International journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in

Vol.2., Issue.4, 2014

RESEARCH ARTICLE

ISSN: 2321-7758

DEVELOPMENT OF PNEUMATICALLY OPERATED COMPRESSION MOLDING MACHINE

ERANNA. H

M.Tech scholor, Product Design and Manufacturing, Dept. IEM

Sri Siddhartha Institute of Technology, Tumkur, 572105, Karnataka

Article Received: 17/07/2014 | Article Revised on: 22/07/2014 | Article Accepted on:23/07/2014

ERANNA. H

ABSTRACT

This paper deals with the development of pneumatically operated compression molding machine. A study of different compression molding machines at different industries showed that most are fully manual and some are hydraulically operated compression molding machines, but the cost of these machines is too high for small scale industries and these machines are well suited for the high pressure requirement. In order to overcome this problem an attempt has been made in developing a pneumatically operated compression molding machine. While preparing FRP composite specimen for testing purpose, many variables like temperature, pressure, time of curing have to be taken into consideration. In this machine temperature of dies can be controlled automatically by using temperature sensors and the pressure is controlled by using FRL (filter, regulator and lubricator) unit. This machine solves the problem of small scale industries where small sized plastic components are manufactured.

Keywords: Pneumatic system, Temperature sensor, Nichrome Heating elements, Dies.

INTRODUCTION

Compression molding is one of the most common processes used to mold plastics into a usable form and it is also one of the most cost effective. Most often, compression molding is used to create a wide variety of parts and components ranging from compression molded car parts to medical products.

Presently there are many types of compression molding machines are being used in industries for manufacturing the components of composite, some of them are manually operated molding machines and some machines are hydraulic operated molding machines. The main problem with manually operated molding machine is, it requires more man power to operate the machine and the output of this machine is comparatively very less than the output of hydraulic operated compression molding machine. There are many types of hydraulic molding machine are being used in industries, some of them are automatic and some are semiautomatic. The hydraulic machine can be used in some applications where there is a requirement of high pressure or load for manufacturing the components, these high capacity molding machines cannot be installed

in small scale industries, because the cost of hydraulic molding machine is more and it is used for production of small plastic components.

By considering the above problems there is a need for development of low cost pneumatically operated molding machine. The development of pneumatically operated compression molding machine solves the problem of small scale industries by reducing the investment and maintenance cost of the machine. The researchers can use this machine for production of FRP composites.

LITERATURE SURVEY

Presently there are many types of hydraulic operated compression molding machines are available in the market. These hydraulic operated compression molding machines are too costly, require more space and well suited for high pressure requirement in large scale industries. It is highly expensive for the owners of small scale industries to invest huge amount on these high capacity machines. In this literature survey many papers and thesis have been reviewed. After the literature review, the customer survey is conducted to know the problems with the present compression molding machine and customer needs in the development of the new compression molding machine. The customers are researchers those who working with composite materials. From the customer interview the needs have been identified and are listed below**.**

1. Less cost
2. Portable
3. Easy to operate
4. Automatic temperature control

DESIGN OF MACHINE COMPONENTS

Pneumatically operated compression molding machine consists of following components

1. Air cylinder
2. Upper Die
3. Lower Die

1. Design of cylinder

Cylinder Thrust

The cylinder thrust is a function of piston diameter, operating air pressure and the frictional resistance (though in the case of static thrust, the frictional resistance is zero). Cylinder thrust can be calculated by the following formula. The following calculation shows the minimum force that can be applied on the material by using this cylinder

