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Automation for Pre-treatment of Powder Coating Using PLC

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ABSTRACT:The method of powder coating involves covering a material's surface with a dry, flowing freely thermoplastic or thermo set powder., after that melted, and then it hardened into an even coating. This process of the powder coating is the finishing process to the material. Surface preparation for this process of powder coating is called as pre-treatment. Since metals will receive the majority of the powder coating application. In the pre-treatment of powder coating, themetal is dipped in the seven tanks. in surface preparation, there are Mechanical& chemical cleaning Techniques, like sandblasting and scratch brushing are examples of mechanical cleaning.Today the seven tank process of material is done manually, which the operating & workers cost is more. The cost of this process may be significantly decreased by automating the seven tank process. Pre-treatment process includes Degreasing, Water wash, Acid pickling, Water wash, Phosphating, water wash last is drying are all parts of the traditional seven-tank process.in this project designing the control panel to automate and control this pre-treatment process using PLC with the help of ladder diagram.

KEYWORDS*:* Seven tank process, powder coating**.**

I.INTRODUCTION

In the traditional powder coating pre-treatment method, the metal job is physically loaded and unloaded into seven tanks. As a result, as compared to the setup's initial expenditure, workers cost, time, effort, and ongoing costs are on the higher side.

The following advantages can be attained by using a fully automatic seven tank process system based on a PLC:

- Human mistake is less likely to occur.
- Productivity is higher.
- Product quality is better.
- Costs are lower.
- Time is saved.
- Performance is high.

Therefore, the major goal of choosing this topic for the project is to take a realtime issue from the existing situationand transform it into a fully smart & autonomous process to obtain the benefits listed above& our motivation for this project is in now a days in pre**-**treatment of powder coating lot of time consumes in manual operation**.** Automation reduce human error & ensuring the proper metal coating**.**

II.LITERATURE REVIEW

A powder coating is a type of long-lasting, solvent-free coating. Due to its outstanding application performance and environment friendly usage, it is frequently used in the metal sector. In recent years, the usage of powder coatings has spread quickly, and the standards for useful powder coatings have also been consistently enhanced. To increase adhesion and corrosion resistance, a component is first prepared with pre-treatment before being coated with powder. Prior to painting, theprocess of phosphating is frequently used. It involves converting the surface of virgin steel into metallic phosphate. Comparing post treatment to conversion coatings without final rinses results in an increase in corrosion and humidity resistance of around two to ten times. Posttreatments are often based on chromic acid.A few fundamental principles may be used to describe the benefits of a control panel that is based on a PLC controller: The quantity of wires required for connections is decreased as compared to typical process control systems. Because a PLC uses less energy than

a lot of relays, consumption is significantly decreased. A PLC controller's diagnostic features enable quick and simple error identification. By changing a program through a console or using PC software, it is simple to modify the running sequence or apply a PLC controller to a different working process, without needing to make any changes to the wiring unless additional input or output devices are needed. It is less expensive than a typical system, particularly when several I/Odevices are required and operating tasks are intricate. A PLC has more reliability than a timer or an electromechanical relay.

Relevance to current Research

In the paper by authors Dr. Settar S. Keream, Khalid G. Mohammed, Mayyada Sahib Ibrahim [1], the electromagnetic field (EMF) is produced in a conductor when the magnetic flux connecting it changes, which is how a DC generator works. Both the field and armature windings are present in a DC generator. The findings from this paper isA DC motor, also known as a direct current motor, is a type of electrical device that uses direct current to generate a magnetic field to convert electrical energy into mechanical energy.

Relevance to current Research

In the paper by authors V.Mahesh Kumar, A.Sivasankar, G.Prabakaran, R.Dhanabal, A.Muthu Krishnan [2], through a control panel, PLC activities are possible. The system where control or monitoring instruments are displayed is called a control panel. The 5T hydraulic flywheel assembly press control panel is intended for use with the machine the flywheel that four-stroke engines employ.The control panel is made up of the PLC kit, SMPS, transformers, Bus bars, protection and safety circuits, I/O terminals, alarms, timers, light, relays, indicators, and contactors. The machine's valves, pumps, motor, and other components are properly linked to the output terminals. The system hardware is made simpler by the panel wiring. The findings from this is,how to do connections of equipment to automate system using PLC.

