Sized PVC sheets are put between the electrodes, and a high frequency at a high voltage is delivered. The electrodes seal together when the PVC warms up fast. The blood bag has three tubes donor transfer and transfusion ports. The edges of welded bags are clipped. Clamps and needle coverings are used to secure the tubing. After being examined, the acceptable bags are sent to the labelling section. Anticoagulant preparation.

3.1.5 Solution

The anticoagulant constituents are premixed, and solution is prepared in a pyrogen free distilled water. All the operations are done in conformity with GMP (Guaranteed Maximum Price). The anti-coagulant solution is filled in the blood bags.

3.1.6 Sterilization

Steam autoclave is used to sterilize blood bags. Done at this.

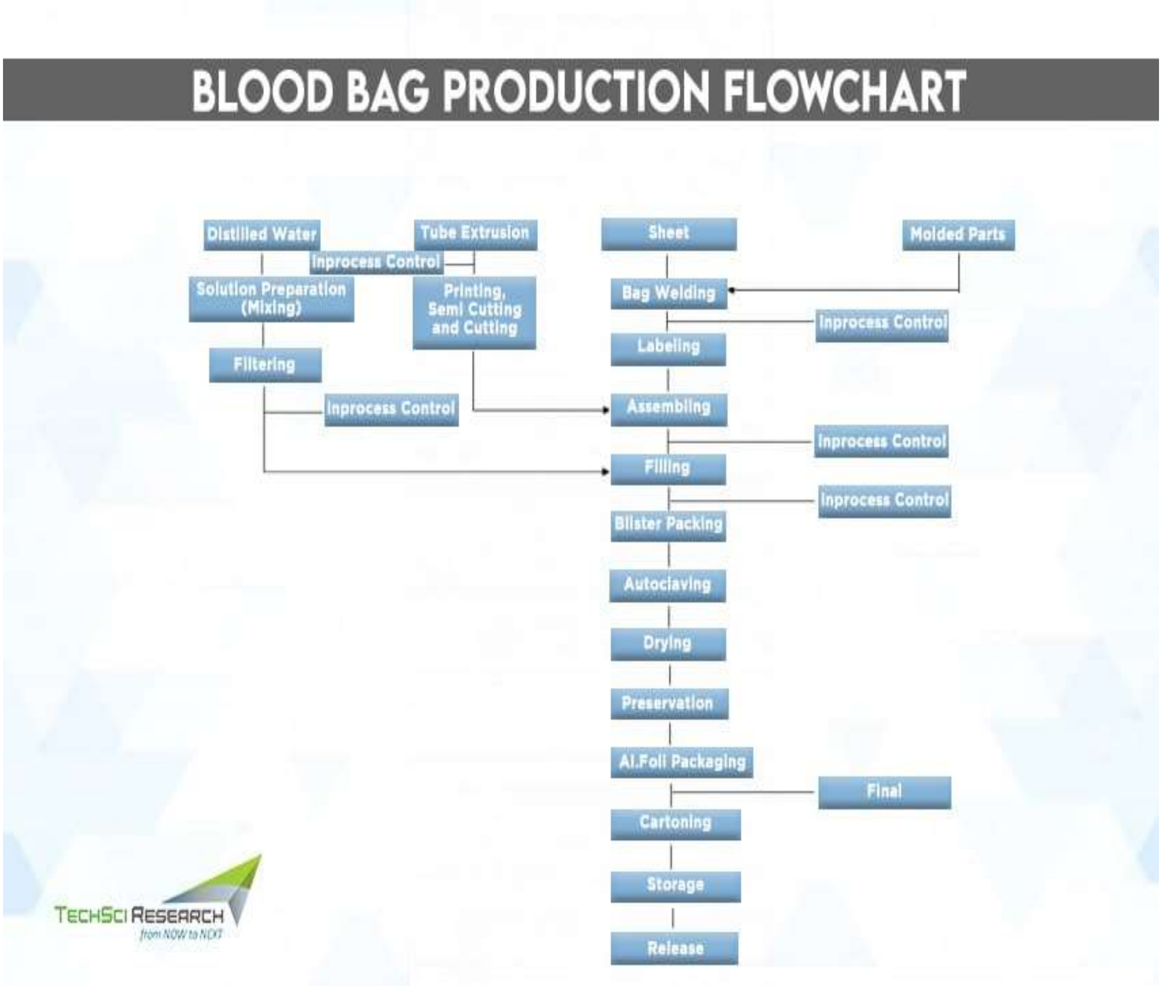

Fig 3.2: Blood bag production flow chart

3.1.7 Inspection

Particulate matter, leaks, and other apparent faults are all eliminated during this step of the inspection. Following that, the examined bags are placed in a foil pack and cartooned.

3.1.8 Plant and machinery

Sheet extrusion line, Injection Molding m/c, H F Welding m/c, High speed mixer, Tube marking m/c, Vol. filling equipment, Ultrasonic cleaner, Autoclave.

Begin by cleaning and organizing your workspace. Create a well-ventilated working environment. Protecting yourself is the first step in any welding project. Wear safety equipment and make sure you're working in a well-ventilated area before you start. Protect yourself by wearing long-sleeved apparel and heat-resistant gloves. Any weak places during welding are eliminated by removing all contaminants from the plastic. You should dry the plastic after washing it with a clean or lint-free cloth.

For example, the letter of PP denotes Polypropylene, PVC means Polyvinyl Chloride, and PE for Polyethylene. These are the letter identifiers should be the base for selecting the best rod to match the specific type of plastic. For instance, if you are joining polyethylene, you will require a polyethylene rod.

3.1.9 Joining Plastic

Preheat the welding gun for at least 2-3 minutes: Different plastics melt at different temperatures. As a result, you should match your welding temperatures to the materials you'll be welding. The recommended temperature ranges from 200°C to 300 °C or 390°F to 570°F. Subjecting the plastic beyond these temperatures may cause the plastics to melt ineffectively. In extreme cases, these plastics can completely burn. Keep in mind that welding plastics such as PP require you to heat the welding gun to 300C or 570F. The recommended temperature for melting PVC is 275°C or 527°F.

SE pliers to trim the ends of the welding rods: hold the pliers diagonally towards the rod and snip it. If you don't have pliers, you may use a trimming knife instead. Trimming the endpoint of a rod increases the chances of getting a smooth and steady weld. It also prevents the formation of a big bubble of plastic once you start welding. Always allow the welding gun to cool off amid changing nozzles and inserting a new welding rod. As you begin welding again, ensure that the gun is heated up to the recommended temperature.

3.10 Completing the Weld

Allow the plastic to cool for a minimum of 5 minutes: Before you continue working on the plastic, allow it to cool down to room temperature. One advantage of welded plastics is that they take a brief time to cool. The most basic way of determining if the fused plastic has cooled off to the desired temperature is by passing it close to your body. Zero heat means it is ready for you to continue working on it. Make sure it welds completely before it cools down. Addition of welding rods is required if does not weld completely. Safety is one of the key features at welding points so make sure the place is safe and if peels of easy after cooling. Make sure it does not get stick to the plate.

3.11 Sand the welded joint

For consistency, smooth out the rough ridges with 12-grit sandpaper. Sand is required to make sure it is leveled properly. Surrounding plastics gets prevented from scratches. Rotary tool is being used by welders to speed up sand welding process. Ensure that you carefully sand since plastics are tender and prone to scratching easily.

Sandpapers with Grit 180/320 are to be used for plastic finishing. The purpose of such sandpapers is to neaten out the weld under work. The numbers 180 and 320 represent the grit sandpapers that are famous for production of grits of high quality. Extra carefulness is required while using these grit papers as the plastic can get scratches as a result of using them. The procedure for sanding using 180/320 grit sandpaper should be like that of the 120-grit sandpaper. To make the weld smooth and consistent we required rubbing. Rub it until you feel like it is good enough. Start by using the sandpaper to sand the plastics that are blended. Use sandpaper of lower grit while moving upscale to ensure fine results. At the end, this will let you with a clean high quality grit sandpaper to finish up the task. Keep in mind the fact that the sandpapers that are coarser are the low-grit ones and not the high grit ones.

Fig 3.3: PVC Blood Bag

Welding is one of the main techniques to make items nowadays and it is very informative when it comes to learning about welding. These items are an integral part of our daily life. The plastic industry has also employed a large labor force, providing income and a livelihood to millions of people.

CHAPTER 4: CAD MODELLING

4.1 CREO Model

The CAD modelling of the prototype was done using CREO Parametric 7.0. Two separate parts were made and then they were assembled. Appropriate dimensions were chosen. This program is used to improve the designer's efficiency, the quality of the design, communication through documentation, and the creation of a database for production.

