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Design & Development of Vaccum forming Machine

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ABSTRACT

Thermo-forming normally consists of heating a thermoplastic semi-finished product until the forming temperature is reached, and subsequently the desired form is obtained by means of pressure difference and mechanic stretching. Thermo-forming is a forming method that, by means of several process steps, facilitates the production of an inherently stable plastic part.

Keywords: Molded Plastic Product**,** Thermoformed mold,machine design, development.

1. INTRODUCTION

Thermoforming has been around for a very long time, and has transformed the world that we live in. It is a process that has helped to make items from the simplest of food packaging trays, to car interior parts, sets and costumes in Hollywood blockbuster movies, lifesaving medical equipment, and even components for space exploration. The possibilities of this production method are endless, with applications seen in almost every industry you can think of. Despite seeing and using thermoformed plastics every day, not everyone has even heard about thermoforming before, let alone had the chance to use it to design and manufacture something fresh out of their own imagination. 'Thermoforming' is used to describe any process in which heat is used to shape and mould plastic, although in this guide we will be talking specifically about 'vacuum forming', which can certainly be considered part of the thermoforming family, only with some very important extras. Thermoforming is a complex and very important industrial process in which the thermoplastic sheets or foils are processed into a new form by using heat and pressure/vacuum. Thermoplastic materials are easily formed by heating, which makes thermoforming widely available. It is the most important in the food and pharmaceutical industry for food and drug packaging, in electrical/electronic industry for enclosures and anti-static trays, in medical for radiotherapy masks, prosthetic parts, thermoplastic aligners, in automotive industry for wheel covers, wind and rain deflectors, in aircraft industry for interior trim panels and covers, in buildings for roof lights and door panels, in furniture industry for chair backs and kitchen panels, in nautics for boat hulls and dashboards, in graphic design and arts for coloring 3D printed surfaces , and in many other industries. Bearing in mind the high requirements in the food industry – productivity and flexibility of the system, special attention should be paid to the design and realization of product stacking machine. Thermoplastic materials are used in this technology and one of the most important factors is the temperature of processing a plastics sheet. It should be high enough to soften the sheet and to enable its forming but also not too high because of the risk of material damage. In case of thermoforming machines it is possible to use a certain temperature distribution in order to obtain the product wall thickness as uniform as it is only possible.

2.Objectives :

- To study alternate design solutions of vacuum forming machine transmission.

- To study time & temperature of vacuum forming process improvement.
- To redesign & fabricate vacuum forming machine.
- To study the quantity of production and reduce time, scrap, electricity required during machining.
- To study performance of the optimize vacuum forming process parameters using new machine.

3.Methodology:

The below flow chart shows the seqential operation/steps that will be performed during the project process.

