Application of a Programmable Logic Controller in a Paint Prepairing Industry

Sajan Saha, Pratyusha Biswas Deb, Oindrila Saha

Abstract— This paper is based on application of Programmable Logic Controller for filling paint containers in paint preparing industries. Here Allen-Bradley or Rockwell Programmable Logic Controller (Micrologix 1100A) is used to implement this operation. Programmable Logic Controller is a digital operated electronic system used for automation of typically industrial electromechanical processes. It reduces time and manpower in any industry. After successful implementation of the program by ladder logic, which is used as a programming language, the industrial purpose to fill colours in containers in a paint preparing industry can be achieved.

Index Terms— Automation, Ladder Logic, Paint Industry, PLC, RSLOGIX500.

1 Introduction

A PLC (Programmable Logic Controller) is a digital operated electronic system, designed for use in an industrial environment, which uses a programmable memory for the internal storage of user oriented instructions for implementing specific functions such as logic. PLCs are designed for multiple analog and digital inputs and outputs arrangements, extended temperature ranges, immunity to electrical noise and resistance to vibration and impact. A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result. PLC uses a programmable memory to store instructions and carry out functions to control machines and processes. Programs to control machine operation are typically stored in battery backed up or nonvolatile memory. PLC performs the logic functions of relays, timers, counters and sequencers. It uses a programmable memory to store instructions and specific functions that include On/Off control, timing, counting, sequencing, arithmetic and data handling. The application diagram of PLC is shown in Figure 1.

This paper focuses on Allen-Bradley or Rockwell PLC (Micrologix 1100 A series) using which automated filling of paint containers in a paint industry can be achieved. The programming language used here is Ladder Logic due to its user friendliness. The software used is RSLOGIX 500. PLC in this paper is used to control the filling of paint containers with paint.

- *Sajan Saha is a student, Department of electrical engineering in Narula Institute of Technology, India, PH-+918620011731. E-mail: sajansaha188@gmail.com*
- *Pratyusha Biswas Deb is currently working as Assistant Professor in electrical engineering department in Narula Institute of Technology, India PH-+919748941162. E-mail: pratyushabiswas85@gmail.com*
- *Oindrila Saha is a student, Department of electrical engineering in Narula Institute of Technology, India. PH-+919830379697. E-mail: oindrilasaha93@gmail.com*

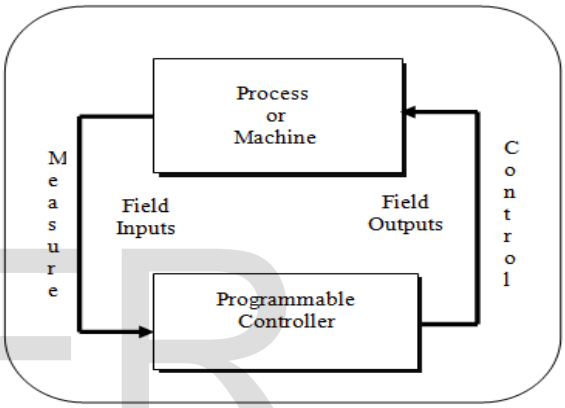

Figure 1: PLC Application Diagram

2 Objectives of This Work

The main objectives of this paper:

1) To use PLC to control the automated filling of paint containers in paint industry
2) To use PLC to control and show the effect of adding two different colours in some fixed ratio to obtain a required colour.

3 Advantages of Using PLCs in Automated Filling of Paint Containers in a Paint Prepairing Industry

1) PLC control system increases reliability i.e., once a program has been written and tested it can be downloaded to other PLCs. Since all the logic is contained in the PLC's memory, there is no chance of making a logic error.
2) PLC control system are easier for troubleshooting i.e., PLCs have resident diagnostic and override functions allowing users to easily trace and correct software and hardware problems.
3) PLCs operate in real-time which means that an event taking place has a faster response time.

4) PLCs are used to reduce human efforts.
5) PLCs are used to achieve consistency in manufacturing work, improve quality and accuracy of work in difficult and hazardous environment.