Creo Model for this Project Is as under:

4.1.1 Main body

Main body is consisting of base that is attached to the support that will going to support the upper part of the main body. In lower part of main body, we have created a die that has the dimension according to the blood bag. There is a whole in the upper part so that the secondary part of the machine can move freely on it.

Following figure shows the main part of the model.

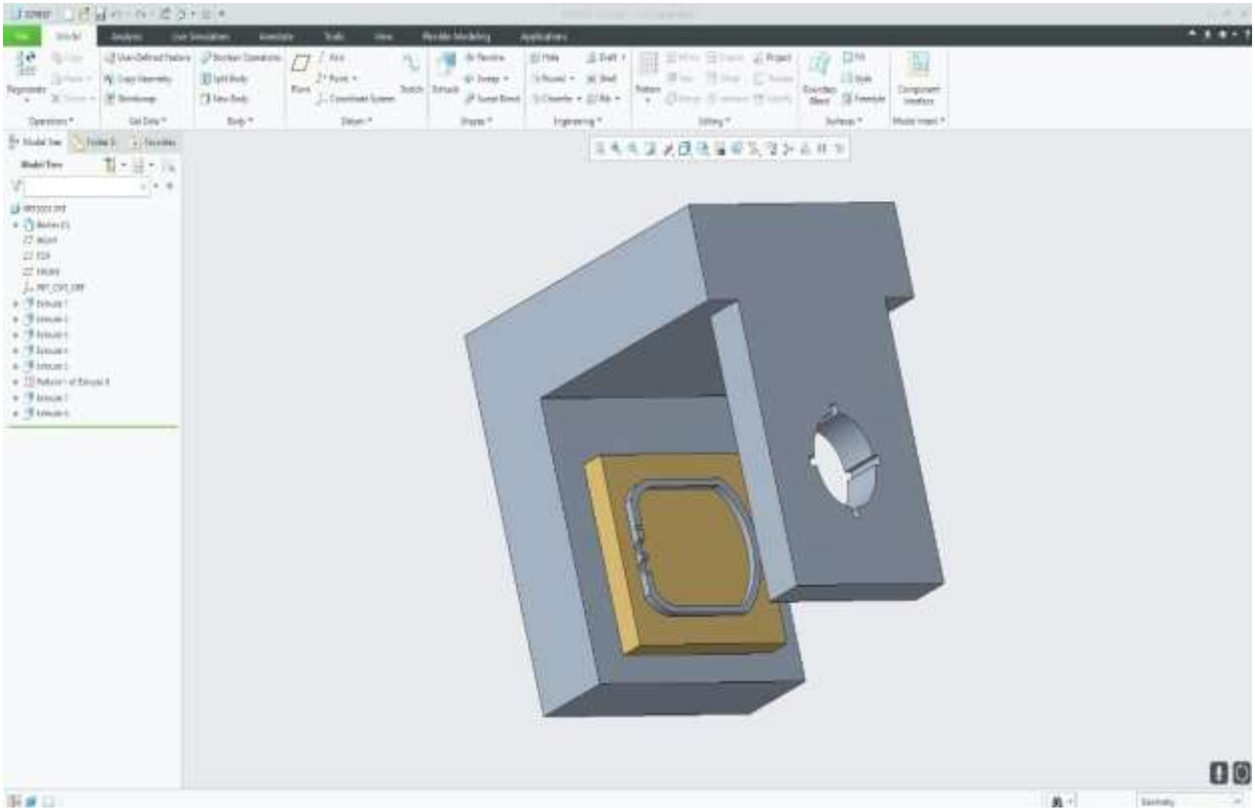

Fig 4.1: Part 1 Isometric View

4.1.2 Sliding Part

This part consists of two things one is vertical part that will slide on the upper part of the main body and second one is horizontal part that contains the upper part of the die that has same dimension as of blood bag and as of lower part of the die that is attached to the main part.

Following figures show the sliding part of the model

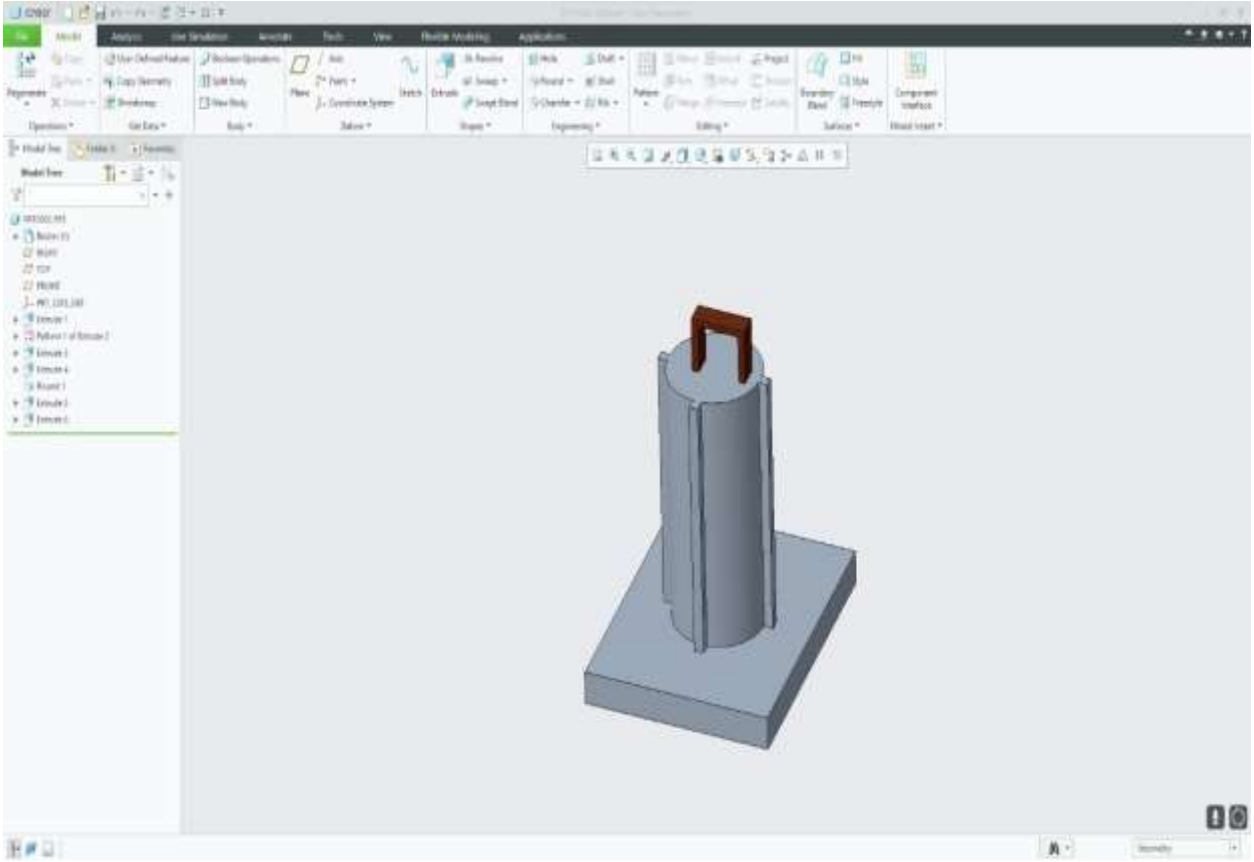

Fig 4.2: Part 2 Side View

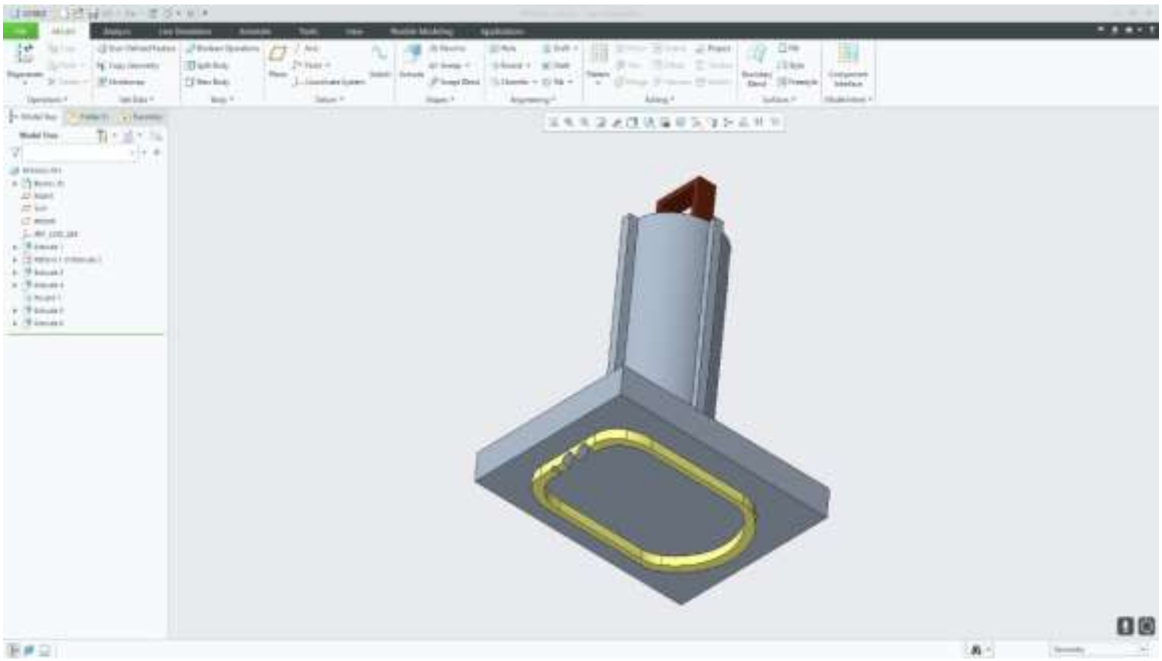

Fig 4.3: Part 2 Isometric View

4.1.3 Assembly

We have created two parts that are main part and the sliding one. Now we will assemble it Following figures, the assembly of both parts.

