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Design and Fabrication of Small Format Vacuum Forming Machine

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Abstract: ***The vacuum forming is a unique simplified method of moulding. Vacuum formed products are prevalent in our daily lives. The process involves heating a plastic sheet until soft and then dropping it over mould. A vacuum is use for sucking the air particles from mould for producing the rapid prototype model, to reduce the mould fabrication time. Using prototype for the mould makes it economically feasible to produce low quantities of large part and operate medium size production runs. The sheet is then removed from the mould. In vacuum forming process the Low forming pressures are used, which enable comparatively low cost tooling. Since the process requires only low pressure cups and packaging.***

Keywords: Vacuum forming, plastic sheet, mould, dies.

I. INTRODUCTION

The plastic is a material consisting of any of a wide range of synthetic or semi synthetic organic compounds that are malleable and so can be molded into solid object. All basic method using pressing machines, rolling machines and extrusion machines had already existed since early days an industry does not develop until there are demands and supply for the demand. We propose vacuum forming method. Thermoforming also called vacuum forming is an industrial process used to fabricate a large part of the objects we use daily, such as food packaging, disposable plates, blister packaging, plastic toys and interior paneling. Today small scale industries (SSI) are growing largely so they need packaging instrument or machine at minimum cost. We proposed a design; it is feasible to small scale industries. This machine can also used in household business purpose.

II. LEITERATURE REVIEW

In previous researches many researchers worked over the modification on the vacuum forming process to increase its performance. It found from research record so each designing the tool for part drawing involve lot of error procedure.

A. N. Cappetti, L. Garoflo[4]- Super forming process

This paper shows the basic parameter of SPF process. change it original dimension and processing temperature were chosen three different value of each of them. For every combination of parameters and using finite element part was made.[4] The super plastic forming (SP) technology leads the limit of standard presswork either of form or of thickness distribution but the lead time and the energy expenditure are more difficult for industrial use process variable must be carefully selected to grant product workability and industrial attractiveness.[4]

B. C. Schuller, D. Ponzzo [3]- computational thermoforming

We have been studied the method of fabrication texture 3D model using thermoforming. This method provides combined hardware and software solution to manufacture customized unique objects. In this method simulation is preferred over forming process.[3] This method proposed a new fabrication method to produced object with a high resolution texture using thermoforming. they have proposed a solution relies on common hardware available in many digital fabrication labs and produces object with a surface quality greatly superior to competing techniques.[3]

Objective

1) Thermoforming is the process of taking a flat sheet of plastic and changing it into a contoured shape.[2]
2) The best thing to do is start with simple parts using simple techniques and progress to more complicated parts using more complex technique.[2]
3) An algorithm to convert a textured digital 3D model into a 3D printable mold , plus the image to be printed on the plastic sheet before thermoforming .[3]
4) A calibration algorithm that estimates the material parameter from a set of set of photographs taken with a reflex camera .[3]

III. METHODOLOGY OF SOLUTION

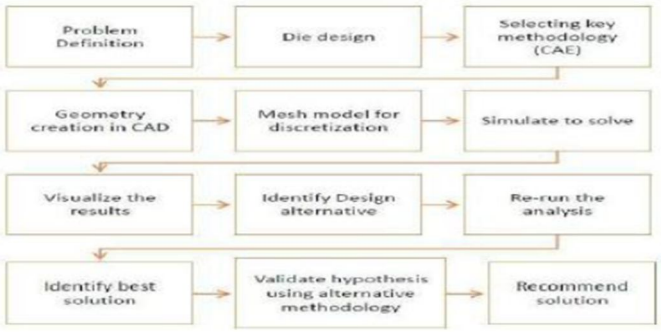
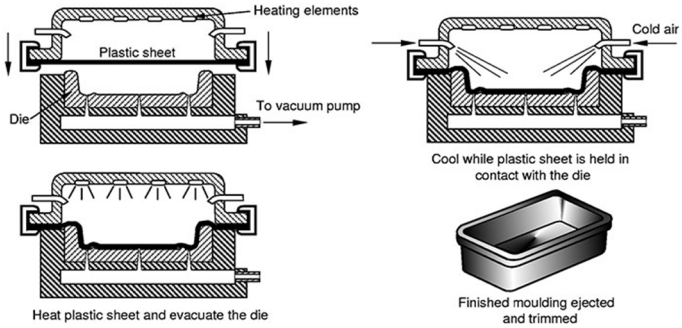


