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SILO Process using PLC

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Abstract - The objective of this project is to design, develop, and monitor "Automatic Color Mixing and Filling Using PLC and SCADA". A modern programmable logic controller delivers a wide range of functionality which consist of a basic relay control, motion control and process control as well as being used in Distributed Control Systems. There are various types of interfaces that are used when people need to interact with the programmable logic controller to configure it or work with it. In this application system is going to mix the color in different proportion and fill into bottle using PLC (Programmable Logic Controller) and SCADA (Supervisory Control and Data Acquisition). Here Delta PLC is used, which acts as the heart of the system. The system sequence of operation are designed by using ladder diagram. Various electronics and electric devices that usually be controlled and operated by the PLC such as a submersible motor pump, conveyor belt, solenoid valve, relays etc. This system is use in color mixing plant, milk industries, chemicals, foods, mineral water and many more manufacturing, processing and packaging industries. A prototype has been developed to illustrate the application .Filling is the task that is carried out by a machine and this process is widely used in many industries. In this project the filling of the bottle is controlled by using controller known as PLC which is also the heart of the entire system. For the conveyor system dc motor has been selected for better performance and easy to operate. A sensor has been used to detect the position of the bottle. In our project we have used less number of system hence the overall cost has been reduced to an extent. Ladder logic is used for the programming of the PLC, which is the most widely used and accepted language for the programming of the PLC. The PLC used in this system is a delta plc which makes the system more flexible and easy to operate

***Key Words*: PLC, Ladder Logic, Delta plc**

1. INTRODUCTION

Automating repetitive tasks in the industries increases the productivity and reduces the probability of error and maintain product quality. Old methods of a mixing fixed quantities of the various types of liquids and filling them in bottles involves manual mixing of the constituent components based on measurements and bottling of the mixture as desired. Manual handling of such tasks is time consuming and expensive, often lack consistency in product quality due to human errors. A Laboratory Prototype of a Programmable Logic Controller (PLC) which is based on the automated liquid mixing and bottle filling system which is designed to automate the control and mixing of two different liquids in defined proportion and filling generated mixture in bottles which achieve quality control; reduce human intervention and improve productivity.

1.1 Automation

Automation is used to reduce the human work and helps in increasing the production. PLC plays an very important role in the world of automation industry. It acts as major function in the Automation field which tends to reduce the complexity, increases safety and cost efficient. It requires continuous monitoring and Inspection at frequent intervals. There are possibilities of errors in parameter measuring, human intervention at various stages and also the lack of advance features. Thus this paper takes a sincere attempt to explain the benefits to the companies by making process automated. In order to automate a plant and minimize human intervention there are a need to develop a system which monitors the plant and helps to reduce the error caused by humans.

1.2 PLC

PLC is the main part of the system which makes the whole process simple, flexible and accurate. A liquid or water mixing and filling bottle system with PLC allows the user to mix liquid in different proportion and fill the bottle till a desired level without wastage of the liquid. Ladder logic is used to perform the sequence of operation. The system is controlled by a Delta PLC which operates on 24V DC and is a compact PLC which has a fixed number of inputs and outputs i.e., 32 number of digital input/output ports and 6 number of analog input/output ports. In addition the use of SCADA has also been implemented for the monitoring of the entire system.

2. Working

There are three tank, first tank contains color 1 liquid, second tank contains color 2 liquid with the respective solenoid valve connected on it, and middle container is mixing and filling container. Mixing container connected with solenoid valve and a level sensor to sense the water level on it. When the level sensor moves from NO contact to NC contact the conveyor belt (i.e. DC Motor) starts rotating. Afterwards the bottle is placed on the conveyor then IR sensor 1 senses the bottle and conveyor belt stops below the

solenoid valve 3.Then there will be delay of 5 seconds, after this solenoid valve open and starts filling the bottle for 15 seconds, after 2 second of delay filled bottle will move forward on conveyor system till the proximity sensor 2 senses the bottle. After this the process continues till the stop switch is not pressed. We can programming the PLC by using ladder logic. Ladder diagrams are also called line diagrams or elementary diagrams .Ladder diagrams are used to represent the function of the control control circuit and associated devices but they don't show the elements of the control circuit and their actual physical positions .As control circuit becomes more complex a ladder diagram can be less complicated to read than a wiring or connection diagram.