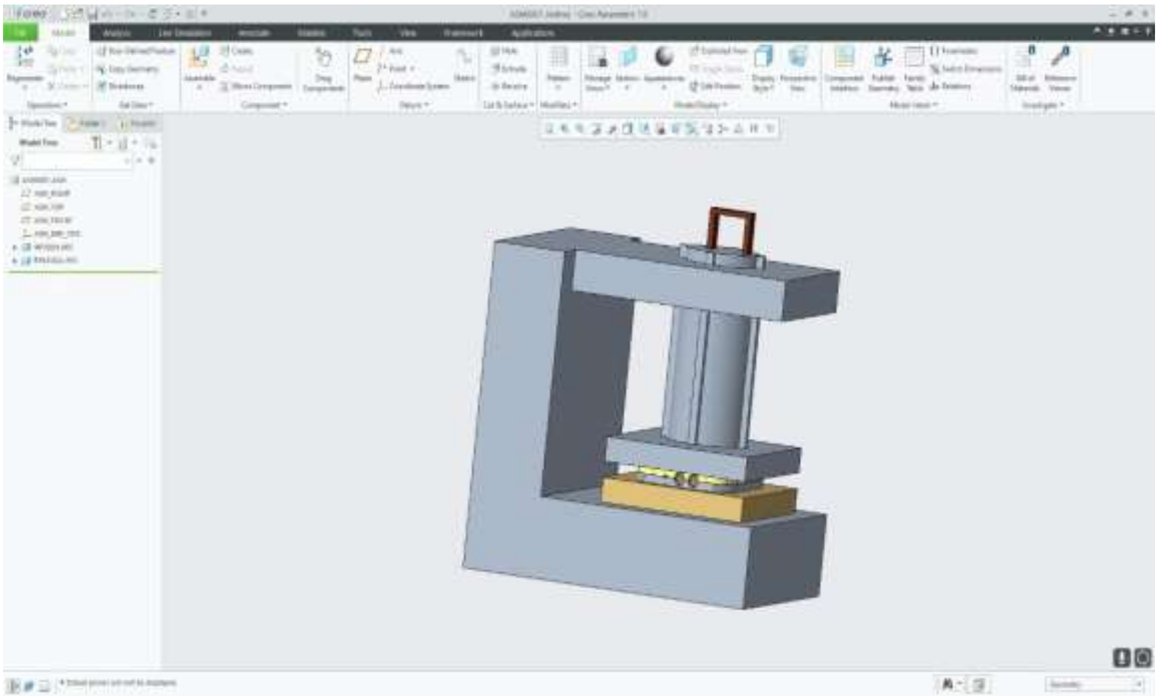

Fig 4.4: Assembly Fusing PVC

Above figure shows that when the sliding part is in contact with the die of main body.

Following figure shows that when the sliding part has done the welding and has gone above to cool down or to rest.

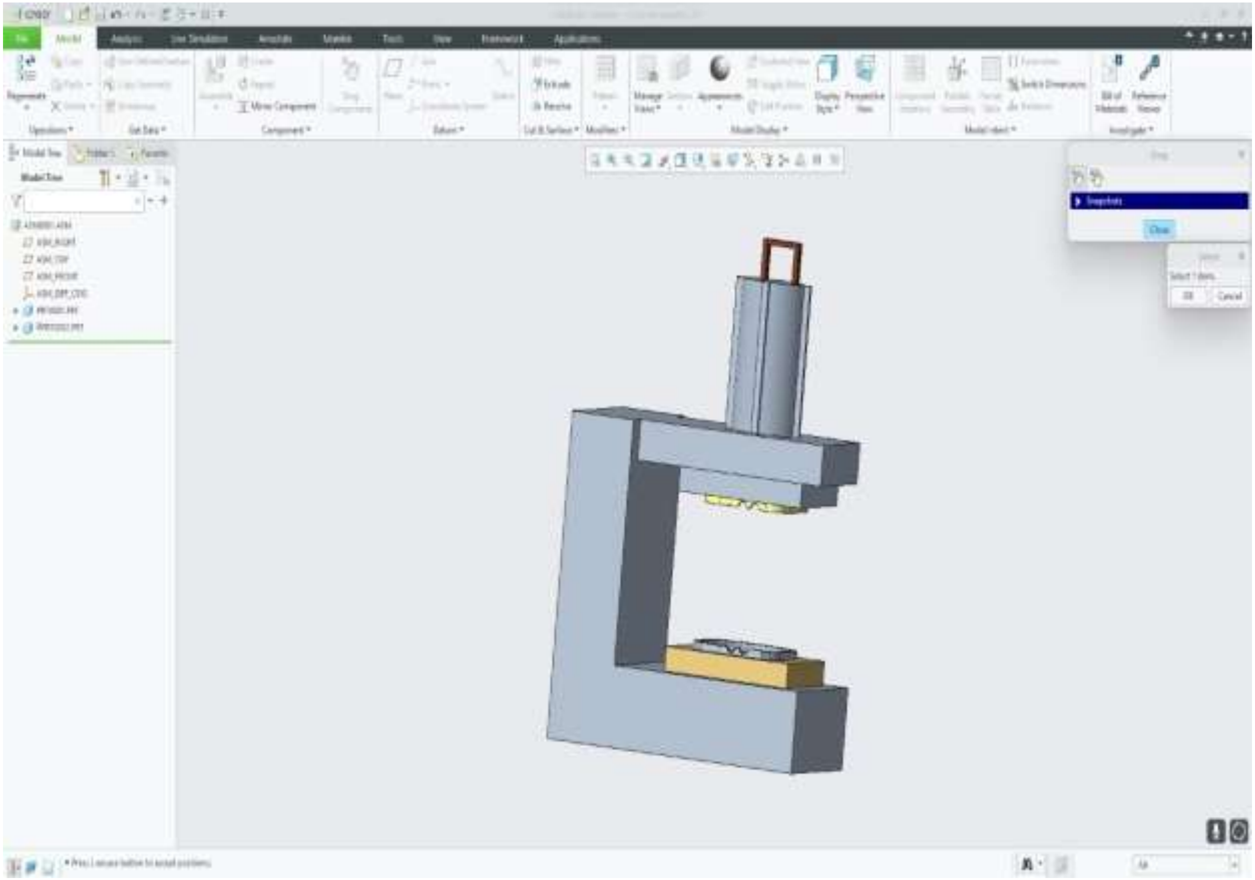

Fig 4.5: Assembly Standby Mode

4.2 Solid Works Model

It's a SOLIDWORKS 3D design software-integrated drawing less manufacturing system. You may transmit product and manufacturing information (PMI) directly in 3D with SOLIDWORKS, skipping time-consuming 2D processes and avoiding possible issues.

