Design AMD Fabrication of Optimized Vacuum Moulding Machine

J. S. Soni[1], C. Prashanth[2], G. Mahesh[3], A. S. Satish[4]
[1]Professor, [2-3]Students, [4]Associate Professor
Department of Mechanical Engineering, Bharat institute of Engineering and Technology
Ibrahimpatnam - 501 510, Hyderabad, Telangana, INDIA

Abstract: - Vacuum forming machine is a simple way of thermoforming, where a plastic sheet is heated to forming temperature, stretched on to a single surface mould and forced against the mould by a vacuum. This forming process can be used to form plastic into permanent products such as casings and protective covers. Normally draft angles are given during design of the mould at least about 3 degrees for easy removal of formed plastic part from the mould. Parts having high depth can be formed if the formable sheet is mechanically and pneumatically stretched prior to bringing it into contact with the mould surface and applying vacuum. There are few types of forming machines. Such as vacuum forming, pressure forming and twin sheet forming. There are different types of plastic sheets which can be moulded; they are ABS Thermoform plastic sheets, PETG Thermoform plastic sheets and Polycarbonate / lexan thermoform plastic sheets. Materials used in vacuum forming are generally thermoplastics. The commonly and easiest to use thermoplastic is high impact polystyrene sheeting (HIPS). This is moulded around a wood, structural foam or cast or machined aluminium mould, and can form to almost any shape.

Key-Words: - Vaccum forming, Vaccum moulding, HIPS, Thermo forming.

1 Introduction

Vacuum forming is also known as Thermoforming as it is a thermal process. It is a forming process where a plastic sheet is heated to a forming temperature, formed to a specific shape in a mold, and trimmed to create a usable product. The thin sheet, or "film" when heated in an oven to a high-enough temperature that permits it to be stretched into or onto a mold and cooled to a finished shape.

In its simplest form, a small tabletop or lab size machine can be used to heat small cut sections of plastic sheet and stretch it over a mold using vacuum. This method is usually used for less number and prototype parts. In complex and high-volume applications, very large production machines are used to heat and form the plastic sheet and trim the formed parts from the sheet in a continuous high-speed process, and can produce many thousands of finished parts per hour depending on the machine and mold size and the size of the parts being formed. Thin-gauge and heavy-gauge (thick) thermoforming. Sheet thickness less than 1.5 mm is usually used on the thermoforming machine from rolls or from a sheet. Sheet thicknesses greater than 3mm are usually placed to the forming machine by hand or an auto-feed method already cut to final dimensions. Heavy, or thick-gauge, cut sheet thermoforming applications are normally used as permanent structural parts. There is a small but growing medium-gauge market that use sheet from 1.5 mm to 3 mm in thickness [4].

2 Literature Review

The present research covers the topics related to the quality important philosophy and its vital part in the actual business strategy to improve financial performance. This study gives a special emphasis to quality management and the aim to connect it with financial results. The main relation between both the areas is the use of statistical approaches such as design of experiments and response surface methodology which are used in process improvement and product development [3]. The food packaging thermoforming industry was selected to apply these relatively new concepts; two specific processes were used: *contact heating and plug-assist thermoforming.* The present study describes the theory behind thermoforming process used in the production of food containers [1] & [2].

Types of thermoforming molds:

