

# A REVIEW ON VACUUM FORMING MACHINE

<sup>1</sup>Dishang Bhatt, <sup>2</sup>Masoom Bhagat, <sup>3</sup>Bhavik Kotadiya

<sup>1,2,3</sup> B.Tech Student,

Mechanical Engineering Department,  
Parul University, Vadodara, India.

## Abstract

Vacuum forming, a form of thermoforming process is one of the most ancient and simplest approach for forming plastic substances in favored shape. There are many different ways in which vacuum forming is carried out. Generally vacuum forming technique comprises heating of a thermoplastic sheet to its sub-melt temperature and overlaying it over a mould. Then suction of air is executed with the assist of vacuum and the shaped product is taken out. This method is taken in account with the help of heater, clamp, mould and vacuum. This formed plastics has its very own packages in equipment producers, model car, aircraft industries, clinical applications, fixtures industries and many greater. Those distinct packages demands distinct way of forming which ends within the new layout and production of the machine. As a result the optimized machine or layout of system is required which can allow most styles of forming under one heater. This examine is purpose to study the paintings made by many researchers over the year and to get technical technique to make optimize vacuum forming device.

**Key words:** Vacuum forming

## I. INTRODUCTION

From early days there are various approach to form plastic into desired form like pressing machine, rolling machine or say injection moulding. But to boom producibility with less processability time and to get uniform product at very cheap price, a brand new technique or system has to be undertake. Vacuum Forming is quite simple and useful method to shape favored form of plastic at very ease charge. This method works at the precept of thermoforming with the addition of vacuum inside the procedure. This system is achieved via vacuum forming gadget which specifically consists of heater, mould, material sheet and vacuum. The technique consist of heating of the sheet located at the studded clamps in the vacuum chamber to its sub-soften temperature and then moving it in the direction of the mould till it drapes around the mould completely after which vacuum is carried out to get the preferred product. Vacuum forming is a business method and may use for diverse programs from growing small prototype to batch or mass manufacturing. The material used for this method is Thermoplastic. There are specifically two type of the polymers substances – Thermoplastics and Thermosetting. A solid thermoplastic material or sheet can without difficulty be heated to its sub-melt or melting temperature and further can cooled down once more to its strong kingdom with or without any deformation. This property of thermoplastic is used to form desired shape from the extruded thermoplastic sheet. This modifications due to raised temperature is commonly reversible. Even as on different aspect thermosetting material cannot be melted and re-solidified by way of raising and lowering the temperature. With vacuum forming procedure thermoplastic may be shaped into complicated design and shapes.

Vacuum forming has each home in addition to commercial use however it had played very critical role in manufacturing industries due to its very green method which is very appropriate for mass production. [2] Vacuum forming produces the product which can be strong, long lasting and mild weight which is very tough to acquire from one-of-a-kind technique in such an ease time. So vacuum forming is typically used in which mass production or batch manufacturing take place. Vacuum forming works on the principle of thermoforming of plastic which is a plastic manufacturing process in which the thermoplastic sheet are heated and pressurized over a mould. This thermoplastic sheet are clamped horizontally and is heated till it attains it's sub-soften temperature with the help of heater. As the sheet receives melt by way of attaining to its sub-soften temperature it is stretched and draped over the mould with the assist of pressurised air. Then this sheet is permitted to cool down and vacuum is applied. The mould is open and the thermoformed part is taken out. The extra material is eliminated out with the help of press or every other way from the fashioned product. Extra element may be reuse with the unused plastic components. This thermoformed part will be a final product or a part of product. The inside temperature of vacuum chamber is controlled by way of thermostat or another heating sensor devices. This gadgets usually continues the temperature and manipulate the heater for this reason. Further water or air cooling gadget is also adopted to ease the procedure. Vacuum forming may be completed in exceptional approaches as per the necessities.

## HEATER

[1] - [5] Heater are infra-red detail set up within aluminium reflector plate which are used to raise the temperature to melt the thermoplastic sheet.

Ceramics heater are most common against the vacuum forming machine. They consist of coiled resistance wire elements. This heater are available in round, square or rectangular shape and can be either flat or curved (parabolic reflector to radiate efficiently) as per requirement. But uniform heating of the sheet over its entire surface area and throughout its thickness is very much essential for better forming. Here ceramics heater have a disadvantage, due to its high thermal mass it takes time to warm them up and are even slow in their response time when adjustments are made in mid process. Whereas there are quartz heater which has less thermal

mass and enables quick response time. The temperature is controlled by thermostat, thermocouple or pyrometer or more accurately by electronic computer devices. A single heater or win heater can be used as per the characteristics and thickness of the material.

## MOULD

The main function of mould is to enable the machine operator to produce the desired number of parts before being ruptured or degraded. Many materials can be used to make mould but it is necessary to choose correct material for mould as per the requirement and its design should be appropriate. Proper design of the mould is required to get uniform thickness and easy removal of the formed product. The material of mould is based on its service duration and severity of the service. Material of mould could vary from clay, plaster to metals. According to the research done by t-form the following factors should be taken in account for choosing mould material.