4.2.1 Isometric View

This is the main design of our project. the design we have created on CREO was the basic design. By going through different design parameters

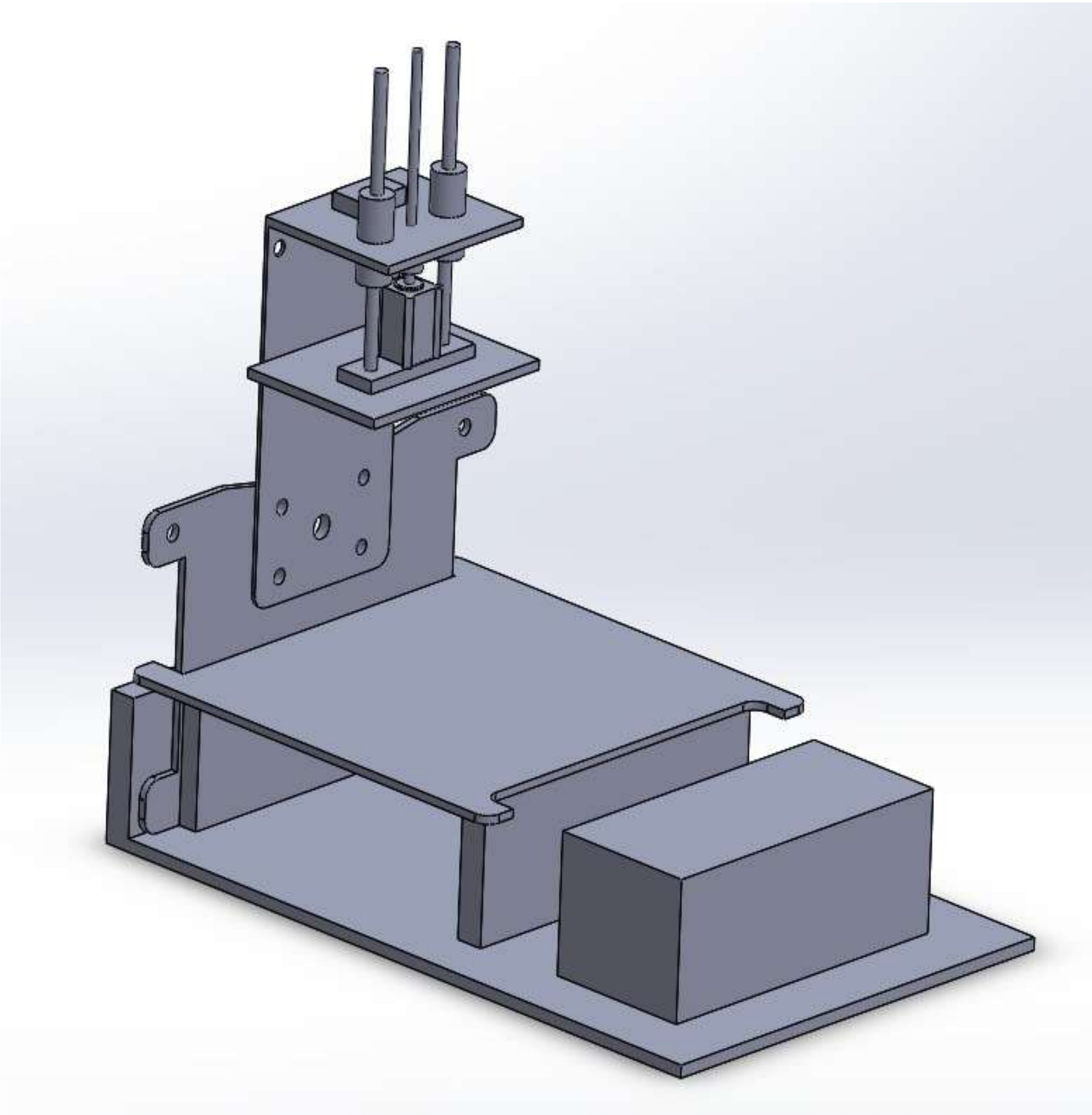

Fig 4.6: Solid works model

4.2.2 Top View

The view of the model from top is as under:

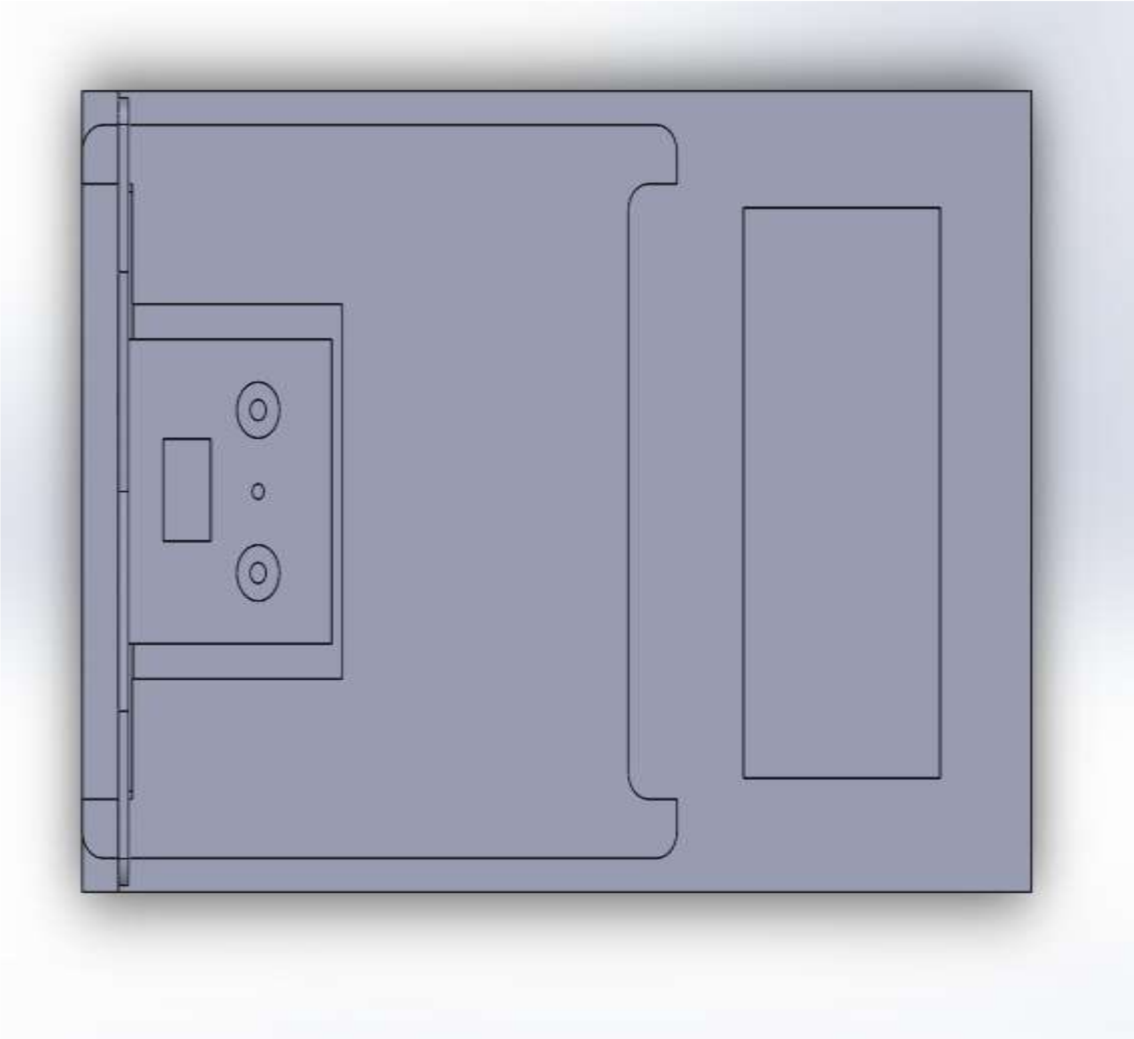

Fig 4.7: Top view of SW model

4.2.3 Side View

The view from the side is as under.