Relevance to current Research

In the paper by authors Rishabh Das, Sayantan Dutta, Anusree Sarkar, Kaushik Samanta. [3], whether to switch the motor ON or OFF is decided by the PLC through the HMI, the user may observe and remotely control the system status, which is conveyed to the computer through MPI. To identify if there was water in the tank, inductive proximity sensors were employed. Due to eddy currents produced on a conductive surface by an external magnetic field, these sensors pick up magnetic loss. Changes in impedance caused by eddy currents produced on an item are detected by an AC magnetic field created on the detector coil. The findings from this paper is how to use inductive sensors to detect the object moment and their connections.

Relevance to current Research

In this paper by authors Than Than Min, Saw Kay Thwe Moe, Hnin Thae Mon [4], thewater is delivered to the tanks through pipelines by the pump in the circuit. Both tanks' levels must be kept under control. When the water level in the tanks drops below a certain level, solenoid valves open to start the pump automatically and close when the level rises. When the borehole's level sensor notices that the water level is low or empty, the pump will not operate. The findings from this paper is using PLC (SIEMENS) how they designed the automated system for the water tank filling process.

Relevance to current Research

In the paper by authors Shaikh Sohail Mohiyodin, Yashwant Sonale,Wathore Kiran, Manish Maurya[5], we learned that Inductive proximity sensors are employed to determine the tank's water level. It serves as the control system's primary component. It functions according to pre-set ladder logic. Switch & Motor it is a switch that is electrically operated. Relays with electro magnets are preferable. Relay converts the PLC's DC output into the correct signal for the motor's input. The Human Machine Interface (HMI) is the interface thatallows users to communicate with a system. The GUI informs the user of the system's status. The findings from this paper is how to utilise the system with ladder logic to control operation using sensor.

No.	Paper Title	Author Name	Key Points	Remark
1	Analysis Study in Principles of Operation of DCMachine	Dr. Settar S. Keream, Khalid G. Mohammed, Mayyada Sahib Ibrahim, 2018	1) Working principle of dc motor. 2) Requirement to operate & connections.[1]	For operation Dc Motor require the rated dc supply to work.
2	Design and Implementation of PLC Based Control Panel for Hydraulic Assembly Press	V. Kumar, A. Sivasankar, G.Prabakaran,R..Dhanabal, A.Muthu Krishnan,2017	1) Control of operation of hydraulic press with PLC. 2) connections of the all sub parts SMPS, PLC, Relay, Motors, buttons MCB.[2]	Connections of all sub-equipment are done in proper manner &useful for doing connection of the control panel.
3	Automation of Tank Level Using Plc and Establishment of HMI by SCADA	Rishabh Das, Sayantan Dutta, Anusree Sarkar, Kaushik Samanta,2013	1) Use of PLC by uploading the ladder diagram (program)in it. 2) Connection of ladder with PLC.[3]	Connecting or uploading the ladder with PLC done with USB to Ethernet cable.
4	Automation of Series Tank Level Control Using PLC and HMI	Than Than Min, Saw Kay Thwe Moe, Hnin Thae Mon, 2019	1) Inductive proximity sensors use to detect object moment. 2) Its interface with PLC [4].	Using inductive proximity sensor level of tank detected, start & stop operation of pump is controlled automatically.
5	Automation of Fluid Tank Using PLC	Shaikh Sohail Mohiyodin, Yashwant Sonale,Wathore Kiran, Manish Maurya, 2017	1) Sensor behaviour when it sense the moment. 2) Operation of relay with PLC to open & close pipes[5].	Operation of open & Close pipe is done with inductive proximity sensor.