Connection diagrams which shows the components of the control circuit which is in a resemblance of their actual physical location. Ladder logic which comes in contacts that make or break circuits to control coils. Each coil corresponds to the status of a single bit in the programmable controller memory. Unlike electro mechanical relays, a ladder program can refer any numbers of times to the status of a single bit, equivalent to a relay with an indefinitely large number of contacts. Each rung of ladder language which has one coil at the far right. Some of the manufacturers may allows more than one output coil on a rung

- Rung input : checkers (contacts)

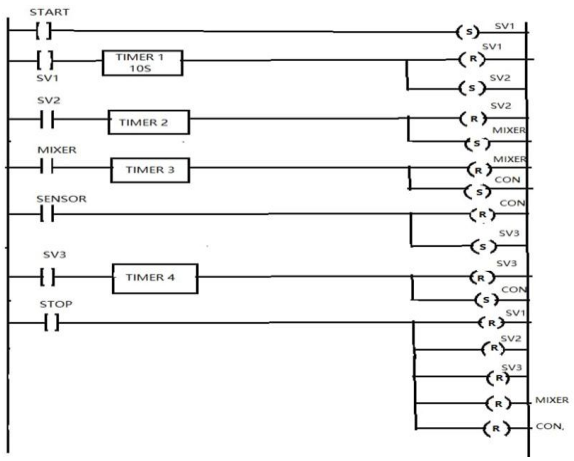
—[ ]— Normally open contact which closed whenever its corresponding coil or an input which controls it is energized: (Open contact at rest)

- —[\]— Normally closed ("not") contact and closed whenever its corresponding coil or an input which controls it is not energized. (Closed contact at rest)
- Rung output: actuators (coils)

—( )— Normally inactive coil, energized whenever its rung is closed. (Inactive at rest)

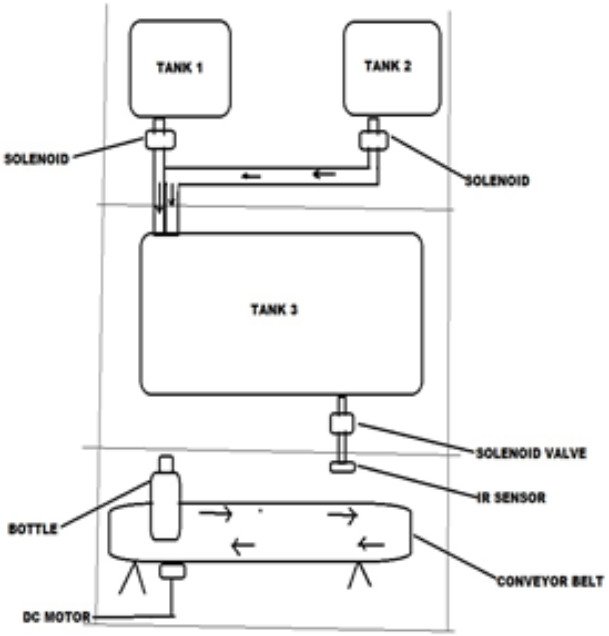
- —(\)— Normally active ("not") coil and energized whenever its rung is open. (Active at rest)

2.1 Ladder Diagram



The "coil" contact (output of a rung) may shows a physical output which is to be operates a various device connected to the programmable controller. A way to identify these is to imagine the checkers (contacts) as a push button input, and the actuators (coils) as a light bulb output. The presence of a slash within the sensors or actuators would indicate the default state of the device at rest. Ladder logic which is a originally a paper method design and construction of relay to used in manufacturing and process. Every device in the relay rack would be represented by a symbol on the ladder diagram which connects between those devices shown. In addition to this other components which external to the relay rack such as pumps, heaters, and so forth would also be shown in the ladder diagram.