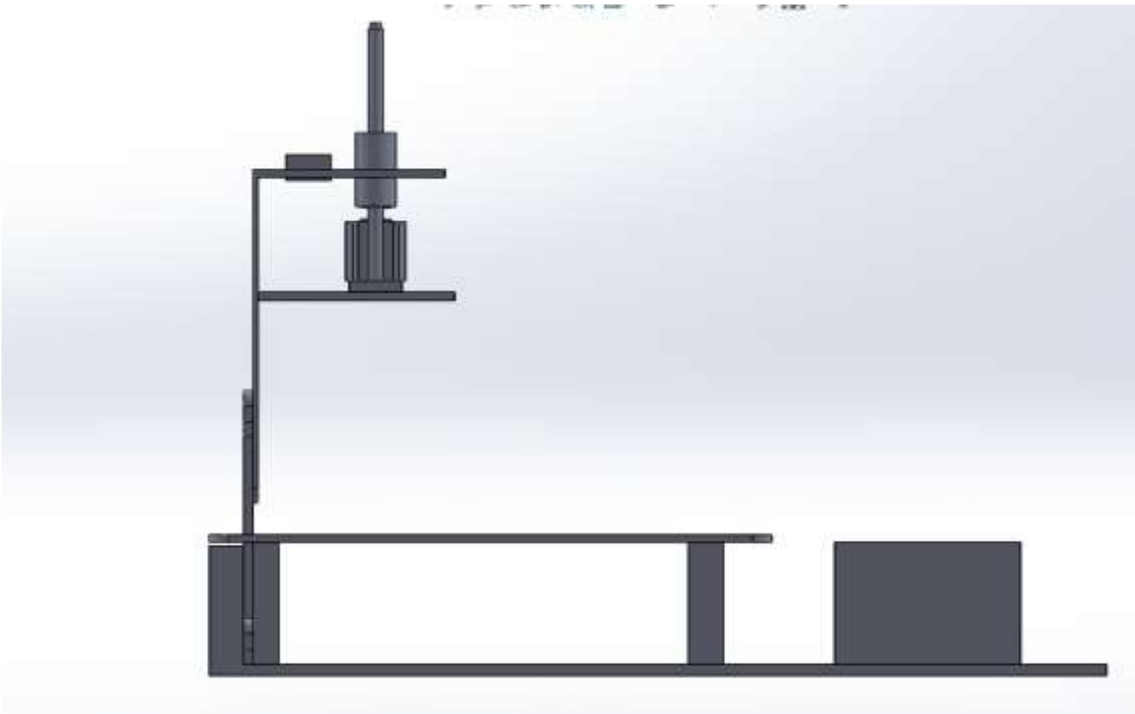

Fig 4.8: Assembly Isometric View

CHAPTER 5: MATERIAL SELECTION

Acrylic was chosen as the basis material for construction since it is a strong, stiff, and transparent plastic. Acrylic is a strong, stiff, and optically clear transparent plastic with excellent strength and stiffness. Acrylic sheets are simple to produce, adhere well to adhesives and solvents, and thermoform effectively. When it comes to weathering, it beats numerous other transparent polymers.

Acrylic sheet has glass-like qualities like clarity, brightness, and transparency, but is half the weight and has several times the impact resistance of glass. Acrylic plastics offer exceptional versatility, durability, and aesthetic attributes in everything from sturdy signage and skylights to eye-catching retail store fixtures, displays, and shelves.

TYPICAL PROPERTIES OF ACRYLIC

	UNITS	ASTM TEST	CONTINUOUSLY PROCESSED ACRYLIC SHEET
Tensile strength	psi	D638	10,000
Flexural modulus	psi	D790	480,000
Izod impact (notched)	ft-lbs/in of notch	D256	0.4
Heat deflection temperature @ 264 psi	°F	D648	195
Maximum continuous service temperature in air	°F		160
Water absorption (immersion 24 hours)	%	D570	0.20
Coefficient of linear thermal expansion	in/in/°Fx10^{-5}	D696	4.0
Light transmittance	%	D1003	92

Fig 5.1 Properties of Acrylic

Fig 10 Acrylic Properties

5.1 Die Mold

The die mold would be like the Copper mold shown in fig 13.The die would be made of conducting It is easy to use a small size heater. The heating element would require about 10 to 20 Ampere current to be heated.

Fig 5.2: Copper Mold

Some of the key features of copper are following

- High Thermal and Electrical Conductivity.
- Soft, ductile, and malleable.
- Resistance to corrosion.
- Anti-bacterial and Biostatic.

5.2 PTC Aluminum

To ensure that the PVC does not fall apart, a special PVC called Formulate HY 50 (fig 12) would be connected. Formulate TM 50-HY is an open-cell insulating, air-sealing, and noise-reduction material. It helps to create a self-adhering, seamless building envelope that keeps out air, dust, pollutants, and pests. It is made for usage in commercial and residential interior construction, and it is compatible with most typical building materials.

Fig 5.3: Foamsulate HY 50

5.3 Motion of Motor

In this project, Arduino controls the motion of motor by sending the signals. The movement results in the motion of the panel up and down. Position and end at final position. Start at the initial position and end at the final position. At the end of downward motion, the motor stops for a movement then it again starts to move upward.

Driving electromotors needs a high voltage and current. Furthermore, spinning direction and speed are two critical elements to govern. These needs may be met with the help of a development board such as Arduino.

5.4 Heating of Die

When the panel stops after the initial position. The Arduino signals them. Heating element to heat the die. It Starts heating. for the given time and stops when it achieves the given value of temperature. The heating time can be adjusted in the code as the delay time. The temperature sensor detects the temperature and transforms it to an electrical (analogue) signal that the Arduino UNO Board can use. A digital value is created by converting an analogue value to a digital value. As a result, the temperature readings sensed are shown on the LCD. The temperature of the element would be around 300 degrees centigrade

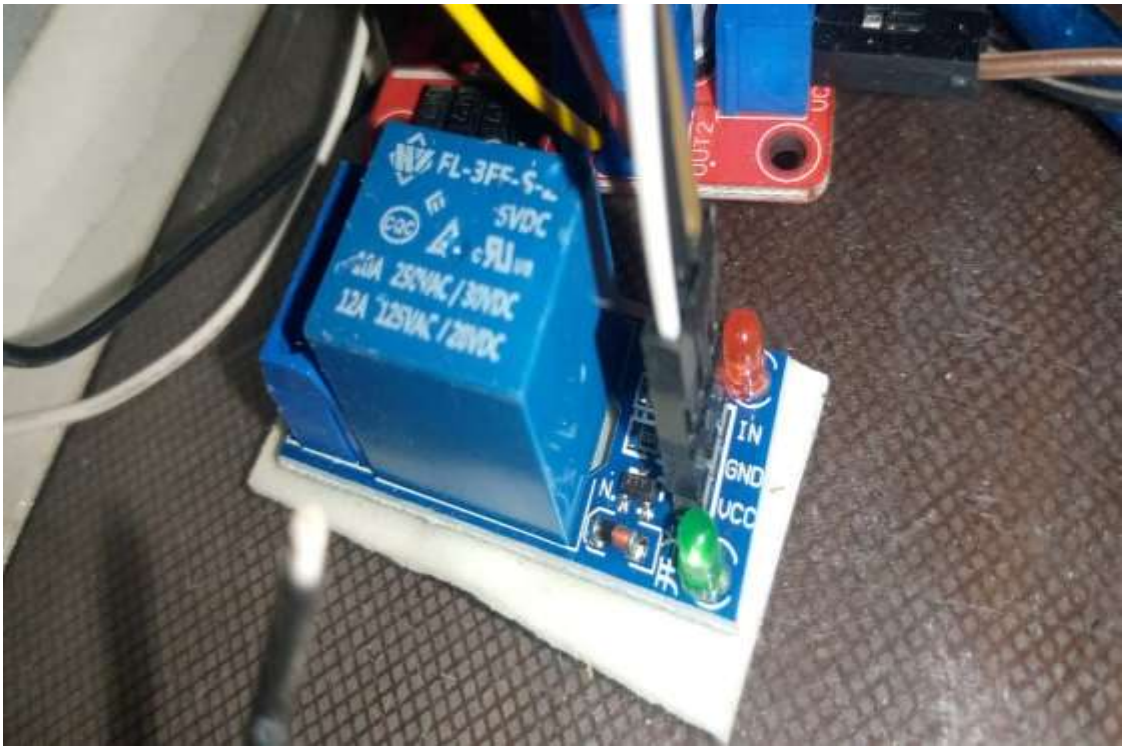

Fig 5.4: Heating sensor

5.5 Arduino

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.[The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable.[4] It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and