Fig. 1: schematic implementation

IV. PRINCIPLE OF VACUUM FORMING

1) *Thermoforming:* Vacuum-forming is a technique to shape a variety of plastics using a mould. The process begins by fixing a sheet of plastic of uniform thickness onto a Mould surface and clamped with a holding device. The sheet is heated up to malleable predetermine temperature by using heating system. In the vacuum forming process the vacuum pressure is used to form heated thermoplastic sheet into the desired shape. The thermoplastic sheet is placed on the mould surface and fixed with the help of clamping unit. The sheet is heated until it is soften and thereafter vacuum need to be applied quickly. A vacuum chamber is used to quickly pull the air out between the mould cavity and the sheet. When the vacuum is created the sheets confirm to be shape of the mould cavity. The formed part is cooled and then ejected from the mould cavity. The remain plastic will be trimmed by manual processes.
2) *The Heater system:* The ceramic heaters are generally used in vacuum forming machine. It consists of coiled resistance wire element set in mould china clay.
3) *The platen system:* The important process in vacuum forming is to lifting a platen. It needs to be done promptly and as quickly as possible so that forming takes place before the being to cool and become a rigid. In small format machine it is done manually but bigger machine required auxiliary operating system.
4) *The Vacuum system:* The vacuum pumps, appropriate to the size sheet being formed and the volume of air being evacuated (approximately -0.83 bar [25 in Hg])

V. WORKING PROCESS OF VACUUM FORMING



Fig,4: working process of vacuum forming

1) The sheet is fixed in place on heat proof air-tight seal
2) The heating elements are then turned on and the plastic slowly becomes soft and pliable as it heats up. The plastic can be seen to sag and as the surface expand.
3) After a few minutes the plastic is ready for forming as it becomes very flexible or rubbery.
4) The heater is turned off and the mould is moved upward by lifting the lever until the locks in position.
5) The 'vacuum' is turned on and these pumps out all the air bench the plastic sheet. Atmospheric pressure above the plastic sheet forces it down on the mould. The shape of the mould cannot be clearly seen through the plastic sheet
6) The plastic sheet is removed from the vacuum former pressed into its surface

VI. APPLICATION AND ADVANTAGES

A. Applications

1) It uses food packaging, automotive parts and trays
2) Use in medical equipment's
3) Engine covers for construction equipments
4) It is use in Railcar interior trim parts

B. Advantages

1) Adaptive design configuration
2) Easy to operate no need of skill operator
3) Initial setup cost is very low
4) Thermal stresses are very low than injection moulding

VII. MAJOR REQUIRE COMPONENT

1) *Heater system:* Heater used in nichrome element mounted within cement plat in zigzag order in order to obtain the best vacuum forming result, using any material, it is essential that the sheet is heated uniformly over entire surface area and through out its thickness.

Fig.1. heater system

2) *Vacuum pump and Vacuum chamber:* Vacuum pump it is main device which generate vacuum suction preasure inside second stage of machine that is vacuum chamber which is shown below.

Fig.2. vacuum pump & vacuum chamber

3) *Vacuum Gauge***:** vacuum gauge it is a measuring device it measures vacuum pressure inside the vacuum chamber.

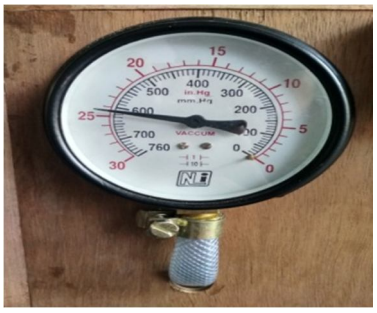


Fig.3. vacuum gauge

4) *Plastic Sheet:* Generally we are using HIPS (high impact polystyrene). It is low cost plastic and easily moldable. It is often specified for low strength structural application. Thickness of plastic is 0.6mm.

Fig.4.plastic sheet

VIII. Model

Fig.5.working model

IX. CONCLUSION

Since, As per above explain, we have observed this techniques are cost effectives and required more skill personnel to handle the system. we proposed a new design of fabrication method to manufacture objects with accuracy and precision using vacuum forming. We believe vacuum forming will have a significant impact in fabrication community with its low cost. The technological improvement in the latter especially brings about a greater energy saving.

X. CALCULATION

1) *Draw rtio* it is a relationship between beginning surface area of unformed sheet.