Let

P = Pressure = 0.3 MPa

D = Diameter of bore = 0.05 m

Thrust in Forward Stroke:-

$\mathbf{F_W = P \pi D^2 /4}$

$F_W = (0.3*10^6\ N/m^{2)}\ \pi\ (0.05\ m^{2)}\ /4$

$F_W = 589\ N.$

Thrust in return Stroke:-

$\mathbf{F_R = P \pi (D^2 - d^{2)} /4}$

$F_R = (0.3*10^{6)}\ \pi\ (0.05^2 - 0.015^{2)}\ /4$

$F_R = 535.76\ N.$

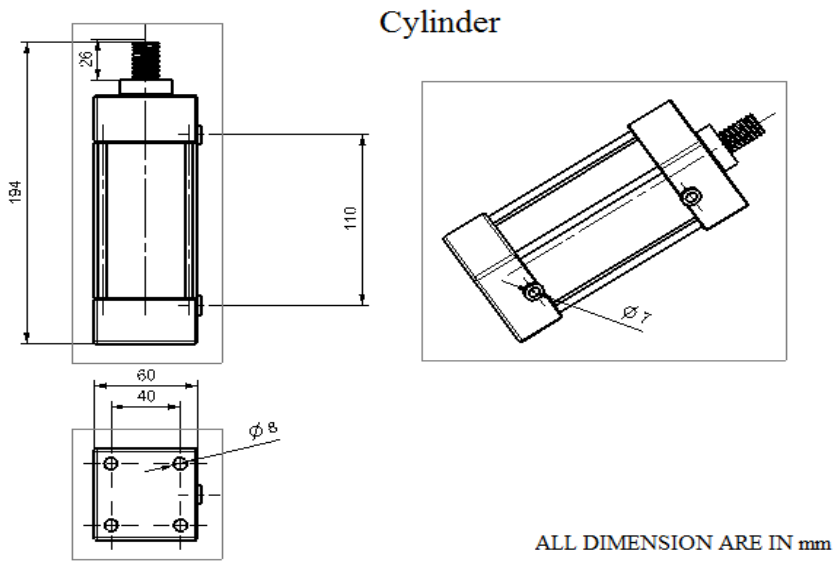

Fig 1: cylinder part drawing

2. Upper die

A square flat plate is used as a upper die plate because the purpose of this machine is to prepare FRP composite laminates for testing purpose.

Size	-	0.2*0.2 m (A square flat plat)
Thickness	-	0.008 m
Density	-	7.8 g/cm^3

3. Lower die

A shell type square plate is used as a lower die to avoid the wastage of resin because during the preparation of FRP laminates.

Size of plate	-	0.22*0.22m
Thickness	-	0.018m
Size of Cavity	-	0.2*0.2m
Depth of cavity	-	0.01m
Density	-	7.8g/cm^3

CONSTRUCTION AND WORKING

The pneumatically operated compression molding machine is constructed by using many components. The function of each component is briefly described below.

The pneumatic cylinder to apply the required load, Direction control valve to control the movement of the cylinder, flow control valve to control the flow rate of air for controlling the cylinder speed, FRL unit for filtering, regulating and lubricating the air, temperature sensors for controlling the temperature of dies, asbestos and glass wool for the insulation between piston rod and dies, a frame is used for the equal distribution of load on the material to be produced by using this machine.

List of components

1. Pneumatic cylinder
2. FLR unit
3. Die Material
4. Contactor
5. Glass wool
6. Heating elements
7. 5/3 Direction control valve
8. Temperature display
9 Temperature Sensor
10. Asbestos Shee

Fig 2 showing 3D model of compression molding machine

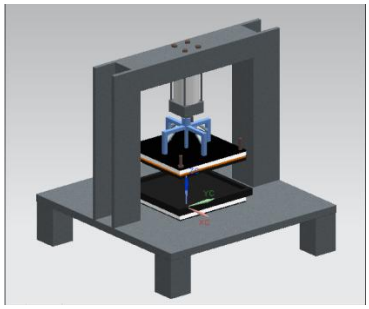

Figure 2: Isometric view of molding machine

Working of machine

The pneumatically operated compression molding machine is fabricated using various components. The components are pneumatic cylinder (50×100mm), 5/3 direction control valve, flow control valve, FRL unit, frame, temperature controller, heating coils, asbestos, glass wool and dies. The cylinder is used for up and down motion of the plunger which exerts the pressure on composite material to be molded; the movement of the cylinder is controlled by the direction control valve. The heat is applied by fixing heating elements on upper and lower die. Molding compound is placed in an open and heated mold cavity. The mold is closed and the pressure is applied to force the material to fill up the entire mold cavity. The heat and pressure is maintained until the plastic material is cured. Once the material is cured it is removed from the mold for finishing.