- Must be capable of repeated thermal cycling.
- Must be easily modifiable.
- Must be able to transmit vacuum from all areas of its surface.
- Must be robust.
- Must be dimensionally accurate.
- Must have a known shrinkage.

There are two kinds of mould – Male mould (positive) and Female mould (negative). The choice of mould should be carried out on the idea of product requirement i.e. – deep drawn object can be highly formed on male mould while object like compartment tray can be shaped on female mould.



Fig 1: male mould and female mould

The dimensional thickness is also dependent on type of mould.

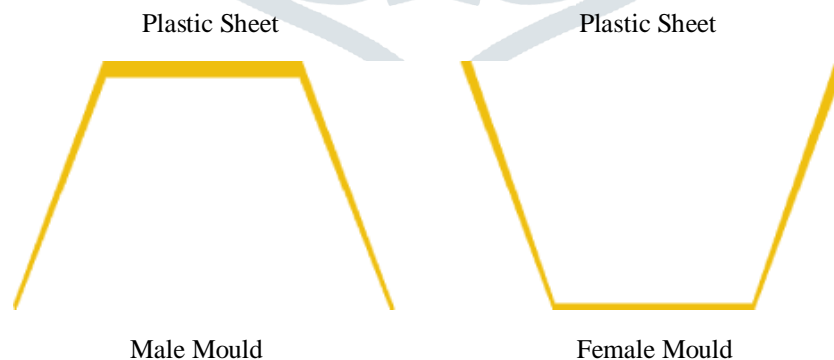


Fig 2: male and female mould forming and the effect of thinning of the plastic sheet.

[4] Material utilized in vacuum forming procedure are thermoplastic polymers. Thermoplastics are split into two one-of-a-kind corporations – amorphous and crystalline. Amorphous substances, e.g. Polystyrene and ABS are easier to form as they do not have that kind of important forming temperature. When heat is applied amorphous substances turns into tender and pliable. The adjustments occur over a number of temperatures and permit the operator to have a reasonably huge forming range. Semi-crystalline and crystalline substances, e.g. Polyethylene and Polypropylene have a far extra important forming temperature. Whilst the use of crystalline substances it is vital that correct temperature manage is used to monitor the heating method. The forming temperature bands for amorphous substances is a good and have wider range and as a result they are less complicated to method as examine to semi-crystalline material. In other words they have got a much better melt energy and will not sag as a great deal as the melt

transition temperature is reached. As in line with the application of product the type of thermoplastic sheet is determined. Some of the materials and their properties is describe in Table 1.

Table 1: Properties of Material

SR NO.	MATERIAL.	DESCRIPTION.	APPLICATION.
1.	Acrylic (PMMA)	High quality, hard, medium - high strength but brittle, good clarity, high cost.	Baths, Domes, Light Diffusers, Roof Lights Sanitary Ware.
2.	Acrylonitrile Butadiene Styrene (ABS)	Hard, rigid, very good impact strength & weather resistance, medium cost	Luggage, Sanitary & Vehicle Parts.
3.	Polycarbonate (PC)	Hard, rigid, very good impact strength & clarity, self-extinguishing, high cost.	Aircraft trim, Light diffusers, Machine Guards, Riot Shields, Signs, Skylights and Visors.
4.	Polyethylene terephthalate Glycol	Good - high impact strength, optically very good, can be sterilized & resilient to wide range of acid oils and alcohols, but not with highly alkaline solutions, high cost.	Dairy & Medical Parts.
5.	Polyethylene - High Density (HDPE)	Flexible, very good impact strength, low cost	Housings & Vehicle Parts
6.	Polypropylene	Flexible, very good impact strength, low cost	Chemical Tanks, Enclosures, Food Containers, Luggage, Medical Applications and Toys.
7.	Polystyrene - High Impact (HIPS)	Wide range of options, high impact strength, low cost.	Displays, disposable items, models, packaging, presentation & toys.
8.	Polyvinyl Chloride (PVC)	Medium - high strength, good transparency in thinner gauges, good fire retardant & chemical properties. Highly resistant to solvents, low cost.	Car Trims, Machine Guards & Packaging.

### MEDIUM

Vacuum is one of the critical element of vacuum forming system. As this vacuum eliminates the air trapped between mould and form sheet. The removal air should be in most fulfilling time. Selection of vacuum is easy task, but it's far vital to take care of time for which vacuum is carried out. As an excessive amount of vacuum may additionally produce undesirable stresses on the form product. The additives of the vacuum pump have to be anti-corrosive as some of the thermoplast material have tendency to surrender the vapour while they are heated. Probabilities are this vapour can also input and corrode the element of vacuum pump.

