

# Industrial Automation for Roto-moulding Plant using PLC

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**Abstract**—Automation systems have been used in almost all industries of food, automotive, textile, machinery manufacturing, agriculture and etc. In this research paper, we are presenting a process loop which can be used in roto moulding process. That has made the process automatic. Because human interruptions can lead to wastage of material, lower quality and increase chances of accidents. PLC based programming can be useful for making process in a sequence and time base.

**Keywords**— PLC, roto-moulding, automation

## I. INTRODUCTION

Today, Technology is developing very rapidly so industrial plants need a very short period of time and more reliably for production process. PLC controlled systems are able to solve complex automation problems quickly and safely. [1] In this way, process control can progress more secure and can be done quickly. Also encountered failures can be identified in a very short period of time and they can be removed easily. Process control technology is the tool that enables manufacturers to keep their operations running within specified limits and to set more precise limits to maximize profitability and safe operation.

Automation is a set of technologies that results in operation of machines and systems without significant human intervention and achieves performance superior to manual operation. Modern automation is the automatic handling and continuous processing of machine, made possible with computer controls. [2]

## II. LITERATURE REVIEW

. **K. Madhanamohan et al [3]** discussed how the present automation system comes in to existence through its various stages. He described the control schemes for industrial automation and system monitoring to improve system operation, system reliability, asset management, etc. The goals of automation is Integration of various aspects of manufacturing operations to reduce labor cost. The fundamental constituents of automated process are: (1) a power source, (2) a feedback control mechanism (3) a programmable command

**Sirkka-Liisa et al.[1]** reviewed about automation technology in the process industry. According to her, the latest technologies, which include wireless networks, fieldbus systems and asset management systems, are boosting the efficiency of process systems. Design of very large distributed systems has presented a new challenge to control theory. A key issue in control engineering is the application to highly complex systems: the coupling of complicated and large

heterogeneous systems in which different disciplines are involved and different types of information are available or have to be uncovered.

## III. ABOUT ROTATIONAL MOULDING

### A. ROTATIONAL MOULDING PROCESS

The mould or cavity is filled with a predetermined amount of polyethylene powder, such as Equistar PVC powders. This is called “charging the mould”.

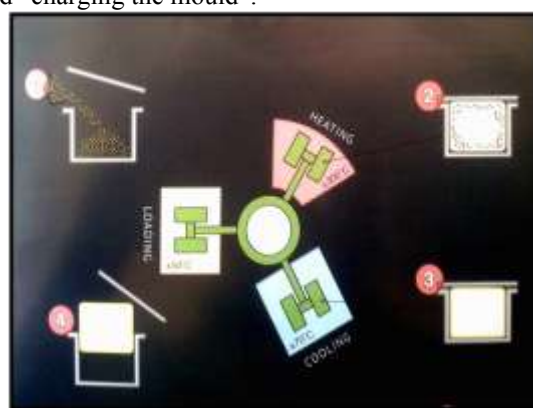


Fig. 1 various steps involved in Process[2]

The mould halves are secured together by a series of bolts or clamps.

For totally enclosed pieces, the entire mould is made of heat –conductive metal. When one or both ends of the pieces are open, heat insulating covers are used to close the mould.

The charged mould is placed in an oven where it is heated and simultaneously rotated around two axes in planes at right angles to each other.

During the heating / rotation cycle the resin melts, fuses and then takes on the shape of the mould being used to form the hollow object.

When all powder has fused into a homogeneous layer on the walls of the mould cavity, a combination of air and water is used in cooling chamber to cool the mould slowly. This helps maintain the part’s dimensional stability.

The mould are removed from the cooling chamber, opened and the finished parts removed. The mould is then readied for the next cycle.

### B. RAW MATERIAL FOR PROCESS

LLDPE (Liner Low density polyethylene)/MDPE (Medium density Polyethylene)/ HDPE (High density Polyethylene) are

being used with density of 0.92 to 0.95 gm/cm<sup>3</sup> and Melt Flow index in the range of 3 to 4.5 gm per 10 minutes.

To produce the good quality water tanks by Rotational Moulding, the material should have following properties.

- ✓ Good mechanical strength.
- ✓ Good material stability over a wide range of temperature and cycle time.
- ✓ Good resistance over warpage
- ✓ Consistency in shrinkage at least 2.5 % or slightly more
- ✓ High ESCR (Environmental stress crack resistance)

#### IV. MATERIAL HANDLING PROCESS

##### A. PROBLEMS

The material handling of rota moulding process is fulfilled by labour work. Human effort is required to complete the process of raw material handling, which contains many drawbacks.