1. Plaster of Paris mold

2. Wooden mold
3. Plastic mold
4. Aluminum mold

3 Methodology

3.1 Software

AUTODESK FUSION 360 Autodesk, Inc. is an American multinational software corporation that makes software for the, manufacturing, media, and entertainment industries. Autodesk is headquartered in San Rafael, California, and features a gallery of its customers' work [5] in its San Francisco building. The company has offices worldwide, with U.S. locations in Northern California, Oregon, Colorado, Texas and in New England in New Hampshire and Massachusetts, and Canada locations in Ontario, Quebec, and Alberta. John Walker founded a company in 1982 who is also a coauthor of the first versions of AutoCAD, the company's flagship computer-aided design (CAD) software. It's AutoCAD and Revit software is primarily used by architects, engineers, and structural designers to design, draft, and model buildings and other structures. Autodesk software is being used in many fields, from the New York Freedom Tower [6] to Tesla electric cars. Autodesk became best known for AutoCAD but now develops a broad range of software for design, engineering, and entertainment as well as a line of software for consumers, including Sketchbook, Homestyler, and Pixlr. The company provides educational versions of its software free of cost to qualified students and faculty through the Autodesk Education Community, and also as a donation to eligible nonprofits through TechSoup Global. Autodesk's digital prototyping software, including Autodesk Inventor, Fusion 360, and the Autodesk Product Design Suite, are used in the manufacturing industry to visualize, simulate, and analyze real-world performance using a digital model during the design process. The company's Revit line of software for Building Information Modeling is designed for users to explore the planning, construction, and management of a building virtually before it is built. Autodesk's Media and Entertainment division creates software for visual effects, as well as animation, game development, and design visualization. 3ds Max and Maya are both 3D animation software used in film visual effects and game development.

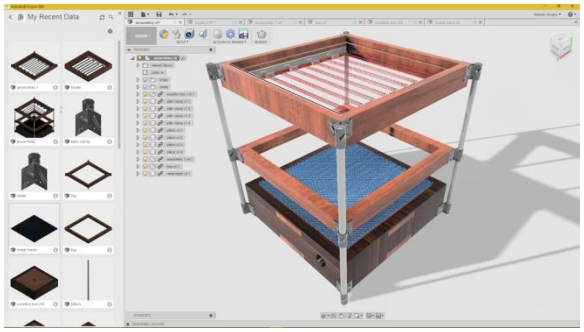

Figure 1: Design methodology

The idea behind Fusion 360 is to offer a single, any time access environment where a wield mechanical, industrial, and conceptual design tools to create models that are both functional and snazzy looking. In Contrast with the traditional shotgun marriage of discrete tools that are used in hopes of muddling to a design that's both useful and not bad looking.

Fusion 360 seems to offer a full range of 3D design modeling capabilities, including free-form modeling. It has translation abilities for importing common CAD file formats. It comes with a collaboration tool and it has automatic versioning. The interface is easy to learn, and the workspace uncluttered. Right clicking seemed to offer all the proper context-sensitive prompts. Performance was surprisingly snappy on my sometimes-lousy Internet connection [7].

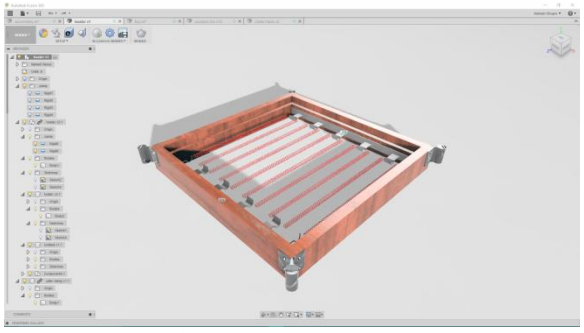

Figure 2: Fusion 360

Fusion 360 appears more than industrial design and mechanical engineering heads to the cloud. If you have the HTML version of this message, look at the image over there. You'll see that Fusion 360 also provides functionalities for

social collaboration, video sharing, creating polls, and even building a Wiki page. This is neat stuff. The kind of stuff that the new generation of engineers and the old who are young of mind grasp intuitively and will soon both expect and demand of everyone.

Designing and Fabrication

Heating system:

After mounting the sheet on tray is pushed for a specific amount of time (stress time) against the heated mechanism, the heat (approximately 280 to 320 F) will travel into the thermoplastic sheet. For efficient contact heating the heating coils are used which are connected in series, each holds 1500 watts. This is one sided heating and this system is placed at the top of machine holder with the help of rods and rubber strips [8].