Draw Ratio = H/D= 25.4/80.4= 0.3159

2) *Draw force*- calculated by empirical relation.

P= [2(Li+Bi)*t+s{(L_o+b_o/Li+Bi)-C}]

Li=190mm, Bi=63mm, Bo=349.2mm, Lo=549.2mm, T=25mm, S=40N/mm^2, C=0.6.

P=[2(190+63)*25+40{(549.2+342.2/190+63})-0.6]

P=12650+24560.915=37.21KN

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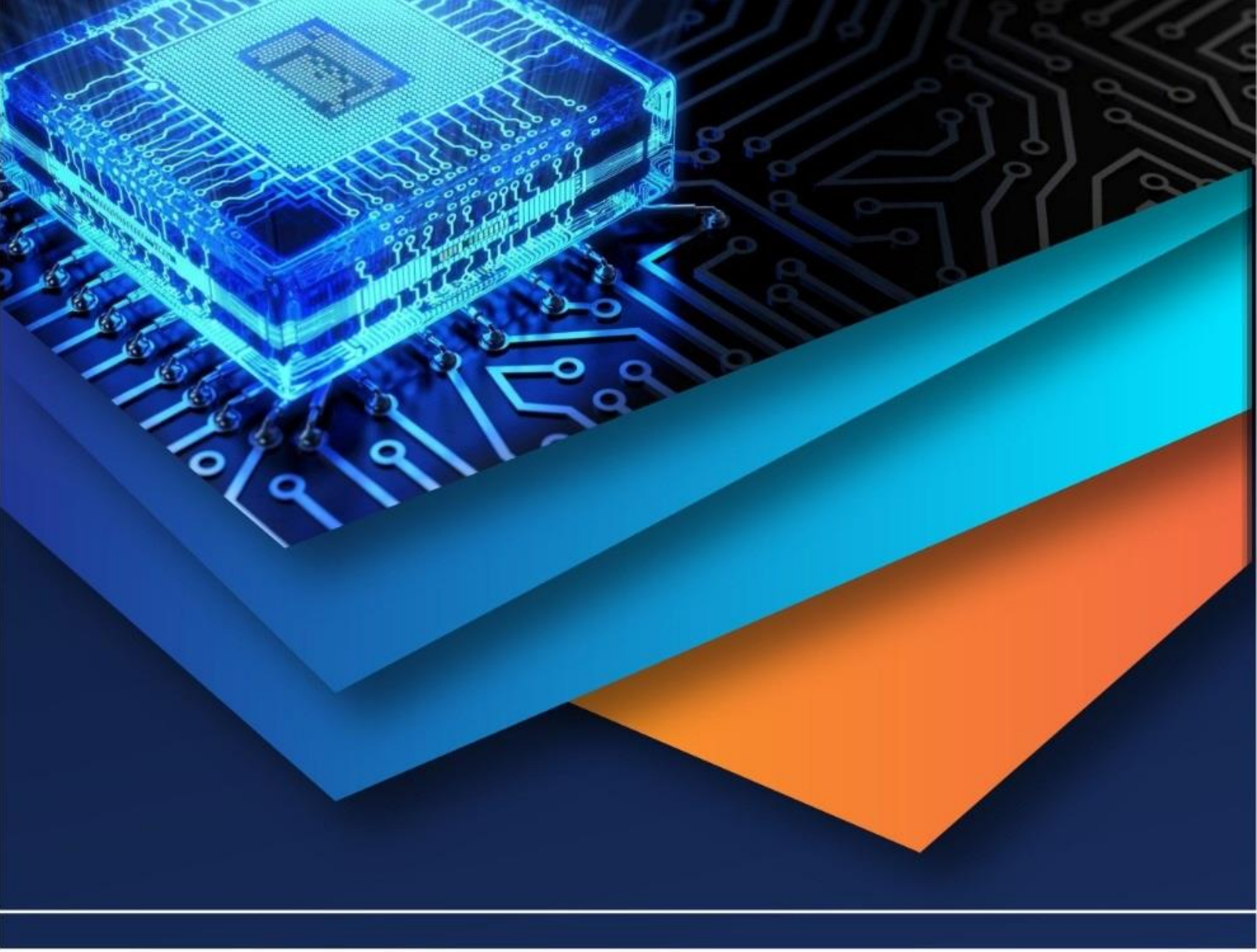

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