PLC based Automation for Pre-Treatment of Casted Material

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Abstract

This paper presents an automation of Pre-Treatment of casted material using a Programmable Logic Controller. The main idea is to automate the procedure of lifting and immersing the metal jobs in different fluids for the pre-treatment process. The proposed system has more advantages over the manual in terms of manpower and efficiency. The system is mechanized with the Delta DVP14SS series programmable logic controller. Field sensors such as the limit switches are used for providing the input to the controller. The relays and contactors are used at the output to energize the two axis movement based overhead crane. A ladder diagram is designed to control the whole system by executing the logic. This experimentation has been completed through different trials and the cycle time is measured. The results show that the system reduces the human effort as compared with traditional manual system. The system can be further made more interactive by integrating it with human machine interface or HMI and counter for counting the total jobs processed by the system.

Keywords: PLC, HMI, Pre-Treatment, Sensor

I. INTRODUCTION

In Industrial environment there are many processes that need to be done for any system to work properly and produce the required results. In foundries after the casting of job and before painting there is a process called as Pre-Treatment. A high-quality conversion coating is necessary for the durability of painted metal goods. The process of applying an inorganic conversion coating on a metallic surface includes removing any surface contaminants, then chemically converting the clean surface area into a non-conductive, inorganic conversion coating. Conversion coatings increase the overall surface area and increase adhesion of the applied organic film. In addition, conversion coatings change the chemical nature of the complete surface, which increases corrosion resistance. For this process we need to immerse the job in different chemicals, and in water with different ph. values. Due to this, job's surface becomes clean and appropriate for painting process. In this project the process was done manually which had various limitations. Now this manual process is replaced using automation which has its own advantages. This paper is about automated work done by the system with the help of PLC (Programmable Logic Controller) for the Pre-Treatment process which increases the efficiency of work and also lessen the total required man power. As human beings are not that accurate as a machine the use of sensors and other devices are done to get proper output within the required time.

II. RELATED WORK

Automation is the use of various controls for operating machinery, factory processes, and boilers etc. applications with very less or minimal human intervention. Some processes have been completely automated. The term automation was not popularly used before 1947. In 1930s feedback controllers were rapidly adopted which led to increase in automation.

Automation has been fulfilled by various means including hydraulic, mechanical, electrical, pneumatic and electronic and computers, usually in combination. Sophisticated systems, like modern factories, ships and airplanes typically use these combined techniques. Industrial engineers have proposed fully automated factories since 20th century. But the real manufacturing began in the 1980s, when US car Industrialists came up with the thought up of "lights-out" manufacturing. The thought to beat their rivals gave an idea of automating the factories to a level that the entire production could be left to robots.

A. What is Industrial Automation in Manufacturing?

In manufacturing industrial automation is nothing but the utilization of "intelligent" machines so that the production can be completed with minimal human intervention. It includes the application of various control units to enable the equipment's to

carry out on their own, with minimal human intervention, with required speed, capacity and precision. The manufacturing automation leads to benefits like operation of processes with less energy, less material, and decreased labor. This enhances quality, accuracy, and precision of the product.

III. OVERVIEW OF THE PROPOSED MECHANISM

The process of Pretreatment using the automated technology uses the following flow shown in Fig 1.The flow diagram explains the complete flow of the system. The flow shows how the job has to take the following steps with the help of the automated system.

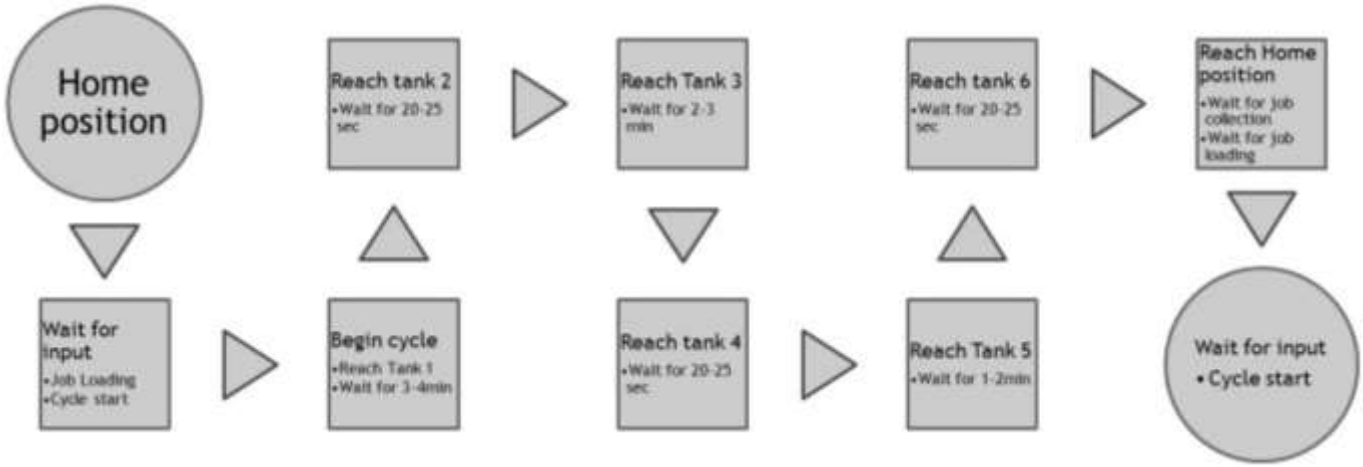

Fig. 1: Flow Chart of Process

For this system we will be using an overhead crane for the moving the material to the required stations and then return back to the home station. The Overhead/Bridge type crane used has a two axis movement, x-axis and z-axis. The design of block diagram for this system is shown below in Fig 2.