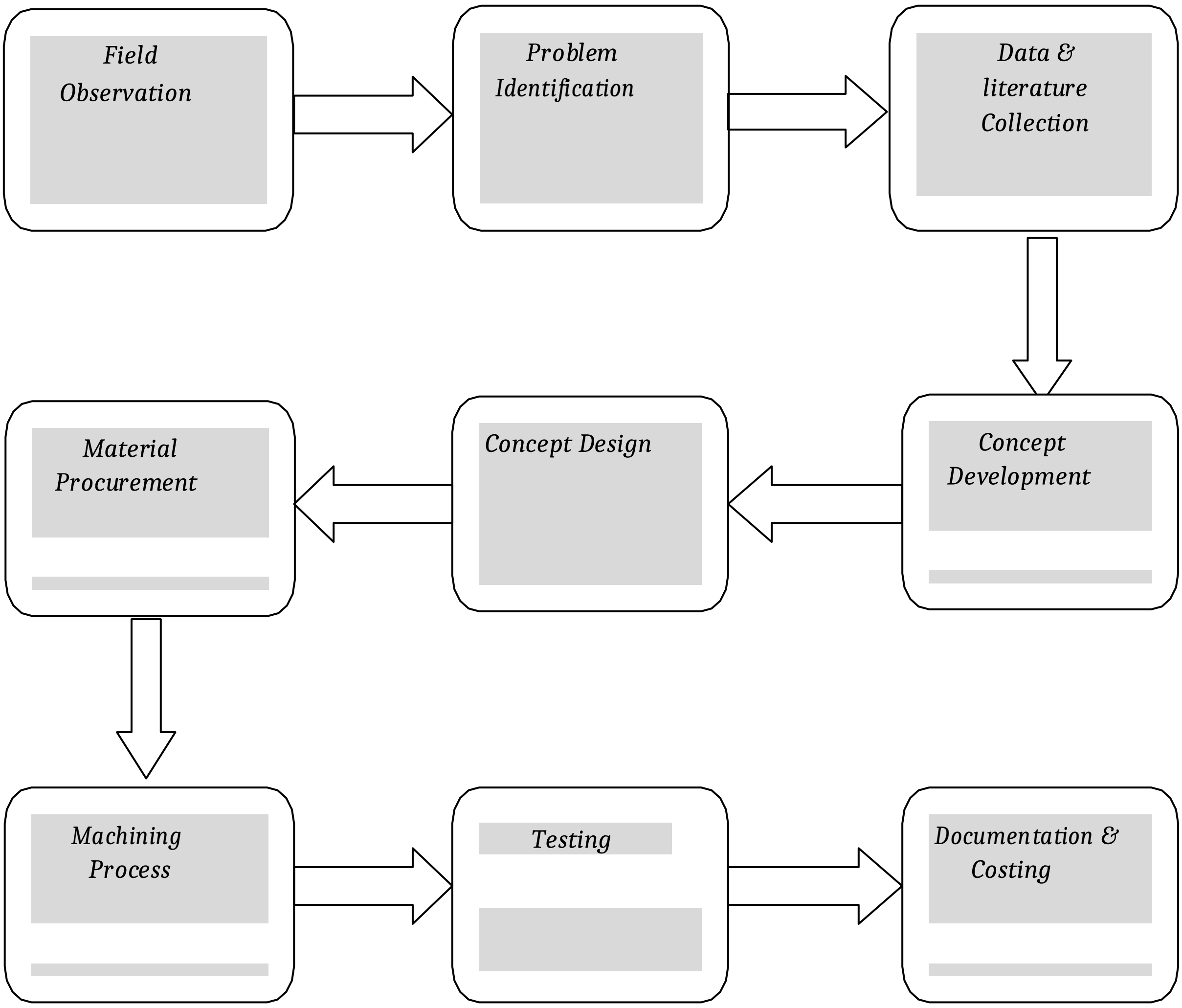


Figure 1- Block diagram of Vaccum Forming Machine

4. PRINCIPLE OF VACUUM FORMING :

a. **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.

b. **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.

c. **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.

d. **The Vacuum system :** The vacuum pumps, appropriate to the size sheet being formed and the volume of air being evacuated.

e. The sheet is fixed in place on heat proof air-tight seal on roller at both ends.

f. 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.

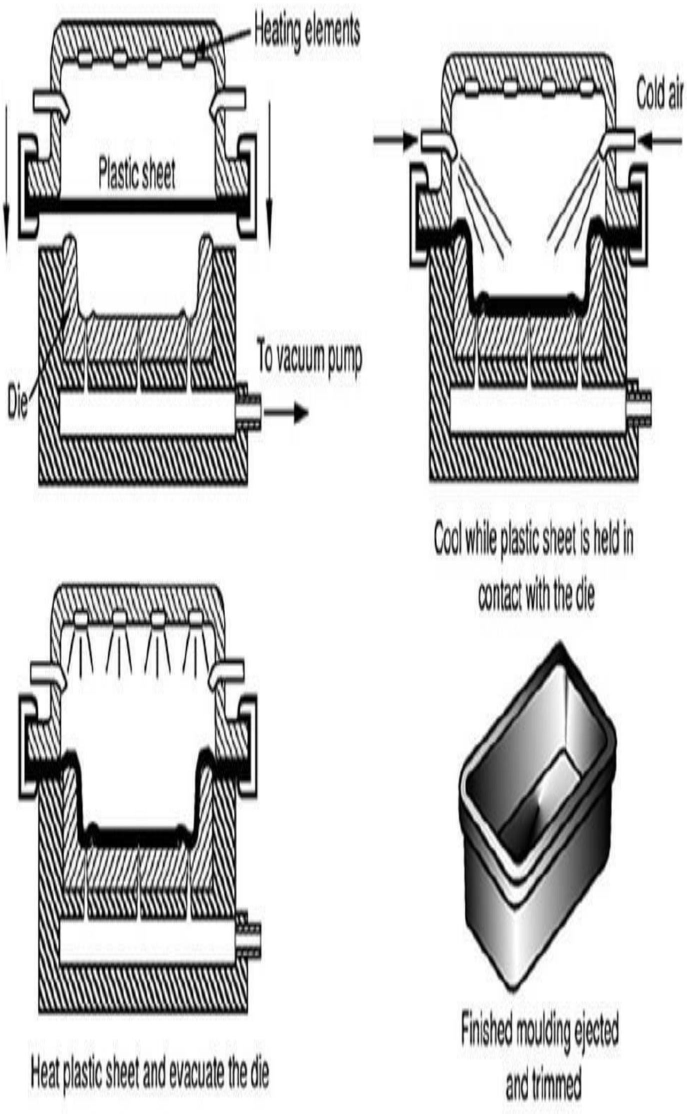
g. After a few minutes the plastic is ready for forming as it becomes very flexible or rubbery.

h. The heater is turned off and the mould is moved upward by lifting the lever until the locks in position.

i. 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.

j. The plastic sheet is removed from the vacuum former pressed into its surface.