III. MATERIALS & METHODS

The loaded object will be dipped into each tank for a set amount of time using a gantry system (vertical and horizontal motorized slider).Every tank will take a varied amount of time for the serial dipping process. i.e., when the object has been loaded into Tank 1, the motor will go on to Tank 2, after which it will move on to Tank 3, and continue so on.

A motorized gripper will be installed on the gantry to hold the item properly.

- Tank 1- Degreasing.
- Tank 2- Water Wash.
- Tank 3- Acid Pickling(De-rusting).
- Tank 4- Water Wash.
- Tank 5- Phosphating.
- Tank 6- Water Wash.
- Tank 7- Passivation.

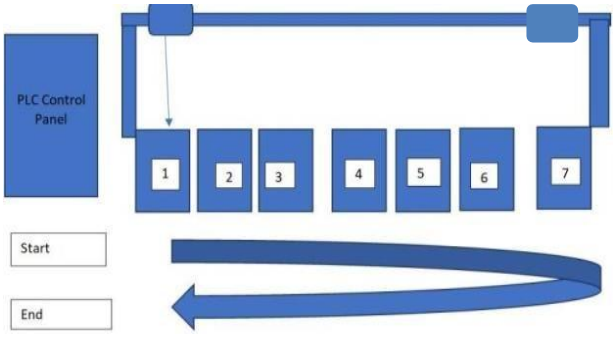

Figure 1.Block diagram of the set-up

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IV. COMPONENTS

A. PLC

Figure 2. GOC 35 (PLC with inbuilt HMI)

- I/OCapacity-16.
- DigitalI0.
- Serial,Ethernet andMODBUSConnectivity.
- It is manufactured by Japanese companyMitsubishi.

The entire procedure will be carried out automatically by the Programmable Logic Controller (PLC), which will be designed to do so. The procedure may be started and stopped with just two buttons: ON and OFF. In addition to this, other button Slider Return will detect the end position and send slider return to originalposition.

B. ON OFF PUSH BUTTONS

Figure 3.ON OFF Buttons

• Snap-in power switches.
• The SDDJE series is available in DPST (Double Throw Single Pole) and SPST (Single Pole Single Throw) configurations.
• SDDJE11200 is an IO-marked SPST ON-OFF rocker switch.
• Operating life of 10,000 cycles; operating temperature range of -10 to +55 degrees Celsius.

C. SENSOR

Figure 4. Sensor

Typeofsensor	**inductive**
Output configuration	**PNP/NO**
Sensor Range	**0-8mm**
Voltage Supply	**10-30VDC**
Housing Switch	**M18**
Rating of IP	**IP67**
Connector for connection	**M12 Connector.**
Max. operating current	**200mA**
Its operatingtemperature	**-25 to75°C**
Kindofforehead	**Embedded**
Bodymaterial	**brass**
Switchingfrequencymax	**1000Hz**
Overalllength	**69mm**
Type of bodyplating	**nickel**
No. ofpins	**4**

D. RELAY BOARD

Figure 5.Relay Board

- 5V4-ChannelRelayinterfaceboardcompactible with TTLlogic.
- It needs 15mA-20mAdriveCurrent.
- It is 250V/10A Ac,30V/10A Dc High-currentrelay.
- It consist of StatusLED.
- Relay is equippedwith the3.1mmscrewholesfor ease ofinstallation.
- Trinity/OmroncompaniesRelay.
- The weight of relay - 61 gram.
- Dimensions of relay- 75x 55x19.3 mm& for single relay (2.95x2.16x0.76).

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E. Motors

Figure 6. Dc Motor

- OperatingVoltage of Motor :12v.
- The RatedSpeedof Motor :200 RPM.
- The Rated**Torque**Dc Motor:1.5 kg-cm.
- The Stall**Torque of** Motor:5.4 kg-cm.
- The LoadCurrent of Motor:0.3 A.
- The NoLoadCurrent Motor:0.6A.

There are two dc motor isone for horizontal moment (Slider forward & Reverse)on gantry and other is for vertical moment (Slider up and Down).