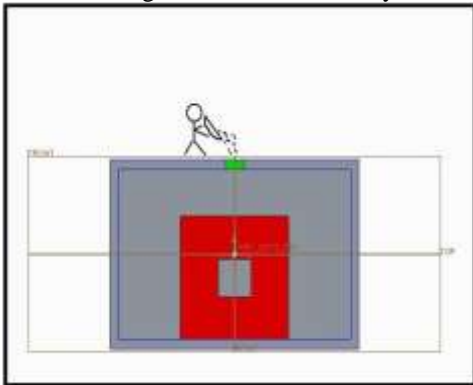


Fig. 2 Manual raw material feeding

Drawbacks Of Manual Raw Material Feeding In The Mould:

- a) Man power required for feeding
- b) Lack of safety of workers.
- c) More time consumption
- d) Inaccurate raw material feeding
- e) Wastage of material
- f) In case of an accident with the workers, Production may be shutdown

##### B. AUTOMATION SYSTEM

In automation system, the PLC based programming has been incorporated which is connected with all components of plant.

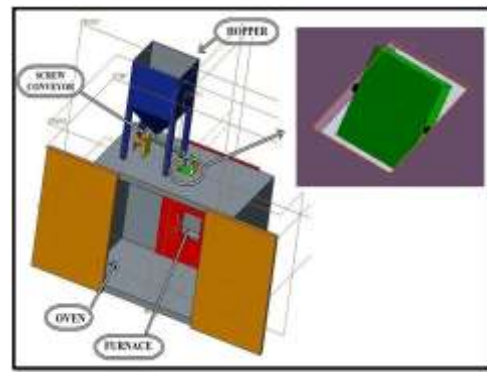


Fig. 3 Automation system

In the above system, we have used a screw conveyor for uniform flow rate of raw material and hopper for storage.

The components of above system are connected with PLC programming.

The sensor of temperature and proximity sensor has been used for better accuracy.

#### V. EXPERIMENT DATA OF EXISTING PLANT:

Currently, there is manual working of process of material feeding by 1-2 man power. The figure shows existing design without automation of plant.



Fig. 4 existing process

- The mould was preheated before feeding the raw material using the burners. Fans are provided for forced circulation at bottom of furnace in side wall and better heat transfer takes place. It was obtained up to 65-70 °C.



Fig.5 Pre-heating process



Fig.6 Forced Cooling of hot moulds by fans

**A. PLC BASED PROGRAMMING:**

A PLC is a microprocessor-based controller with multiple inputs and outputs. It uses a programmable memory to store instructions and carry out functions to control machines and processes. PLC is used in almost everywhere in our daily life and many industrial areas just like automotive, food, textile, machinery manufacturing, agriculture and etc.

PLC controlled systems are able to solve complex automation problems quickly and safely. In this way, control can progress more secure and can be done quickly. Also encountered failures can be identified in a very short time period and they can be removed easily. Programmable Logic Controller (PLC) can be used here for roto-moulding plant. It is more efficient and makes a system automated. [7]

The PLC performs the logic functions of relays, timers, counters and sequencers. It has the following advantages:

- Low cost
- Reliability
- Reprogram ability

PLC consist of [5]

- Input Module
- CPU with Processor and Program memory
- Output module
- Bus System

According to the program, PLC generates different signals and processes are controlled.

The flow diagram shows how material is to be transferred/handled. Initially, hopper is filled with LLDPE, raw material.

Load cell is a device that measures the load of raw material for required amount which is predefined according to size of tanks.

The screw conveyor conveys raw material from hopper to gate opening on furnace.