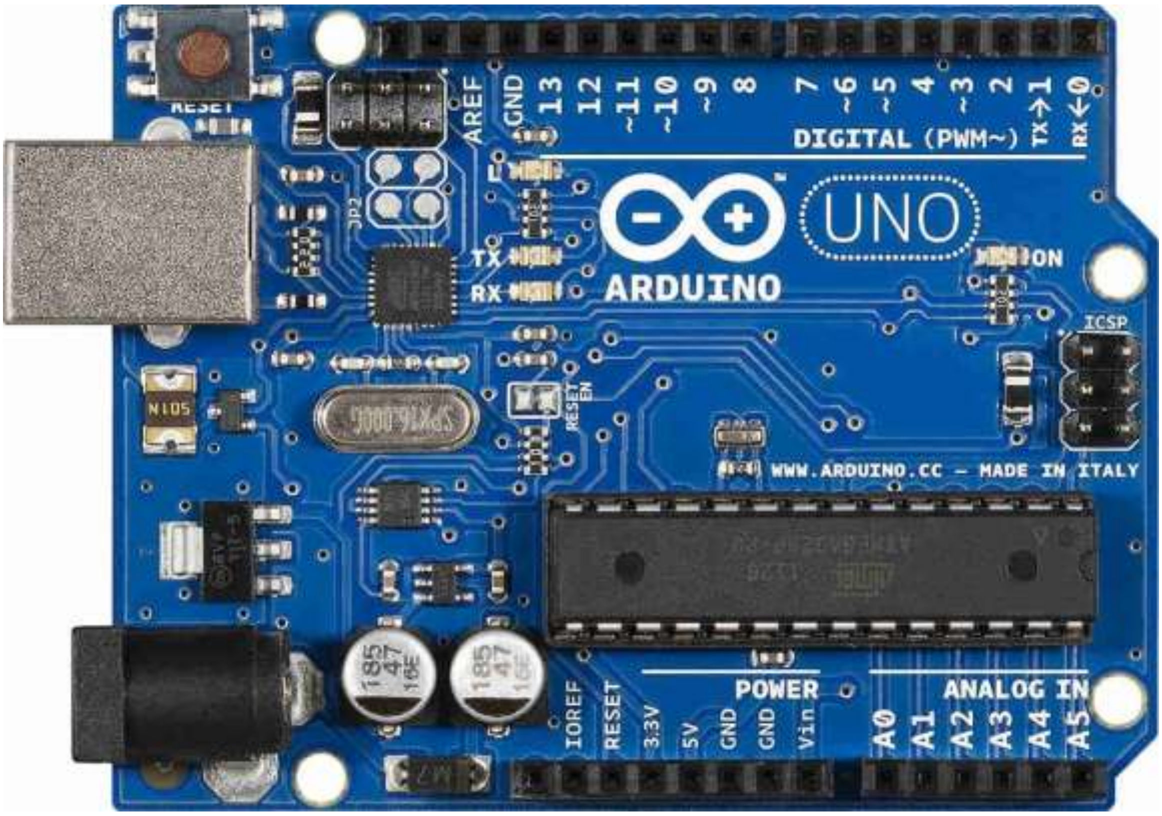

Fig 5.5: Arduino

20 volts. We will connect an Arduino UNO which will control the motion of servomotors thus helping move the die up and down. All the data from the components is fed into the Arduino.

5.5.

5.6 LED

The LED used is 16 x 2. It is connected to the Arduino. I2C has protocol with 4 wires. The LED is used to display the value of temperature and pressure at the mold and heating element.

Fig 5.6: LED

5.7 SSR

A solid-state relay (SSR)is an electronic switching device that switches on and off when an external voltage AC or DC is applied across its terminals. Their function is to serve as an electromechanical relay. These contain all stationery parts and thus provide a longer-lasting operational lifetime. They consist of sensors that will respond to specific inputs. There is a switching device that switches the power to load circuit, this device is electronic. The control signal that activates this switch without any mechanical part is controlled through a coupling mechanism. The designs may be designed in such a way to switch either DC or AC Loads as required. On comparison to electromechanical relays, they are faster and contain no physical contacts that may wear out. SSR WOULD BE GETTING A 5V SIGNAL from Arduino through sca pin using yellow wire

Contacts would be connected once it passes through 10 ampere relays. This is the reason to use an ssr. Ssr would give a 20 volt at the output terminal. The output of ssr would be attached to the sheet using red and black + - terminals which would heat the die mold. The total power to heat the panel would be 140 watts since 10ampre current passes and 14 volts is applied

.

Fig 5.7: SSR

5.8 Power Supply

AC voltage supply would be used and converted to simple DC voltage with the help of an adapter which in turn to be used to power the heater motor and Arduino.

Fig 5.8: Power supply

5.9 Stepper Motor Driver

The motors that drive stepper motors are known as stepper motor drivers. These provide position control with high precision without the use of a feedback system. They are continuously rotating. These motors provide control of current that can be adjusted to fit requirements. They also have translators that are built in and allow these motors to be controlled with high precision using steps and direction inputs that are simple to

understand. These modules are basic carrier boards for a variety of stepper motor driver ICs give low level interface. These low-level signals are usually generated by an external microcontroller

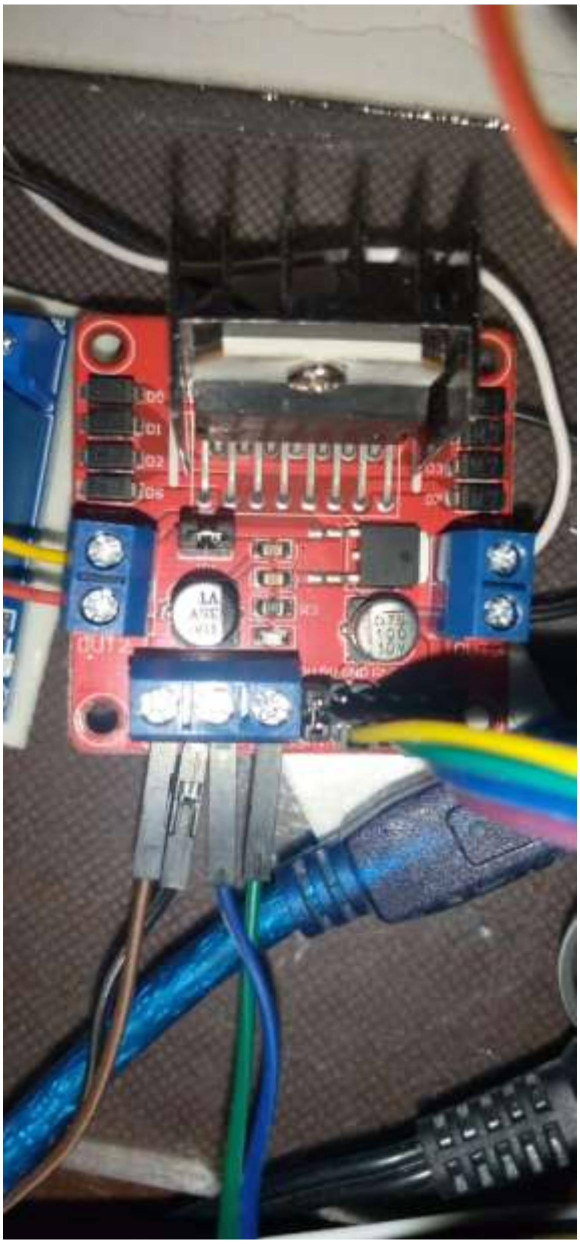

Fig 5.9: Stepper Motor

The graph shows the frequency at which the motor runs. In this case we will use stepper motor driver eca778af along with six mosfet 3205 and 2 capacitors.

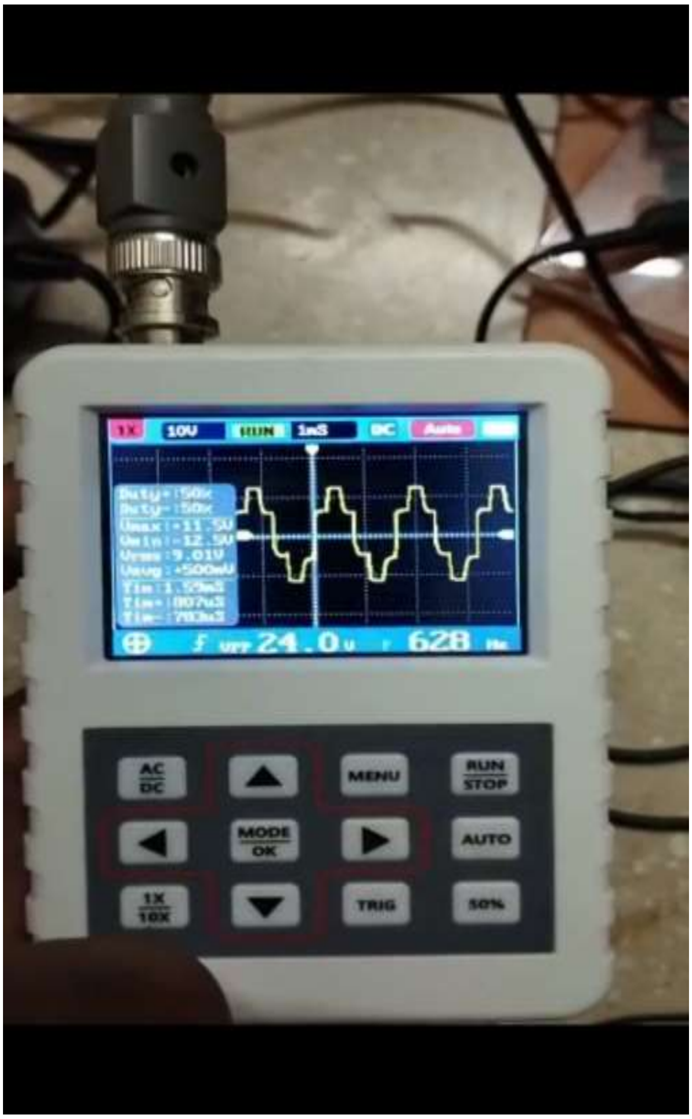

Fig 5.10: Digital Graph

5.10 IRF3205 Mosfet

It provides a high current using N-Channel, and allows switching of currents that may be up to 110 Ampere and 55 volts. The specialty of the (MOSFET) is that it has exceptionally low on resistance of only 8.0mΩ making it suitable for switching circuits like Inverters, motor speed control, DC-DC converter etc. It is also one of the easily available and cheap MOSFET with a low on-resistance.

