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PLC Based Liquid Filling and Mixing

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Abstract: **The objective of this paper is to design, develop the "PLC Based Liquid filling and Mixing". This work will provide low operational cost, low power consumption, accuracy and flexibility to the system and at the same time it will provide accurate volume of liquid in bottle by saving operational time. In this work, a prototype has been designed. The system sequence of operation is being designed by ladder diagram.**

Keywords: **PLC, Proximity Sensor, Solenoid Valves, DC Motors.**

I. INTRODUCTION

Different type of sector, where liquid are used as a product. That's offers opportunities that can be transformed into success only by those companies that have technology to take it beyond competition. High degree of flexibility is its prior need. Also industries face many other challenges. The pressure to continually increase production volumes has stressed older systems and has increased maintenance requirements. For manufacturers, this creates two problems: higher costs and increased downtime. Production managers are being challenged to reduce cost, wastage and downtime. New technologies are required that will reduce water usage, increase energy efficiency and minimize downtime in high-speed beverage production environments. Increasing competitive pressures, ever more stringent legal regulations, rising costs of commodities and energy and consumers whose preferences are subject to rapid change – beverage companies today are forced to increase their flexibility and operate with maximum efficiency at the same time. The key to this problem is an integrated process approach. After all, if all processes are perfectly coordinated with each other and reliable communications have been established between all parts of the manufacturing plant, it is much easier to address the big challenges In small industries, the refilling system usually operates in manual mode and even this is true for some other industries also. Literature suggests that microcontrollers are being used in these industries as it brings a cost effective solution for controlling the process. Although PLCs are costly, still those are also used in industries. The implementation of PLC for commercial bottle filling and mixing plants is not discussed widely in literature, therefore in this work an endeavour is made to bring out the important facts about its commercial use.

This paper is divided into 3 sections; the conveyor section (transfer section), filling section and mixing section. The whole sections are controlled by the Delta PLC. The mechanical part of the project consists of mechanical drawing, measuring, welding and fabricating process, while electrical part consists of electrical drawing; electrical wiring and programming. The software of the Delta PLC theory includes the electrical and mechanical actuators for the hardware will be showing a good result to fulfil the objective of this paper.

2. BLOCK DIAGRAM OF LIQUID FILLING AND MIXING

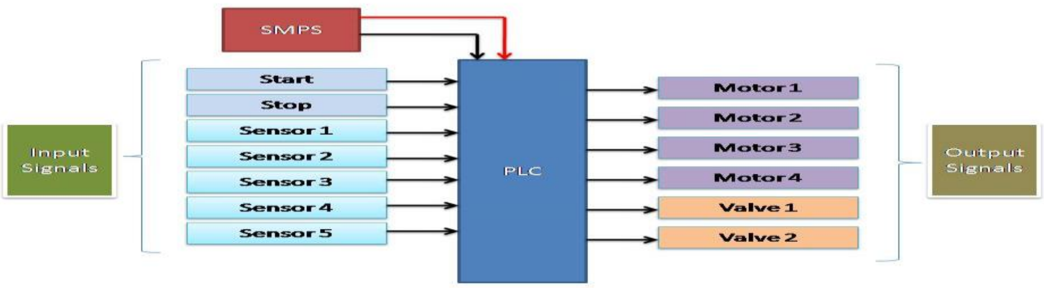


Figure 1

This paper is a complete application of automation. The various process of this system is controlled by PLC. PLC is heart of the system and the system is controlled according to the programmed PLC. Figure 1 shows the block diagram of the whole process. There are seven inputs to the PLC out of which five is the output of the proximity sensor. The proximity sensor senses the presence of the bottle at the conveyor belt. In this work metallic bottles are used which are detected by a proximity sensor. Infra red sensor is another choice that may be used in place of proximity sensor. When the bottle is sensed by the proximity sensor, a signal is sent to the PLC through signal conditioning circuits. The PLC then operates the dc motors to start the mixing process and deliver the mixture to the tank. In real time systems AC drives may be used for the purpose. Depending upon the need, proportion and amount of two different liquid to be filled and mixed in bottle, the closing and opening operation of valves connected to motors is controlled through PLC. PLC is a programmable device developed to replace mechanical relays, timers and counters. PLCs are used successfully to execute complicated control operations in a plant. The PLCs helped reduce the changeover time from a month to a matter of just few days. PLC consists of an input/output (I/O) unit, central processing unit (CPU) and memory. The I/O unit acts as the interface between PLC and real time systems. All logic and control operations, data transfer and manipulation work is done by CPU. PLCs provide the advantages of high reliability in operation, flexibility in control techniques, small space and computing requirements, expandability, high power handling, reduced human efforts and complete programming and reprogramming in a plant. The PLC is designed to operate in the industrial environment with wide ranges of ambient temperature, vibration, and humidity and is not usually affected by the electrical noise that is inherent in most industrial locations. It also provides the cost effective solution for controlling complex systems