Door is made of M.S./S.S, with 5 mm thickness, when material flows on the door, it deflects/ open due to weight of material

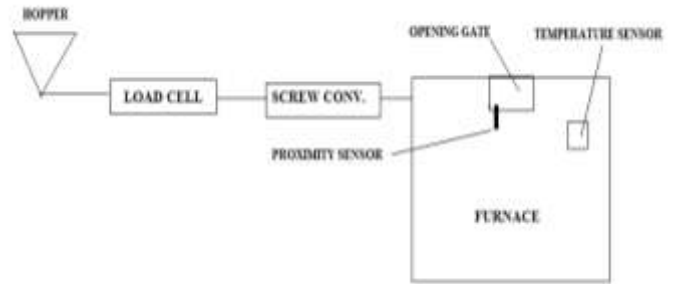


Fig. 7 Flow diagram of process

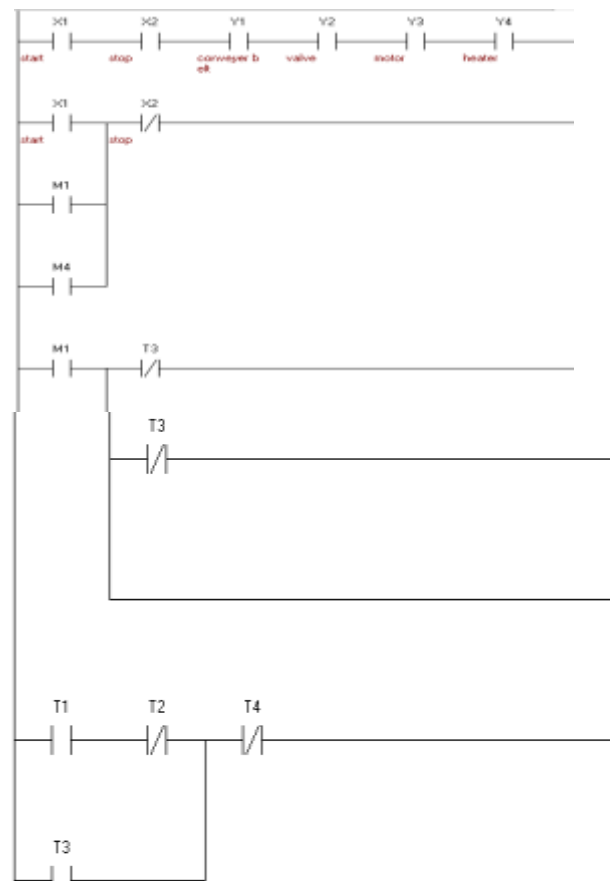
**All the data below observed and taken for 500 ltr tank:**

1<sup>st</sup> layer:

- Heating temperature obtained = 245 °C  
Time taken for heating = 4.5 min
- Forced cooling temperature obtained = 4 °C  
Time taken for cooling = 21 min

**Again, the process is repeated for 2<sup>nd</sup> layer:**

- Heating temperature obtained = 262 °C  
Time taken for heating = 10.5 min



PLC based programming was done in DELTA WPL soft 2.35. The prepared programmed was checked in SCADA and simulation was done.

That makes sure that programmed sequences are followed in accordance with actual sequence.

## VI. RESULTS AND DISCUSSION

After 1st year cost of electricity and maintenance is to be considered.

- As the process is automatic so there is a considerably reduction in setup time of 6 mins for a single time operation of 60 mins.

For a whole day of 8 hr (working) time 50 mins can be saved.

- As production rate directly affect the productivity of an organization. There is an increase in productivity.
- Because of an automation process. There is a uniform flow of material and for a single operation 0.5kg- 0.6kg of raw material can be saved. At the end of the 3-3.5 kg can be saved. **It directly affects the cost of tanks.**
- In manual feeding process worker has to phase a high temperature as they pouring raw material from top of oven chamber so by making process automatic workplace safety is increase.
- As there is no human intervention in the automatic material handling process. There are a less chances of an accident
- Cooling temperature obtained = 30°C
- Time taken for cooling = 23 min
- Now, time required for whole process:
- Time for pre-heating process = 1 mins
- Time for raw material to be brought at furnace = 3 mins + 3mins
- Heating time = 4.5 + 10.5 = 15 mins
- Cooling time = 21 + 23 = 44 mins
- Total = 66 mins
- After the experiment on manual material feeding process above data were collected

## CONCLUSION

From the automation system, The Research work represents automation of Rota moulding plant for rotational moulding industries. During the first step, the crucial task was to find the feasible solution that can be implementable also not for a paper work project. From this research work it can be concluded that by making raw material feeding process automation, we will get the following advantages:

- Reduction in man power 1-2.
- Reduction in setup time. (10-12 mins)
- Reduction in wastage of raw material
- Considerably increase in workplace safety
- Less chances of an accident.
- Accurate flow of raw materials
- Production rate increase

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