Fig 5.11: IRF3205

If you need a MOSFET to use in a switching circuit that operates at less than 55V and less than 110 A, the IRF3205 is a better choice. Due to its high threshold voltage, the IRF3205 is not suitable for on/off control with embedded controllers. A peak of 40 amperes and down current of 10 amperes. The MOSFET are used to convert 24-volt DC to three phase AC to be supplied to the motor. They do so by creating pulses and fluctuating the DC power supply. The fluctuating DC is controlled by a regulator which regulates the speed A fan is placed under the PCA and stepper motor driver for cooling purposes

5.11 Capacitors

It is a storage device that works electronically in an electric field. It is a two terminal passive electrical component. The effect of capacitor in a circuit is termed as capacitance.

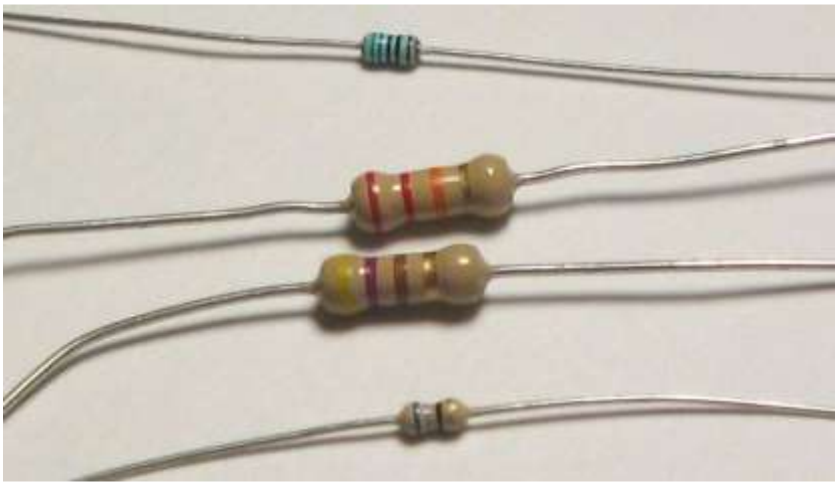

Fig 5.12: Capacitor

5.12 H Bridge

The polarity of a voltage delivered to a load is switched using an H-bridge. These circuits are commonly employed to allow DC motors to move forward or backward in robotics and other applications. The name is derived from the standard schematic diagram representation, which depicts four switching components as "H" branches and the load as the crossbar. Most DC-to-AC converters (power inverters), most AC/AC converters, the DC-to-DC push–pull converter, isolated DC-to-DC converter, most motor controllers, and other power electronics use H bridges. A bipolar stepper motor, for instance, is virtually always operated by a motor controller with two H bridges.it is used in this case to halt 4 amperes current in the motor so it is at a steady position when turned off.

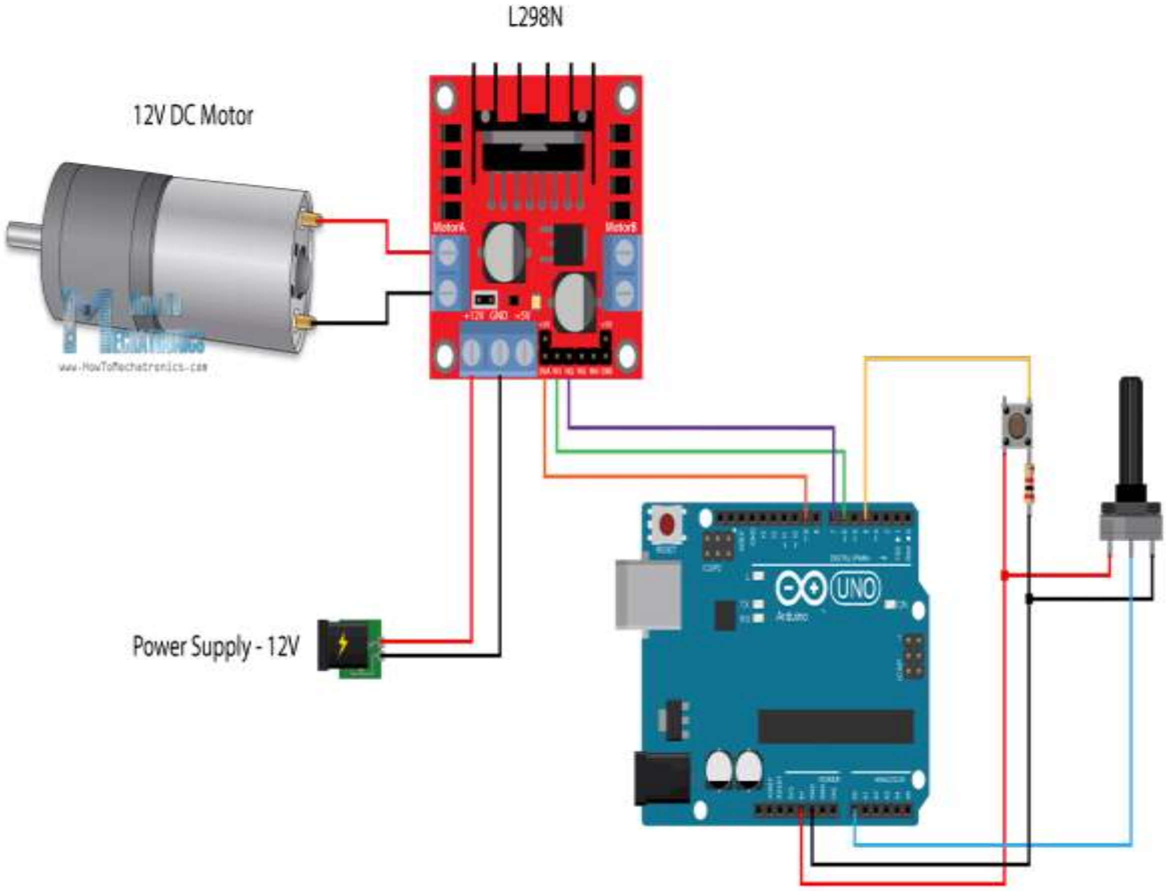

Fig 5.11: Circuit of H Bridge

It is used in this case to halt 4 amperes current in the motor, so it is at a steady position when turned off. It is used to run the motor in steps.it cannot be run by controller as it only provides 0.5 A current, and the motor requires 2 to 3 A current. When the motor is running, we have a back emf due to which current is less than the halt current which is required when the motor stops running and is at a steady position if these current flows through Arduino it would burn so that’s why H bridge is used.it gets an input of 24 volt and gives output of 5 volts through the controller.

5.13 7298 IC

It works as a bridge and gives the step angle to the motor.it supplies the adequate amount of current to the motor when it gets stuck.

Fig 5.12: IC

5.14 Relay

This switch is controlled electronically. The device is made up of a number of input terminals for a single or multiple control signals along with contact terminals that are functioning. This switch is allowed to have any number of connections which may be of any form, it could be making or breaking contacts, or even a combination of both. A relay of 10 Ampere is connected which will be turned on when the heater is turned on. 10 amperes would pass through the nichrome wire. The rating must be 20 Ampere so it can handle it

.

Fig 5.13: Relay

5.15 PL DC Motor

Motor of 1400kva used. Works on three phase AC and 120 degrees difference line to line. Motor has a wire winding. Three wires coming out merge to two and inside to internal core (white wire) and the other (black wire) both connected to PCA printed circuit assembly. Three wires for hall effect conditioning of signal, to check the position of motor. Motor with eight poles used, divide eight by three, to control the up and down motion of the motor, three wires from side. If we use three phase AC the motor would go directly to the end position. The three wires are connected to the Arduino which tell the position of the motor at that time, in this way we have a better control over the motor. It can be stop at any time and location.it is controlled by a step angle of 1.8 degrees. The motor uses a coupler of 8mm , two guide rods and a lead screw for the movement of the heating element.

Fig 5.14: DC Motor

5.16 Temperature Sensor

The DS18B20 digital thermometer measures temperatures from 9 to 12 bits in Celsius and has a nonvolatile alarm function with user-programmable upper and lower trigger points. A 1-Wire bus connects the DS18B20 to a central CPU, using only one data line (and ground) for communication. The temperature sensor can obtain direct power from the data line. This functions as to eliminate the use of a power supply that may be connected externally. It comes with an inbuilt 65-bit serial code, thus allows connection to a single 1 wire bus. As a result, using a single CPU to control many DS18B20s is straightforward.

