Design and development of automatic loading and unloading of moulding box in heat moulding machine

K Sethuramalingam*[1], P Aravind[2] , V Arun Kumar[3] , A Tony Thomas[4]

[1,2] UG Scholar, Kongu Engineering College, Erode, Tamil Nadu, India
[3,4] Assistant Professor, Kongu Engineering College, Erode, Tamil Nadu, India

*Corresponding author:sethulingam45@gmail.com

Abstract. In heat moulding machine required shape can be obtained from the raw material at temperature range of 200 to 250 ^{0}C. The raw material used in the heat moulding machine is rubber and the melting temperature of rubber is 180 ^{0}C. In this process loading and unloading of moulding box is done manually. Hence heat produced inside the moulding machine may harm the operator or worker. Sometimes it leads to major accident for workers. If the worker continuously working in the hot zone may cause skin problem. To overcome this problem small table is designed with the help of pneumatic cylinder the loading and unloading process done automatically. Micrologix 1000 PLC is used to control the whole process. Wiper motor is used to move the table from one place to another place. The targeted position is sensed by the induction type proximity sensor. By the above mentioned components loading and unloading of moulding box is done automatically and the operator's safety will be assured.

Keywords— *Moulding*, Rubber, Wiper motor, Pneumatic Cylinder, Micrologix 1000 PLC, Proximity Sensor.

1. Introduction

The main objective of this paper is to design a machine for automatic loading and unloading of moulding box in heat moulding machine, so that it reduces the problem of labor insufficiency and provides safety to the labor. This system is more productive operationally and technically feasible. In this system the operator can replace the raw material away from the hot zone. It will reduce the human effort and provide safety from hot environment to the operator. In the existing heat moulding process the loading and unloading of moulding box is done manually. Figure 1 explains the existing system of heat moulding machine.

IOP Conf. Series: Materials Science and Engineering **402** (2018) 012120 doi:10.1088/1757-899X/402/1/012120

Figure 1. Exisiting Model

The drawbacks of the existing system is mainly the heat generated inside the moulding machine may cause health hazards to the worker. Sometimes even it leads to major accidents to workers. If the workers work in the heat zone of heat radiation it would prone to skin diseases. Heat-related illness can range from mild conditions such as a rash or cramps to very serious conditions such as heat stroke.

1.1. Proposed system

To overcome the above mentioned problem small table is designed with the help of pneumatic cylinder based loading and unloading process, it is carried out automatically. Micrologix 1000 PLC is used to control the whole process. Wiper motor is used to move the table from one place to another place. The targeted position is sensed by the inductive type proximity sensor. By above mentioned components the loading and unloading of moulding box is done automatically. The figure 2 shows the block diagram of the setup.

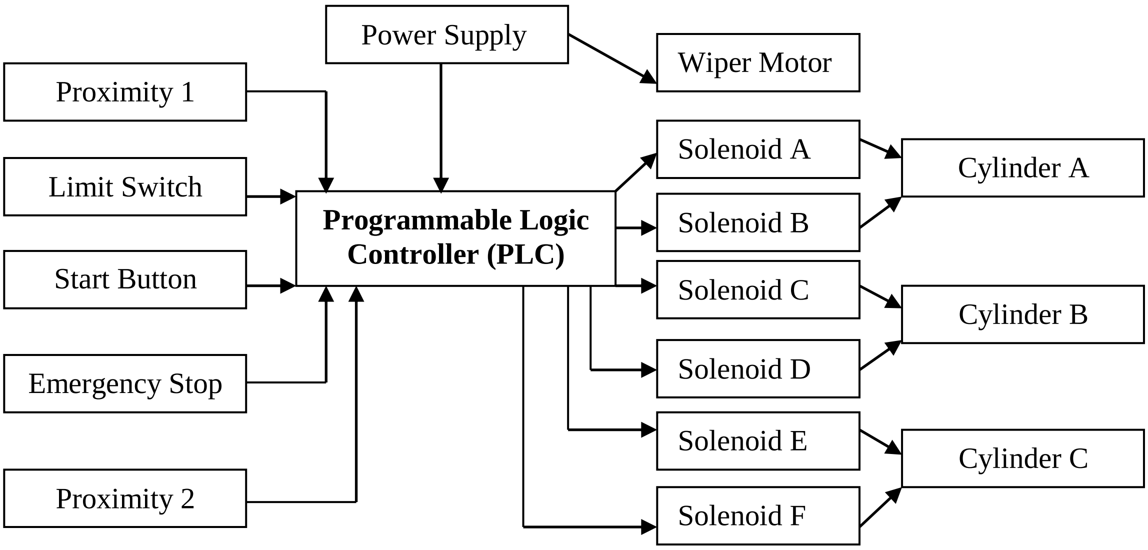

Figure 2. Block diagram of Setup

IOP Conf. Series: Materials Science and Engineering **402** (2018) 012120 doi:10.1088/1757-899X/402/1/012120