Fig 3: Working model

RESULTS AND DISCUSSIONS

1. Preparation of FRP Composite

The fig 5.1 shows the fiber reinforced composite prepared by using pneumatically operated compression molding machine under the pressure of 0.5MPa and at the temperature of 50^0 C. The material is kept under pressure of 0.5MPa for 1 hour 30 minutes and heated under the temperature of 50^0 C for 40 minutes.

Jute fiber	=	23.5%3 (layers)
Sisal fiber	=	36.4% (4 layers)
Polyvinyl alcohol	=	40%

Figure 4 : Thermoset laminate

2. Testing of Prepared FRP Laminate

Thermoset FRP laminate has been prepared by using developed pneumatically operated compression molding machine. The hardness test have been carried out by using 2.5 mm diameter ball indenter as per ASTM E10 standard and the tensile test have been carried out by using Universal testing machine as per ASTM D638 standard.

a) Tensile test for FRP laminate

Width	=	24.3mm		=	0.0243m
Thickness	=	3mm		=	0.003m
F_y	=	216 kg	= 216*9.81	=	2119N
A_c	=	w*t	= 24.3*3	=	72.9 mm^2
σ_y	=	F_y / A	= 2119/72.9	=	29.0MPa
F_{max}	=	312 kg	= 312*9.81	=	3060.72 N
σ_{max}	=	F_{max}/ A	= 3060.72 / 72.9	=	41.985MPa

b) Brinnel hardness test for FRP laminate

$$BHN = \frac{2F}{\pi Di[Di-(\sqrt{Di2}-d2)]}$$

F = 187.5 kg

D_i = 2.5 mm

d = 0.7 mm

$$BHN = \frac{2*187.5}{3.14*2.5[2.5-(\sqrt{6.25}-0.49)]}$$

BHN = 477

CONCLUSION

The following conclusions are drawn based on the results obtained in this project work

1. Pneumatically operated compression molding machine is developed with low cost and well suited for production of small sized FRP composites.
2. The FRP composites can be produced by using this machine with controlled temperature and pressure.
3. The temperature can be controlled automatically and can be varied from atmospheric temperature to 200^0 C.
4. The pressure can be varied from 0.1MPa to 0.8 MPa.
5. The tensile strength and hardness of the developed FRP composite are tested as per ASTM standard.

REFERENCES

[1] Poonam G. Shukla and Gaurav P. Shukla, "Design& Fabrication of Pneumatically Operated Plastic Injection Molding Machine", *International Journal of Engineering and Innovative Technology (IJEIT),* Volume 2, Issue 7, January 2013, PP 98-101.

[2] Syed AltafHussain, B. Sidda Reddy and V. Nageswara Reddy "Prediction of elastic properties of frp composite lamina for longitudinal loading", *ARPN Journal of Engineering and Applied Sciences,* vol. 3, no. 6, ISSN 1819-6608, December 2008. PP 70-75.

[3] Antoine Rios, Bruce Davis and Paul Gramann, "Computer Aided Engineering in Compression Molding", *The Madison Group: Polymer Processing Research Corporation*, 2011, PP 1-12.

[4] David O. Kazmer and Russell G. Speight, "Polymer Injection Molding Technology for the Next Millennium", An article, Mold flow International Pty Ltd.

[5] Felicia, O. Akerele, Nathaniel and C. Akhire, " Design and Construction of a Three- Mold Hydraulic Interlocking Brick Molding Machine", *Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS),* Volume 4, Issue 3, Scholarlink Research Institute Journals, 2013, ISSN: 2141-7016, PP 527-532.

[6] Peetu Paul, Nirmal Job A, Justin Koshy, Dr. K.E. George and Dr. Biju Cherian Abraham, "Development of Novel Polymer Composites", *International Journal of Engineering and Innovative Technology (IJEIT)*, Volume 3, Issue 2, August 2013, ISSN: 2277-3754, PP 377-380