2.2 Block Diagram



A. Solenoid Valves:

Qualified application voltages as following description: AC 110V AC 380V; AC 220V DC 24V ±10%; AC 36V DC 12V Induction coil insulation has qualities of high moisture proof, heat-resistance and succeeded water immersed handling function. Capacity of induction coil sequent electric current and maximum temperature up to 90oC.In this project, it is normally used to automatically control the flow of the water that shall fill the water bottle. When the water bottle placed over the conveyor belt, which is initially at motion, is sensed by the Photoelectric sensor, the conveyor stops running and at the same time the solenoid valve gets energized and water starts flowing through the valve for a certain time period (depending on the time we set on the timer in the PLC programming).As the time period is over then the solenoid valve gets de energized and water stops flowing through the valve. The conveyor belt starts moving again and the valve

remains de energized until and unless the bottle is sensed by the sensor again.

B. DC Motor:

The DC motor used is a DC geared type motor whose shaft is interconnected with the shaft of the roller. This motor has an input voltage of 12v with an input current of 600mA to 14A. It's no load speed is 50 RPM. The reason for selecting this motor is to achieve high torque at a constant speed. It has a torque of 70kgcm which provides sufficient amount of torque for our load. The motor comes with a metal gearbox and centred shaft. Shaft is loaded with bearing for wear resistance. The reason for choosing such a high torque is having such heavy rollers used on the either side of the hardware which is mounted with a conveyor belt.

C. Conveyer Belt:

Conveyor belt: A belt of length 2*(3ft.2inches) and width is 3.9 inches. The material used is PVC. Reason for choosing this belt is has low friction and oil resistant. Total net weight of the rollers are 5 Kg. The diameter of the shaft of the roller is taken 1 inch whereas the diameter of the rollers are 3.5 inches. The length of the shaft whose one side is elongated for coupling with the motor is 3 inches. The length of the roller is taken 4 inches.

D. Sensor:

Operating voltage of this IR sensor is 6 – 36 VDC and its output current is 300 mA. It's response frequency is 0.5 kHz. It's output type is n – p – n 3 wire (Black, Blue and Brown). It is made of brass or plastic .In this project, It is used to sense the position of the bottles. A round shaped sensor is used which can detect opaque, transparent or any other kinds of objects. In this case it is detecting different plastic bottles. The sensor used here is a diffused reflective type sensor. The range of sensing the objects are 100 mm.

E. Water Tank:

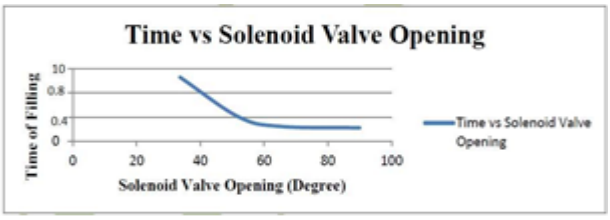
The function of the water tank is to store the water which is to be filled in the water bottle via solenoid valve whenever required. The water tank contains a float switch which is normally used to determine the level of water and whenever the water level in the tank falls it is restored by the water stored into the reservoir with the help of the pump through a narrow pipe which is connected with the tank.

4. Result

SOFTWARE TEST: According to the working process of the system PLC programming, Ladder logic (LAD) simulation software TIA V12 is used. PLC programming in the form of Ladder diagram.

PUMP CONTROL: Control of pumps which are start and stop to fill the liquid tank to run complete system

FILLING PROCESS: As the empty bottles sent in to filling area the position of the sensor and proximity sensor confirmed the perfect position of bottle for filling. Solenoid valve gets open for particular period of time to fill required amount of liquid in bottle. After filling the bottle sent for next operation.



From the fig. above indicates that the solenoid valve opening increases the time required to fill 200 ml liquid in bottle decreases. As the valve angle gets increases the flow rate also increases. So for filling different amount of liquid in to the bottle the filling time should be remains constant but the flow rate will be change

5. CONCLUSION

The main objective of this system was to develop a bottle filling system based on certain characteristics. The system presents an automatic filling system controlled by PLC as per the filling requirement which has easy base operation. The system has the advantages as simple structure and reliable operation. The system is controlled by PLC. This was successfully implemented. We consider this system as a journey where we acquired knowledge and also gained some highlights into the subject which we have shared in this report. By the installation of jet nozzle and strong solenoid valve can reduce the time to fill bottles and can efficiently increase productivity. A capping section could also be introduced. The nozzle positioning must be given more care and concentration. The system could be redesigned if there are increased in bottle size and productivity.

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