Carrying tray:

Carrying tray is used to clamp the thermoplastic sheet, which has two frames where the sheet is clamped between them. This tray carries the sheet to the heating system and to forming force vacuum chamber. It moves in linear direction over the rods with the help of linear ball bearing. It has the exact length and with same of heating system, to both the trays [9].

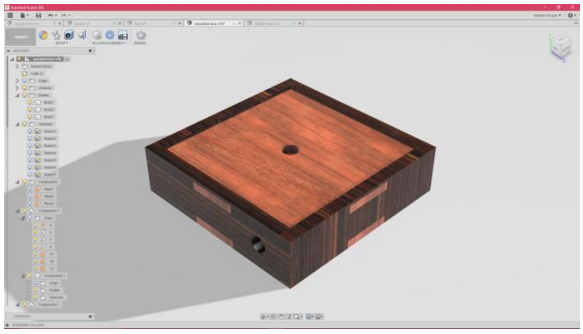

Figure 3: Carrying tray

Forming force vacuum chamber:

The forming force used in the thermoforming processes are usually vaccum and air pressure. The aim of the pressure difference is to force the flat sheet in to the mold and take the shape of the entire mold. Vacuum forming makes use of the self-sealing ability of the plastic sheet in which the air is removed from the enclosed cavity and this causes a pressure reduction on that side of the sheet, which allows atmospheric pressure, with additional applied air pressure, to fill the cavity and force the plastic sheet into the evaluated space. This causes the sheet to fill over the mold shape [10].

Figure 4: Forming force vacuum chamber

In order to achieve higher forming speeds and greater detail formed shape it common to use air pressure in conjugation with the vacuum to provide a greater pressure differential and better forming result. In the case of contact heating thermo forming, the clamping provides a sealed pressure chamber which allows the increased air pressure to exit inside of the space between the mold and the heating plate. When the vacuum forming process begins, the air pressure is applied for a specific amount of time (form time) to cause the plastic sheet to stretch. Vacuum cleaner is used to create vacuum where nozzle is connected to the hole opening of vaccum chamber.

Rods, clamps and bearings:

Rods acts as pillars to the entire machine made of aluminum and are made to suit to the diameter that fits the bearings to roller over the rods and are cut in lathe machine. These rods are fitted to the machine with clamps made of wooden blocks acts as bass to rods. Linear ball bearings are rolled over the rods caring the tray that holds thermoforming sheet [11].

Thermoforming limitations:

The thermoforming manufacturing process is ideal for producing large Volumes of products. However there are several limitations in the process that must be taken under careful consideration. Lubrication of the OPS it has become at some manufacturers of plastic containers. The OPS sheet goes through a silicon bath prior to entering the pre-heater in the thermo forming process. The high temperatures at which the plastic is formed can cause the

plastic to stick and it is therefore necessary to use some lubrication which helps to make sure that the OPS slides into all of the intricate crevices of the mold. At low temperatures and pressures it is unable to fully form the product into the mold and thus a loss of detail in the finished product.

Figure 5: Finished product.

4 Results and Discussion

For the successful selection of the optimum OPS sheet a design of experiments (DOE) approach will be used and the following objectives were used:

- Familiarization with thermoforming processes and procedure.
- Identification and quantification of factors.
- Establishment of ranges for all variables.
- Preliminary testing with stock product.
- Randomization and blocking of external factors.
- Formulation of testing matrix for final series of tests.
- Testing of 8 different for final series of tests.
- Determination of significant factors.
- Statistical analysis of testing.
- Economic analysis to determine the suitability of solution.

Figure 6: Design of Experiments (DOE) approach

5 Conclusion

Using this simple fabrication design one can fabricate a vaccum forming machine at cheaper and affordable cost. Wood is used for fabrication of this machine. We can vacuum form any type of shapes we required like plastic body of RC cars, drones and further their hobby field body covers. We can even mold trays to store tools and other accessories.

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