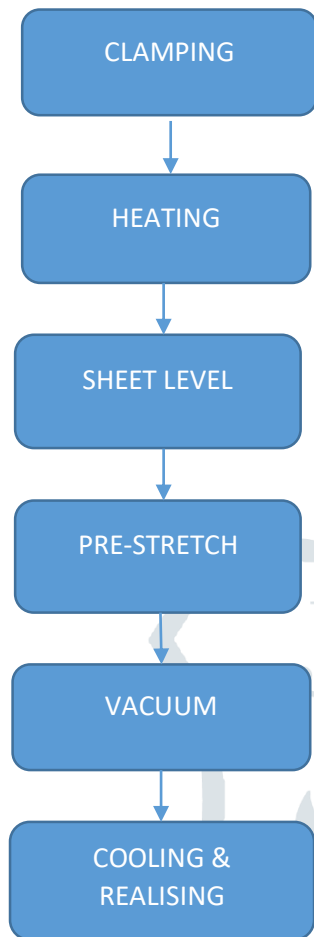
**VACUUM FORMING PROCESS**

Fig 3: Vacuum Forming Flowchart

[3] In vacuum forming process (as shown in Fig.3) pressure and temperature are used to form plastic sheet into desire shape. The thermoplastic sheet is placed with the help of clamp. The temperature is raised by placing heater above the sheet. As the sheet get soften or reach sub-melt state the heater is removed and the mould is brought such that the sub-melt plastic sheet get drape around the mould. Than using vacuum pump the air trap between sheet and mould is drawn out immediatly and sheet takes complete shape of the mould. Then the formed plastic is allowed to cool and is taken out from the mould. The excessive material is removed from the formed product.

**WORKING OF VACUUM FORMING MACHINE.**

First off, the plastic sheet is mounted with the help of insulated clamp which do not transfer heat. The heater is then located above the sheet. The temperature is then raised till the sheet attain its submelt temperature. Then the heater is send to its original position. The mould is then delivered up this sort of way that the submelt plastic get drape round it. The pressurized air is locate to help in drapping of the material around the mould. As the material get drape round the mould the vacuum is started out which take out the air trapped between the material and the mould. Then the drapped material is permitted to quiet down. As the material cooled down it settlement and strongly griped over the mould. The reverse air is again blown interior to remove form product from the mould, and the final product is taken out.

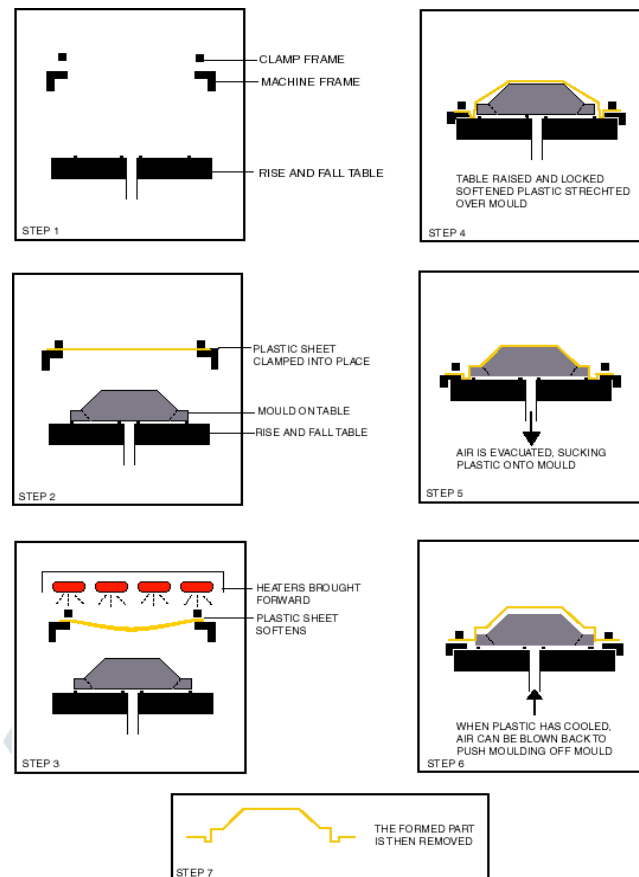


Fig 4: Vacuum Forming

## APPLICATIONS

1. Seed Trays, Flower Tubs, Animal Containers.
2. Production of Miniature Parts for Architectural Models.
3. Roof lights, internal door liners, PVC door panels.
4. Manufacture of chocolate moulds for specialised chocolates.
5. Prototype concepts for other plastic processes.
6. Training aids for students studying polymers and plastic processing. And many more.
7. For quick prototyping.
8. To make plastic product of different design.
9. To make delicate plastic parts

## ADVANTAGE

1. It is very easy to use.
2. Easy installation & setup.
3. Low initial and maintenance cost.
4. Fulfill every requirement of design.
5. Has less adverse effect on the final product.
6. Production is quick in reliable rate.
7. Doesn't require skilled workers to operate.

## CONCLUSION

Thorough study of the vacuum forming machine shows us that it is one of the best method of thermoforming and even best method to create plastic formed product in very easy possible way without being much expensive. It also don't give much of the remaining scrap material. This technology also draw less power for forming a product. It is also efficient in giving a good quality and quantity of a product in very short period of time.

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