F. SMPS

Figure 7. SMPS

Switched Mode Power Supply is used to give 24 v Dc supply for PLC. SMPS is supplies power which make the use of switching regulator for transferring power effectively.

- Takes Input of-230 V AC
- Gives Output of- 4 V DC , 3 A

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V. METHEDOLOGY

Initially the hardware model is prepared which is similar to actual setup of seven tank process. The two dc motors are used such that one motor can move the slider horizontally and other motor can move object vertically, this dc motors mounted on gantry system. The hardware model is fabricated by welding the iron rods,assembling the two motors ongantry system & arranging the seven tank according to pre-treatment of powder coating. Connections of the control panel is such that, the 230V, 50Hz AC supply is used andconnected to SMPS through MCB. The SMPS gives output of 24V, 3A DC. The output of SMPS is given to GOC-35(PLC with inbuilt HMI) to energize PLC & the power switches ON,OFF,Slider Return is connected to inputs (I_0, I_1, I_2) of PLC. The output of PLC (Q_0, Q_1, Q_2, Q_3)is connected to two Dc Motors through relay & 12V Battery is connected to relay for motors.The PLC is programmed in codesys2.3 software with the help of Ladder Diagram. The Ladder Diagram is a programming language used to write program in PLC. We had written the program in codesys2.3 and uploaded to the PLC through USB to Ethernet cable. Hardware model is tested and satisfying results were obtained by achieving less time for whole process completion.