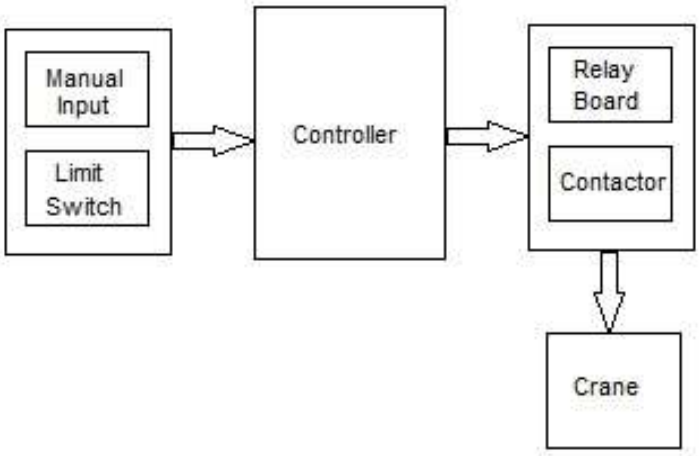

Fig. 2: Block Diagram

Fig 2 illustrates the block diagram of the system which consists of input section, control section, output section.

A. *Input Section:*

The input section contains two types of inputs i.e. the manual input which is made for manual control and the limit switches/Field input which provide the automatic input.

B. *Controller Section:*

The inputs are given to the control section for processing and accordingly the output of controller is given to the output section.

C. *Output Section:*

The output generated by the control block is very low as compared to the required output for driving the motors of crane. Due to this mismatch between power requirements, we use relay boards. As the motors are 3 phase we need to use contactors for switching the directions.

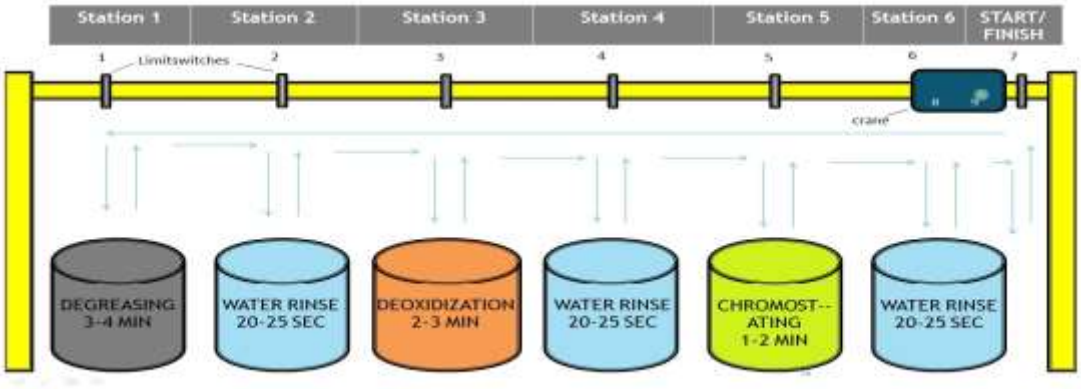

Fig. 3: Design Project Flow of System

There are total 9 limit switches used by the system.7 limit switches are placed on the frame exactly above the tanks for detecting the stations. Limit switches 8 & 9 are used for detecting the immersing height and the moving height. The type of connection used for the limit switches is the NO type. As soon as the operator presses the cycle start, the controller checks for the position of crane. If the crane is present at home position the limit switches 7 & 9 will be providing a high input to the programmable logic controller. When the required condition is satisfied the cycle is triggered.

The crane immediately leaves the home position and makes an upward movement to reach the moving height. The crane then moves to the extreme left and then stops at station 1 when it is in contact with the limit switch 1, and moves downwards to reach the immersing height. The immersing height is detected by the limit switch 9, and an internal timer is engaged for 3 minutes.
After the time is executed the cranes makes its path to the next tank by moving up and reaches limit switch 8 for moving height. The crane the moves right and stops at the 2nd tank with help of limit switch 2.Downward movement is carried out by the crane till the immersing height. A timer is run for 25 sec in the tank containing water.

The crane then continues the ladder logic and repeats the move up and moves right and then down followed by the internal timer for the specific tank.

After completing all 6 tanks the stops at the home position indicating the completion of cycle, and then the jobs are ready to be collected.
As the crane is back in the home position the cycle can be restarted by pressing the cycle start on panel.

IV. RESULTS

After developing the ladder logic tests were conducted to ensure the proper working of the system. After testing necessary changes were made for functioning properly. In addition, the cycle time is recorded. Five trials conducted to measure the amount of time for required by the crane to reach its checkpoints.

Table – 1

Station	*Time required*
Down to Up	*15s*
Up to Down	*15s*
Home To Staion1	*22.6s*
From Station To Station on right	*3s*
Hold Time	*25s*
Station 1 Timer	*210s*
Station 2 Timer	*25s*
Station 3 Timer	*150s*
Station 4 Timer	*25s*
Station 5 Timer	*90s*
Station 6 Timer	*25s*
Total Cycle Time	*1057s*

V. CONCLUSION

In this paper work, we have developed an automation oriented system which enhances the capability of the manual Pre-Treatment system. PLC's these days are advancing in terms of capability and applicability. The programmable logic controller used is selected from the Delta series the also the software used for programming is freeware, hence making the system affordable. The connections and installation of hardware is improved as the PLC input and output devices are

assigned specific addresses, further simplifying the troubleshooting. In this paper cost reduction is mainly achieved in terms of total workforce. Required workforce is reduced to half for the operation and maintenance of the automated system. Hence the system achieves better efficiency.

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