5. WORKING PROCESS OF VACUUM FORMING :



6.Transmission Components :

3 Phase AC Geared motor
Power = 1HP
Speed Reduction Ratio = 20:1 (for 1440 RPM) =

72 rpm.

7. Design & Calculation :

1) Motor Selection :

Load on motor is consider as combine load of PVC sheet bundle & transmission system components in maximum 100 Kg.(Approx).

F = 100 X 9.81 = 981N = 1000N

The power is to be transmitted to conveyer by a sprocket having diameter

D = 125mm. = 0.125m.

R = 62.5mm. = 0.0625m.

We know that, torque required to run the transmission system,

T = F X R = 1000 X 0.0625 **T = 62.5 N.m.**

P = Power of motor

N = Speed of motor = 60 rpm.(Assume)

P = 2 Π N T

= 2 Π x 60 x 62.5

P = 392.699 Watt.

Thus, selecting a motor of the following specifications

2) Shaft Design :

To find diameter of shaft by ASME code.

For commercial steel shaft 30C8 material,

Syt = 400 Mpa.

Actual shear stress τact = Syt = 400 = 133.33 N/mm2 2 X FOS 2 X 1.5

T = /16 x τact xd3 62.5 x 10 3 = /16 x 133.33 xd3

d= **13.36 mm select d=40 mm. (Application Basis)**

3) Bearing selection:

As shaft dia. – is 40mm so we have selection a pedestal bearing having shaft outer dia. – 40mm. No.6208.

Total Radial load on bearings are F =50 kg = 50x9.81 = 490.5N.

There are four pedestal bearings are in transmission system, so that load on each bearing will be,

Fr = F/4 = 122.625 N

Radial load on each bearing's Fr = 122.625 N

Equivalent dynamic load

Pe = V. Fr. Ka

= 1 X 122.625 X 1.5

= 183.9375 N.

bearing life is,

L10 =Lh10 10X 606 X n

Lh10 from graph 4.6 PSG Design data book for 60 rpm maximum speed of ball bearing is 200000 Hours.

L10 = 200000 X 660 X 60

L10 = 720 millions of revolutions.

L10 = (C)(103)

Pe

10

C = (L10)(3) X Pe

C =(720)(0.3) X 183.9375

C = 1648.59 N. ≤ 22800 N (Bearing 6208 is safe).

PSG Design data book P.No. 4.13.

4) Design of Pneumatic Cylinder:

Considerations made during the design and fabrication of a double acting cylinder was as follows,

The pneumatic cylinder will to press operation & to rise or lower the die. The total load acting on the cylinder consists of Mass to be put on lift,

F = 25 kg. = 25 x 9.81 N = 245.25 N.

For cylinder design we use pressure will be, 2 bar i.e. 0.2 N/mm²

Therefore, P=F

245.25

$0.2 = 2\ X\ \pi\ D2$

D = 39.51mm.

D = 100mm.

Therefore, we selected 100 mm diametric cylinder. **(Application Basis)**

5) Design of Chain Drive :

(V.B. Bhandari, DME Book. Third edition, p.no.550, 551) (Table 14.2, 14.6)

Let speed of sprocket is 20 rpm. The driving sprocket is mounted on the same shaft of motor so that,

Dia. of driving sprocket d1 = 125mm.

Dia. of driven sprocket d2 = 75mm.

$d1\ N1$

$d2\ N2$

= 72

$N2$

N2 = 43.2 rpm ≈ 44 rpm.

Speed of driving sprocket N1 = 72 rpm.

Speed of driven sprocket N2 = 44 rpm.

No. teeth on driving Z1 = 30

No. teeth on driven sprocket Z2= 20

Let, Ks = Service factor = 1 (Table 14.3)

K1 = Multiple strand factor = 1 (Table 14.4)

K2 = Tooth correction factor = 1.73 (Table 14.5)

Power P= 1HP = 746 watt = 0.746 KW

Power rating of chain Kw = , Kw = 0.4312.

$1\ x\ 1.73$

Kw = 0.53 ≥ 0.4312.

From dimensions of roller chain P.No. 547. Pitch P = 12.70 mm.

Center distance between two sprockets a = 2200 mm.

No. of links on chain

Ln = 371.46 Links

Ln = 372 Links.

Corrected center distance a

a = 2203.35 mm.

Figure.3 : Assembly of Machine

8. Conclusion :

The time for particular batch production is reduces and increase in production after implementation of 'Modified vacuum forming machine'. Similarly, the cost of electricity consumption per unit output is also decreases significantly. The present methods for modified vacuum forming machine are of great significant for modern vacuum forming production workshops.Our machine is affordable to low cost forming applications at optimum cost and it will able to do more production well. It also helps to reduce shop floor area as it can assemble and dismantle easily whenever required.

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