2. Design of the Proposed System

The machine consists of D.C.motor, 5/2 Solenoid valve, Inductive type Proximity sensor,Micrologix 1000 PLC, Roller limit switch, Double acting pneumatic cylinders. The entire setup is modeled and assembled using Solidworks. List of mechanical and electrical components used for the machine is shown in Table-1 and Table 2.

Table 1. List of Mechanical Components

S.No.	Mechanical components	Quantity
1	Wheel	04
2	Shaft	As Required
3	Ratchet	04
4	Pulley	02
5	Ms plate	3x1.5ft
6	Pneumatic Cylinder	03

Table 2. List of Electrical Components

S.No.	Electrical Components	Quantity
1	Power supply unit	01
2	DC motor	02
3	Micrologix1000 PLC	01
4	Induction type proximity sensor	02
5	Roller limit Switch	06

2.1. Design calculation

2.1.1.Motor Calculation

Power of the motor can be calculated as,
$P=I^2R$
P= power ; I= current =0.5 A; R=coil resistance =100 KΩ
Therefore $P = I^2R$
$= 0.5^2 \times 100 = 25W$
Speed of the motor can be calculated as,
Rpm = 120 × Frequency / No. of Poles
120 = standard
Frequency = 0.25
No. of Poles = 3
Therefore, Speed = 120 × Frequency / No. of Poles
= 120× 0.25 /3
= 10 rpm
The specifications of the DC motor is
N=30 rpm
V=12 V

P=18 W
Torque = (P × 60) / (2 ×3.14 × N)
Torque = (18× 60) / (2 ×3.14 × 30)
Torque = 5.72 N-m
Torque = 5.72 x 10^3 N-mm
The shaft is made of MS and its allowable shear stress = 42 MPa
Torque = 3.14 × f_s x d ^{3} / 16
5.72 × 10^3 = 3.14 × 42 x d ^{3} / 16
d = 8.85 mm
The nearest standard size is d = 9 mm.

2.1.2.Cylinder Calculation

Cylinder A
Weight of the sliding component = 22kg×9.81 = 220.725N
Total weight acting on the piston = Dynamic force + Static force
(Weight × Acceleration/Gravity) + (Weight × Friction coefficient)
Dynamic force = (220.725× (0.06-0)/2))/2) = 0.625N
Static force = (220.725×0.2) = 44.145N
Total force = 44.82N
Pressure = Force/Area
10×10^5 = 44.820/(3.14/4)×d/2
Diameter = 40mm
Stroke length = 28cm

Cylinder B
Weight of the sliding component = 7.5kg×9.81 = 73.535N
Total weight acting on the piston = Dynamic force + Static force
Dynamic force = (73.535×(0.06-0)/2))/2) = 0.225N
Static force = (73.535×0.2) = 14.94N
Total force = 14.94N
Pressure = Force/Area
10×10^5 = 14.94//(3.14/4)×d/2
Diameter = 40mm
Stroke length = 28cm

Cylinder C
Weight of the sliding component = 2kg×9.81 = 19.62N
Total weight acting on the piston = Dynamic force + Static force
Dynamic force = (19.62 × (0.06-0)/2))/2 = 0.06N
Static force = (19.62 × 0.2) = 3.92N
Total force = 3.93N
Pressure = Force/Area
10×10^5 = 3.93/(3.14/4)×d/2
Diameter = 40mm
Stroke length = 20cm