Fig 5.15: Temperature Sensor

Temperature monitoring systems, monitoring and control systems, HVAC environment controls and temperature monitoring system being used inside the builds can use this capability of the digital thermometer. It comes with an in-built tolerance of ±10 % and the range of temperature is from -73°C to 273°C.whenever an error is detected it will give a value of 127^{o} error. A resistor of 4.7K Ohm is attached to cater the deviation of 10 ^{o}C. material PTC aluminum 12V heater plate thermostat PTC aluminum electric heating element 50w used for heating air or solid as shown in fig 11. These PTC materials have characteristics that: It has a constant temperature on the surface. It has good material insulation.

5.17 Pressure Sensor

Pressure sensor is used to detect how much pressure is being applied. W are using it to calculate the pressure that is being applied between the mold when the welding is being performed.

Fig 5.16: Pressure sensor

CHAPTER 6: HOW TO RUN MACHINE

6.1 Implementation

First the motor switch would be plugged in to supply power to it. Next Arduino's and the heating elements adapter would be plugged in. The code would be fed into the Arduino. The motor would start from its initial position till it presses against the base. The PVC sheets would be fused in between by the heat of the mold which would start heating once the die reaches the lowest position. After the allotted time, the motor would rotate in reverse direction lifting the upper die back to its position. The PVC sheets would be fused together to form a blood bag.

Fig 6.1: Working model

CHAPTER 7: CONCLUSION

7.1 Limitations

The bag has been fused but the space for tubes and capillaries have been left void due to the technical complications of welding a curved surface and a PVC pipe with a PVC sheet.

7.2 Recommendations for Future Work

It would be recommended to fuse the PVC capillaries and pipe in an efficient and uncomplicated way. Which remains an incomplete task and a research gap in this project.

7.3 Gant Chart

Gant chart of our product is as following

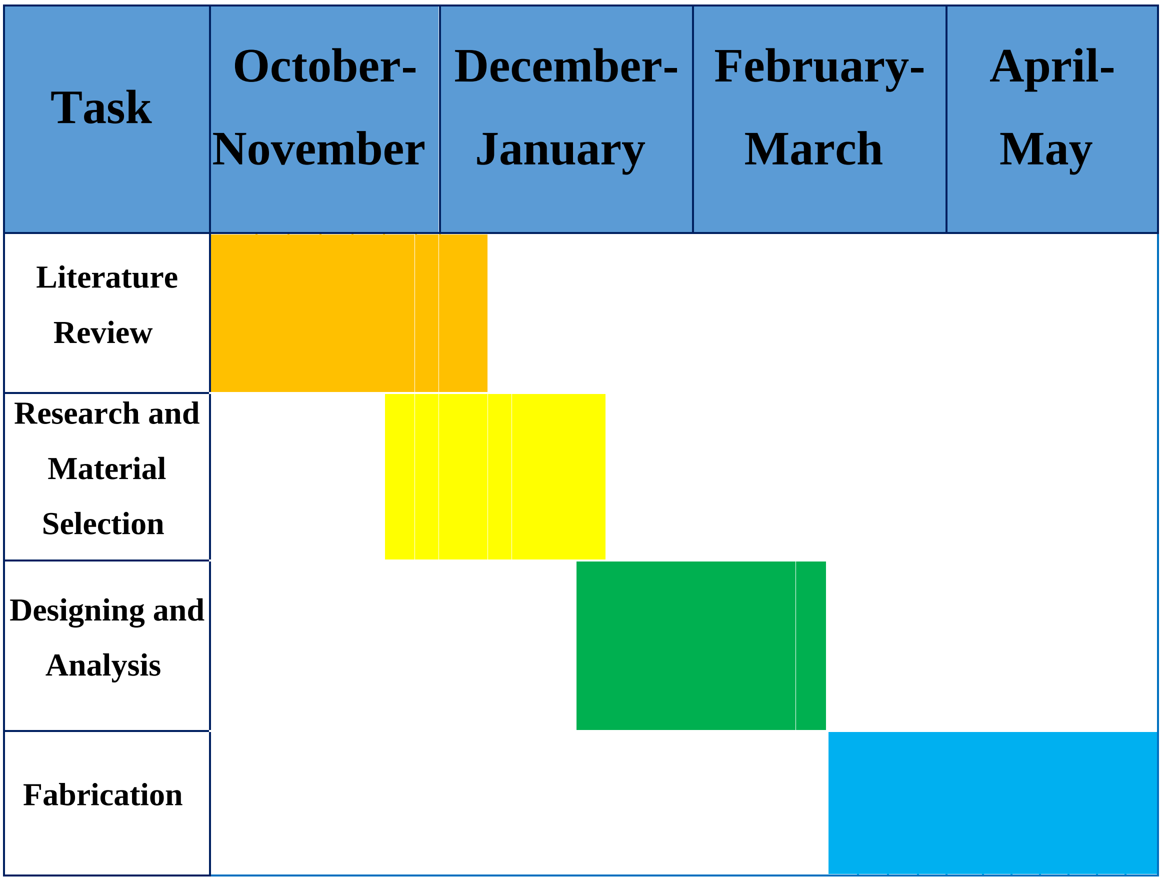

Fig 7.1: Gant Chart

APPENDIX

Arduino Code

Code of Arduino is as following

```
#include "math.h"
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <OneWire.h>
#include <DallasTemperature.h>

LiquidCrystal_I2C lcd(0x27, 16, 4);

#define ONE_WIRE_BUS 6
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);

int on = 5000;
int off = 500;

#define A 2
#define B 3
#define C 4
#define D 5

#define NUMBER_OF_STEPS_PER_REV_for 512*8 //256 512
#define NUMBER_OF_STEPS_PER_REV_rev 512*8
int prev = 0,i = 0;




void setup() {
  pinMode(A, OUTPUT);
```

```
  pinMode(B, OUTPUT);
  pinMode(C, OUTPUT);
  pinMode(D, OUTPUT);
  pinMode(7, OUTPUT); //relay
  digitalWrite(7,HIGH);
  Serial.begin(9600);
  sensors.begin();
  lcd.begin();
  lcd.backlight();
}

void write(int a, int b, int c, int d) {
  digitalWrite(A, a);
  digitalWrite(B, b);
  digitalWrite(C, c);
  digitalWrite(D, d);
}

void forwardstep() {
  write(1, 0, 0, 0);
  delay(1);
  write(1, 1, 0, 0);
  delay(1);
  write(0, 1, 0, 0);
  delay(1);
  write(0, 1, 1, 0);
  delay(1);
  write(0, 0, 1, 0);
  delay(1);
  write(0, 0, 1, 1);
  delay(1);
  write(0, 0, 0, 1);
  delay(1);
  write(1, 0, 0, 1);
```

```
  delay(1);
  write(0, 0, 0, 0);
  delay(1);
}

void reversestep()
{
  write(1, 0, 0, 1);
  delay(1);
  write(0, 0, 0, 1);
  delay(1);
  write(0, 0, 1, 1);
  delay(1);
  write(0, 0, 1, 0);
  delay(1);
  write(0, 1, 1, 0);
  delay(1);
  write(0, 1, 0, 0);
  delay(1);
  write(1, 1, 0, 0);
  delay(1);
  write(1, 0, 0, 0);
  delay(1);
  write(0, 0, 0, 0);
  delay(1);
}

void loop() {

sensors.requestTemperatures();
float  temperature = sensors.getTempCByIndex(0);
Serial.println(temperature);
lcd.clear();
lcd.setCursor(0,0);
```

```
lcd.print("Temp: ");
lcd.print(temperature);
lcd.print("'C");
delay(200);

fsrReading = analogRead(fsrPin);

  Serial.println("Analog reading = ");
  Serial.println(fsrReading);     // the raw analog reading




while(i < NUMBER_OF_STEPS_PER_REV_rev)
{
  //forwardstep();
  reversestep();
  i++;
}

lcd.setCursor(0,1);
  if (fsrReading == 0) {
    Serial.println(" - No pressure");
    lcd.print("P1-No pressure");
  } else if (fsrReading < 10) {
    Serial.println(" - Light pressure");
    lcd.print("P1-Light pressure");
  } else if (fsrReading < 50) {
    Serial.println(" - Light pressure");
    lcd.print("P1-Light pressure");
  } else if (fsrReading < 150) {
    Serial.println(" - Medium pressure");
    lcd.print("P1-Medium pressure");
  } else {
    Serial.println(" - Big pressure");
```

```
    lcd.print("P1-Big pressure");
  }
  delay(1000);

digitalWrite(7,LOW);
delay(on);
digitalWrite(7,HIGH);
delay(off);

i=0;
while(i < NUMBER_OF_STEPS_PER_REV_for)
{
  forwardstep();
  //reversestep();
  i++;
}

//  for (int i = 0; i < NUMBER_OF_STEPS_PER_REV_for; i++)
//  {
//    forwardstep();
//  }

//  for (int i = 0; i < NUMBER_OF_STEPS_PER_REV_rev; i++)
//  {
//    reversestep();
//  }
}
```

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