4 Operational Overview

4.1 Stages of Operation

The automatic paint filling operation consists of four important stages-

1) The first stage consists of switches and sensors which starts the system.
2) The second stage consists of PLC, which is the brain of the system, which gets information from the sensor to take the decision.
3) The third stage consists of orders receive by the actuator from the controller.
4) The final stage consists of paint filling operation and feedback response to the sensor.

The stages of operation are shown in Fig. 2.

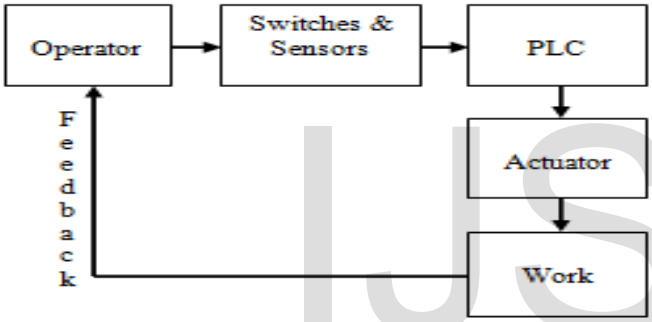

Fig. 2: Stages of Operation

4.2 Methodology

First of all we have to switch on the power circuit and PUSH ON the 'SYSTEM ON' push button. By pushing the 'SYSTEM ON' push button, conveyor belt starts to move.

Then to fill up the containers with the YELLOW colour, we have to turn the green switch or NOVE at yellow position or I/P-1 position on by this the sensor-1 is activated. Now containers start to move. When the containers are passing through the sensor-1, it senses the container and high the O/P-2 or stopper-1 bit and also high the Drain Valve-1 or O/P-1 bit. Then the containers are stopped by the stopper-1 and filled with the yellow color. Also when the stopper-1 is high the timer circuit i.e. on timer delay (T4:0) starts to work for next 250 sec and in this 250 sec the yellow colour drops out from the yellow colour vessel to the container. After 250 sec the timer is reset. And the drain valve-1 and stopper-1 is closed. Then the containers come out by the conveyor belt.

To fill up the containers with the BLUE colour, we have to turn the green switch or NOVE at BLUE position or I/P-2 position on by this the sensor-2 is activated. Now containers start to move. When the containers are passing through the sensor-2, it senses the container and high the O/P-4 or stopper-2 bit and also high the Drain Valve-2 or O/P-3 bit. Then the containers are stopped by the stopper-2 and filled with the BLUE colour. Also when the stopper-2 is high the timer circuit i.e. on timer delay (T4:1) starts to work for next 250 sec and in this 250 sec the blue colour drops out from the blue colour vessel to the container. After 250 sec the timer is reset. And the drain valve-2 and stopper-2 is closed. Then the containers come out by the conveyor belt.

To fill up the containers with YELLOW and BLUE colours, we have to turn the green switch or NOVE at GREEN position or I/P-3 position on by this the sensor-1 is activated. Now containers start to move. When the containers are passing through the sensor-1, it senses the container and high the O/P-2 or stopper-1 bit and also high the Drain Valve-1 or O/P-1 bit. Then the containers are stopped by the stopper-1 and filled with the yellow colour. Also when the stopper-1 is high the timer circuit works for next 125 sec and in this 125 sec the yellow colours drops out from the yellow colour vessel to the container. After 125 sec the timer is reset and the drain valve-1 and stopper-1 is closed. When sensor-2 senses, it turns ON. Now containers again start to move. When the containers are passing through the sensor-2, it senses the contaiers and high the O/P-4 or stopper-2 bit and also high the Drain Valve-2 or O/P-3 bit. Then the containers are stopped by the stopper-2 and filled with the BLUE colour. Also when the stopper-2 is high the timer circuit works for next 125 sec and in this 125 sec the blue colour drops out from the blue colour vessel to the container. After 125 sec the timer is reset and the drain valve-2 and stopper-2 is closed. Then the containers come out by the conveyor belt.