2.2 Assembly -3D Design

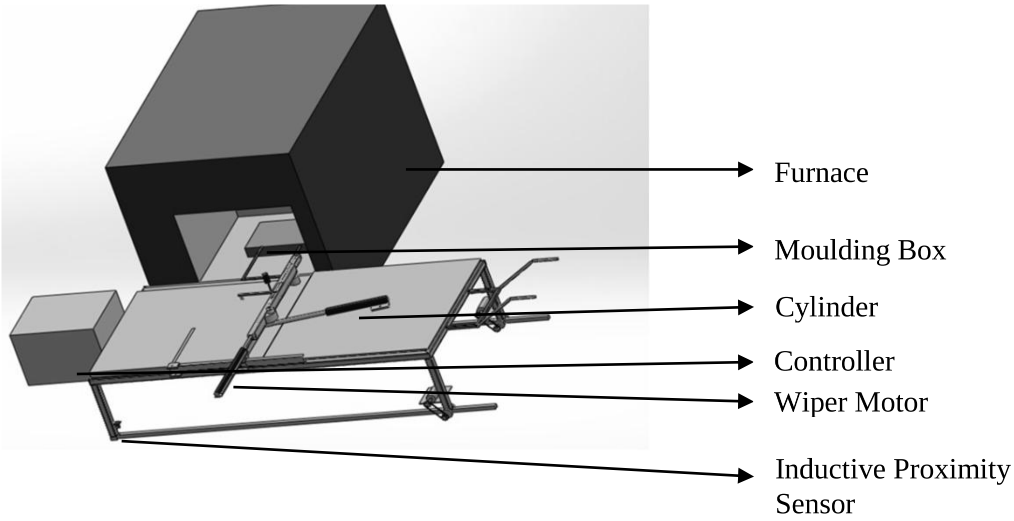

Figure 3. Assembly drawing

3. Principle of Operation

The position of the work table is monitored and adjusted with the help of inductive type proximity sensor as shown in figure 3. Micrologix 1000 PLC is used to control the whole loading and unloading of moulding box in heat moulding machine. By using this setup the operator can work away from the machine. If the table reached the targeted position the PLC stops the Vehicle and the cylinder gets actuated to do the loading and unloading process. Based on the number of plant the length of the track can be adjusted.

In this work, it takes less manual work, less labor and safety is achieved. It has reduced the intense effort required in the manual process by its simpler mechanism and automation. By using the Micrologix 1000 PLC, sensor, wiper motor, Pneumatic double acting cylinder, the loading and unloading process is automated. It is a useful product for those who are in the field of heat moulding machine, because it provides the full safety to the operator with the heat moulding machine. The operating cost and installation cost of this model is much lesser, when compared to the other automated process. This concept will be useful for the operators to reduce their workload considerably.

4. Conclusions

Manual operating cost of the machine is considerably reduced. Also, the safety of the operators are ensured by this work. Health hazards to the operator can be avoided in this work. This project is effectively used in advancing the modern techniques in our moulding machine. This project safeguards the operator at less cost.

- By increasing the mechanism used in the proposed system the loading and unloading operation can extend to the more number of machines which are placed serially.
- Replacing of raw material inside the moulding box can automate using more number of cylinders and mechanism.
- Also the whole loading and unloading process can be monitored with the help of PLC based PC monitoring system.

A Comparison table is shown in Table-3

IOP Conf. Series: Materials Science and Engineering **402** (2018) 012120 doi:10.1088/1757-899X/402/1/012120

Table 3. Comparison Table

Areas considered	Traditional method	Proposed method
Effectiveness	Incomplete	Good
Labor requirement	More	Less
Hazards	Yes	No
Need of expertise	No	Yes
Labor charge	High	Less

Acknowledgement

The authors greatly acknowledge M/s Base Automation, Chennai, for providing the support and infrastructure facility to do this experimental work.

5. References

[1]. Brouwers, N. (2002). *Mechatronics in Assembly Machines. Proc. Of Mechatronics*, **24-26**.

[2]. Gutierrez, A. (2000). PM—Power and Machinery: Design and Testing of an Automatic Machine for Spraying at a Constant Distance from the Tree Canopy. *Journal of agricultural engineering research*, **77(4),** 379-384.

[3]. Naert,(1992). Mechanical part design and Overload influence marginal bone loss and future success in the Branemark system. *Clinical oral implants research*, **3(3)**, 104-111.

[4]. Burt (2002). Automation of the canel system by Micrologix 1000 PLC and flow simulation procedure.

[5]. Dolegowski (1993). Pneumatic windshield wiper motor controlled with the help of proximity sensor.

[6]. Esposito, (2012) Fluid Power with applications, Seventh edition, Pearson education, New delhi.

[7]. Khurmi (2005), "Theory of Machines",First edition Eurasia publishing Housing Private Limited New Delhi

[8]. Rohit Mehta (2003) "Principles of Electrical Engineering", S. Chand and company Ltd., Third Edition.

[9]. Bimbhra P.S. (2008), "Power Electronics", Fourth Edition. Khanna Publisher New Delhi.

[10] Rattan.S.S (2008), "Theory of Machines", Tata McGraw-Hill publishing Company Limited New Delhi, Second Edition, page no 330-350,369-401.