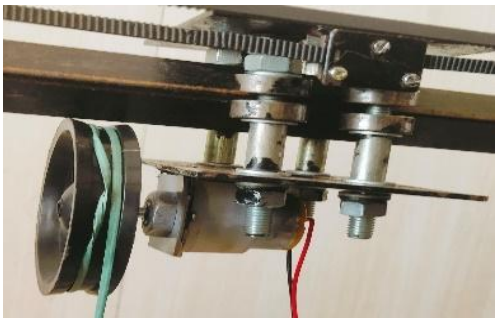

Figure 8. Vertical Dc Motor

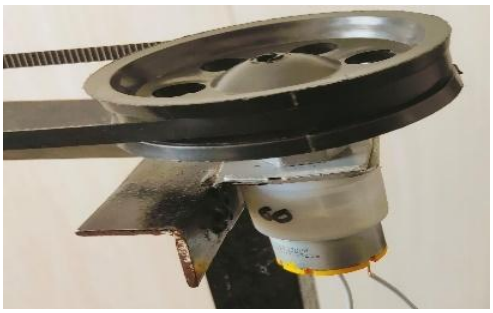

Figure 9. Horizontal Dc Motor

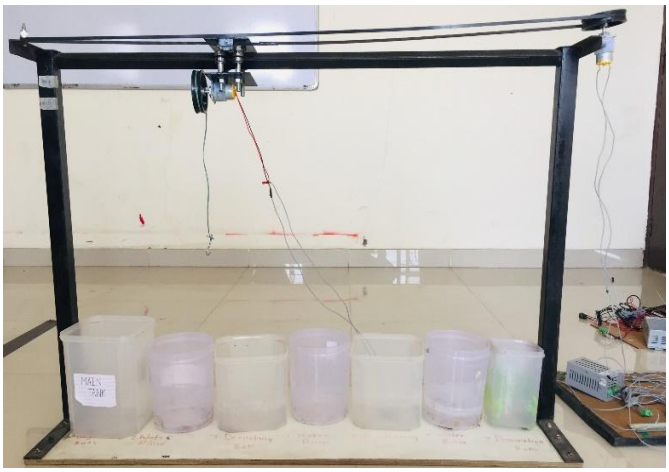

Figure 10. . Hardware Model of Seven Tank Process

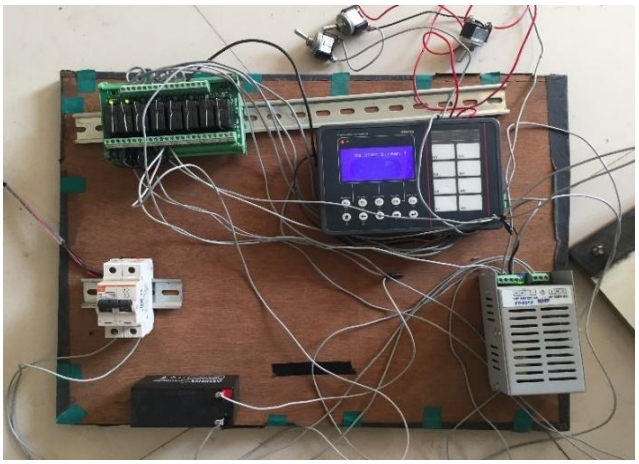

Figure 11. Connections

VI. PROGRAMMING LADDER

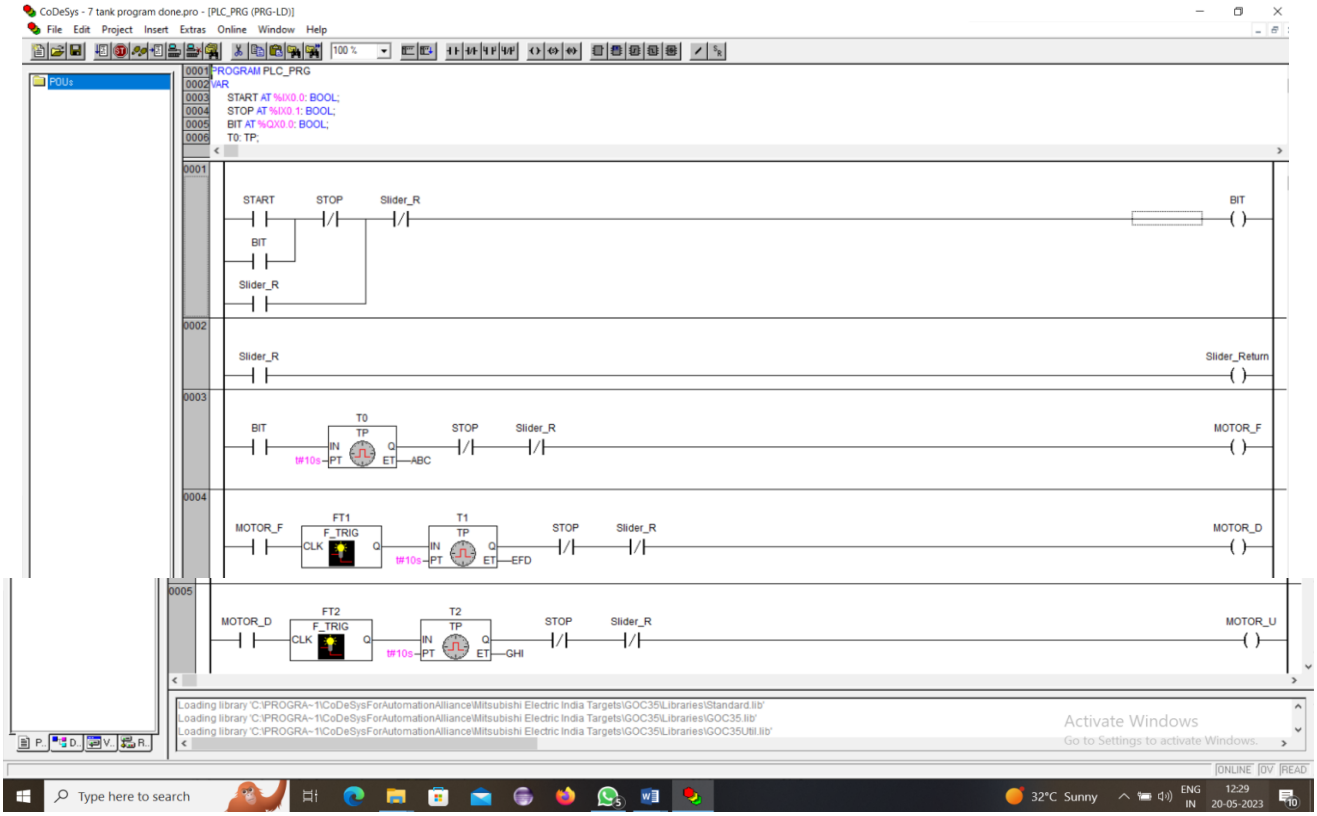

Figure 12. Ladder Diagram

VII. SIMULATION RESULTS

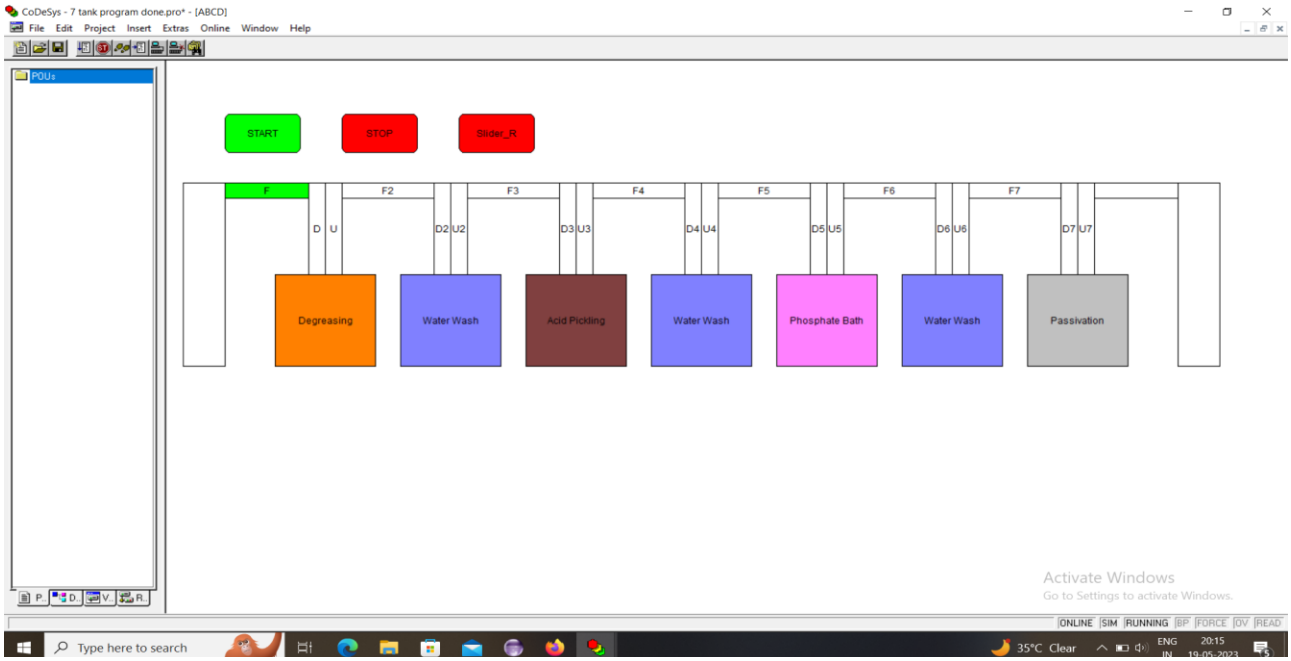

Figure 13. Simulation

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VIII.CONCLUSION

- Searched the solution for a real time problem to the industrial manufacturing Process.
- Checked the feasibility of the project along with the components lists and technical stuff.
- Implemented mechatronics Project including Hardware & Software Programming which is in demand in current industry.
- The Ladder Programming is Graphical Language and can be used for high level industrial project programming.
- So, the system is completely built by using mechatronics and industrial technology that can automatically load and unload the industrial fabricated products in seven tanks and pre-treatment process of powder coating is done.
- Time required for automated operation of seven tank process is reduce three to four times lesser &labour cost is reduced.
- Total pre-treatment process of powder coating is become economical using PLC, instead using of crane to load and unload object in seven tanks.

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