The animated operational diagram for automated filling of paint containers in paint industry is shown in Figure 3.

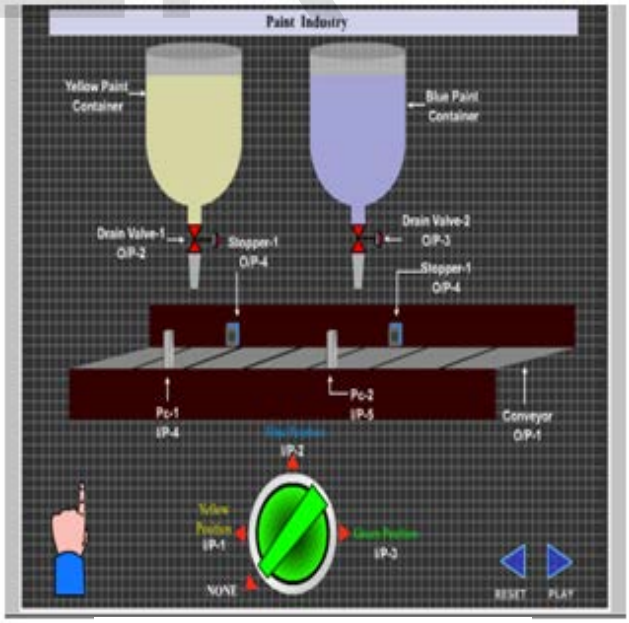

Figure 3: Animated operational diagram

4.3 Programming Instruction

1. Input configuration:

- System On – I:1/0
- System Off – I:1/1
- Belt On – O:2/1
- Input 1 – I:1/2
- Input 2 – I:1/4
- Input 3 – I:1/6
- Sensor 1 – I:1/3
- Sensor 2 – I:1/5

2. Output configuration:

- Belt on - O:2/1
- Holder 1 – O:2/2
- Holder 2 – O:2/4
- Stopcock 1 – O:2/3
- Stopcock 2 – O:2/5

4.4 About Programming

The programming is performed using Ladder Logic as the programming language in RSLOGIX500 software.

5 Observation and Result Analysis

PLCs are used in paint preparing industry for mixing of different paints and filling paint containers. Four input switches are used to indicate different operations-

For input 1– The conveyor belt starts to run.

For input 2– The containers are filled by paint stored in first vessel.

For input 3– The containers are filled by paint stored in second vessel.

For input 4– The containers are filled by paint stored in first vessel (half) and second vessel (half).

Depending on which input switch is pressed, first the conveyor belt starts to run and then the containers are filled respectively as explained below-

- If the selector presses input switch 2 then stopper 1 is activated by sensing a signal from sensor 1. As soon as sensor 1 sends signal, stopper 1 holds the container and the drain valve is activated as per the timer 1is set. When time is over then the drain valve and stopper switches off which allows the container to pass ahead. For this operation sensor 2 is on deactivated mode.
- If the selector presses input switch 3 then sensor 1 is on deactivated state and allows the passing of container through it. Now the container comes to sensor 2 which is now on activated state. Stopper 2 holds the container and drain valve 2 opens throughout the time as per timer 2 is set. When the time is over then the drain valve and stopper switches off which allows the container to pass ahead.
- When the condition of mixing two colours take place then selector needs to press input switch 4 . In this operation two timers are set with half the time duration each. When the container is sensed by sensor 1 it activates stopper 1 and drain valve 1 and container gets filled up with the time set by timer 3. Now when the time is over then stopper 1 allows the container to pass ahead. Then sensor 2 senses the container and activates the stopper valve 2 and drain valve 2 for the same time duration as timer 3. After the set time is over then stopper 2 allows the container to pass. This operation results in mixing of two paints and formation of a new colour.

So, by using the different input switches different paint containers can be filled and also different paints can be mixed in some ratio to obtained a new paint color.

Also, the outcome is verified by using NO/NC push buttons, LEDs, timers in a small circuit.

6 Conclusion

This work is based on PLCs which makes the work reliable, produces faster response, and can be applied in various places to reduces manpower and also allows working in difficult or hazardous conditions. Here in this paper, three different colours are obtained by using two colours but in practical number of different colours can be increased as per requirement of paint industries.

7 Future Scope

Following areas of further study are considered interesting:

1) To implement this programming using RSLOGIX 5000.
2) To implement this programming using counter logic.
3) To implement drives control through PLC.
4) To implement the work on a hardware model.

Acknowledgment

It is a pleasant task to express our gratitude to all those who have accompanied and help us in this work.

Our heart-felt thanks to our family members for their moral support and encouragement, without which the work would not have been possible. Last but not least, we extend our thanks and appreciation to everyone who have helped us directly or indirectly to complete this work.

References

[1] Prof. Burali Y. N. (Head of the Department Electrical Engineering, Nanasaheb Mahadic Polytechnic Institute, Peth Sangli, India) "*PLC Based Industrial Crane Automation & Monitoring* " RESEARCH INVENTY: International Journal of Engineering and Science ISSN: 2278-4721, Vol. 1, Issue 3 (Sept 2012), PP 01-04 *www.researchinventy.com* .

[2] Mohammed Bani Younis and Georg Frey.," *A Formal Method Based Re-Implementation Concept for PLC Programs and Its Application*". 1-4244-0681-1/06/2006 IEEE.

[3] Vijay Kumar Khatri, Ahsan Javed Ghangro, Jetandar Kumar and Syed Jaad UI Haque". *Industrial Data Acquisition and Control System using two PLCs' Networked over MPI Network*", 2009 IEEE symposium on Industrial Electronics and Application (ISIEA2009), October, 2009, Kuala Lumpur, Malaysia., 978-1-4244-4/09/@2009 IEEE.

[4] Jonas Lidén, "*Design and Implementation of an IEC 61850 gateway PLC Systems*", KTH Electrical Engineering, Master Thesis Stockholm, Sweden 2006.

[5] Coia Ferrater-Simon, Lluis Molas- Balada, Oriol Gomis-Bellmunt."*A Remote Laboratory Platform For Electrical Drive Control Using Programmable Logic Controllers*"., IEEE Transactionon Education, Vol, 52, No.3, August 2009.

[6] LiLing Wang1, HongYingwei2., "*Development of a Distributed Control System for PLC-Based Applications*", Proceedings of the Ninth International Conference on Machine Learning and Cybernetics, Qingdao, 11-14 July 2010, 978-1-4244- 6527-9/10/©2010 IEEE.

[7] YU Huiqun., "*The Design and Realization of PID Liquid Level Control System*",Based on S7-200 and EM235, 2010 International Conference on Intelligent Computation Technology and Automation 97807 69540771 / 10$26.00 © 2010 IEEE DOI10.1109 /ICICTA.2010.800.

[8] Jasmin Velagić, Kerim Obarčanin, Enisa Kapetanović, Senad Huseinbegović, Nedim Osmić "*Design of PLC- based PI Controller for the Permanent Magnet DC Motor under Real Constraints and Disturbances*".

[9] S. Da'na, A. Sagahyroon , A. Elrayes, A.R. Al-Ali, R. Al-Aydi, "*Development of a monitoring and control platform for PLC-based applications*", Computer Standards & Interfaces 30 (2008) 157–166.

[10] J.Velagić, A. Galijašević, "*Design of Fuzzy Logic Control of Permanent magnet DC motor under real constraints and disturbance*", IEEE Multi-conference on Systems and Control (MSC 2009), Saint Petesburg, Russia (in press), July 8-10, 2009.

[11] Liu Le, Wang Changsong, Wang Xingbing, "*The research of the free mode communication between Siemens S7-200 PLC and PC*," Mechanical Engineering & Automation, no.04, pp. 22 – 24.

[12] Mohamed Endi.,Y.Z.Elhalwagy.,Attalla hashad., "*Three-Layer PLC/SCADA System Architecture in Process Automation and Data Monitoring*" 978-1-4244-5586-7/10/C 2010 IEEE.