2.1: The main components used are as followed:

i. Delta PLC
ii. Proximity Sensor
iii. Solenoid Valve
iv. DC Motor

Delta PLC:

Many PLC configurations are available but, in each of these there are common components and concepts. The most essential components are:

Power Supply - This can be built into the PLC or be an external unit. Common voltage levels required by the PLC (with and without the power supply) are 24Vdc.

CPU (Central Processing Unit) - This is a computer where ladder logic is stored and processed.

I/O (Input/output) - A number of input/output terminals must be provided so that the PLC can monitor the process and initiate actions.

Indicator lights - These indicate the status of the PLC including power on, program running, and a fault. These are essential when diagnosing problems.

The configuration of the PLC refers to the packaging of the components.

Rack - A rack is often large (up to 18” by 30” by 10”) and can hold multiple cards. When necessary, multiple racks can be connected together. These tend to be the highest cost, but also the most flexible and easy to maintain.

Mini - These are similar in function to PLC racks, but about half the size.

Shoebox - A compact, all-in-one unit (about the size of a shoebox) that has limited expansion capabilities. Lower cost and compactness make these ideal for small applications.

Micro - These units can be as small as a deck of cards. They tend to have fixed quantities

Objectives:

- Be able to understand and design basic input and output wiring.
- PLC hardware configurations
- Input and outputs types
- Electrical wiring for inputs and outputs
- Relays

I/O and limited abilities, but costs will be the lowest.

Software - software based PLC requires a computer with an interface card, but allows the PLC to be connected to sensors and other PLCs across a network.

Solenoid valve:

Flow control (solenoid) valves are connected to liquid tank. After inspection done by the inspection unit the container comes below the solenoid valve there one capacitive sensor placed below the valve and when it sense the container the conveyor stops, then the solenoid valve get ON and fills the liquid to the component based on the instruction given by inspection unit(i.e. which size container has to be filled). Liquid will be as soon as the conveyor stops. Solenoid control valves are electromagnetic plunger valves which control flow rates of liquids or gases. The input to solenoid valve is given by PLC. Three different timings are given to three different containers. The timing of solenoid valve and conveyor stopping is set by the timers used in program. We can change the timing based on the requirement. Conveyor stopping time also varies for three containers. The overhead liquid tank will supply liquid to the solenoid valve. After filling liquid to container the solenoid valve gets OFF and conveyor starts to run. And automatically cycle repeats.

1. Solenoid valve to control the flow of liquid
2. Liquid filled tank
3. Pipe connected to solenoid valve

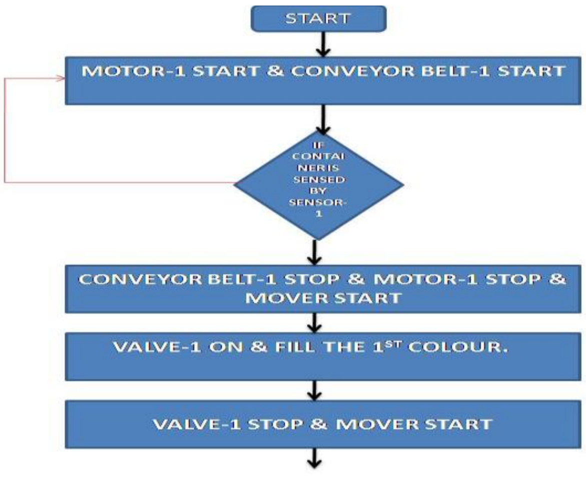
DC motor:

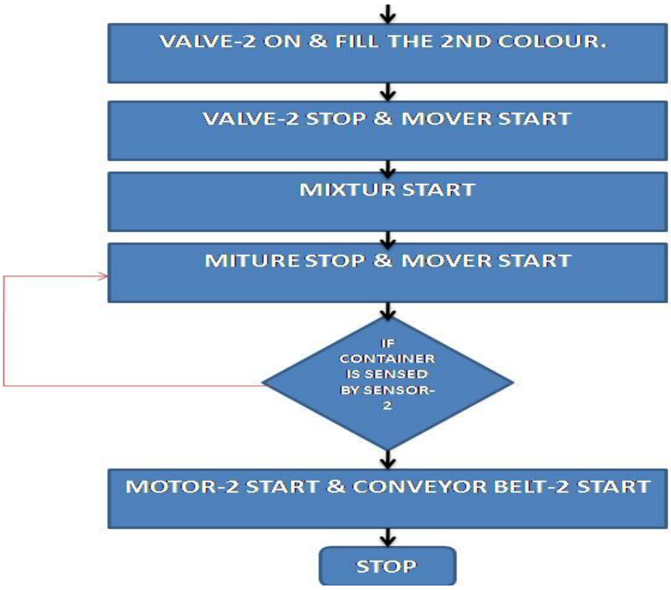
DC motor was used to move the conveyor which is transferring the product between stations. This motor will operate at the voltage of 12 VDC. The conveyor part, it will use dc motor to move the conveyor forward and It will stop according to the sensor or the limit switch position.

2.2: Proximity Sensor:

Capacitive Proximity Sensors is designed to detect and react to any object which moves into the operating zone. The sensors contain an oscillator. The capacitance of this oscillator is linked with the sensing face and when any object moves into the operating zone; its capacitance activates the oscillator. The sensors can detect conductive as well as non conductive material. It is advisable to have an object with permittivity more than one. The conductive objects are generally to be earthed for better results. Capacitive sensors use an alternating voltage which causes the charges to continually reverse their positions. The moving of the charges creates an alternating electric current which is detected by the sensor. The amount of current flow is determined by the capacitance, and the capacitance is determined by the area and proximity of the conductive objects. Larger and closer objects cause greater current than smaller and more distant objects. The capacitance is also affected by the type of nonconductive material in the gap between the objects. The amount of voltage change for a given amount of distance change is called the sensitivity. A common sensitivity setting is 1.0V/100µm. That means that for every 100µm change in distance, the output voltage changes exactly 1.0V. With this calibration, a +2V change in the output means that the target has moved 200µm closer to the probe.

2.3 Flow Chart:





The processes start first when a start button is press, first motor for a conveyor belt first is start and a container on a belt move towards the process. When containers come across the first sensor, sensor sensed a container and a conveyor belt stop and a mover start to move. Mover start move till second sensor sensed the a same container. Second sensor sensed the container mover stop to rotates and first solenoid valve is start for some time interval and its closed. After a completed this part again mover start to rotates and again third sensor sensed a container, mover stop and second solenoid valve start for some time and its also closed. After the two liquid filled in a container its move for a mixer. Blender comes down and mixed a two different liquid in container. After the all this process container move to the second conveyor belt. And a this process continually run till stop button is press.

3. ADVANTAGES

1) Accurate & Proportional mixing of liquid
2) Reduction in operating costs as compare to manual process
3) Increasing production
4) Fully automatic system so that quality production achieved in less time
5) Efficiency & Maintenance easy.
6) Same system used for different purposes

4. APPLICATIONS

1) Food processing technology
2) Beverage processing industry
3) Concrete industry
4) Paint industry

5. CONCLUSION

This paper has proposed an application of automation illustrating a PLC based fully automatic untouched liquid filling and mixing system. The system meets the demand of high-speed production using the least mechanism requirements.

The system has proved to work effectively avoiding unnecessary spill or wastage of liquids. The system also provides high accuracy and precision in proportion of liquid filling and mixing. Although proposed system illustrates the mixing process of two liquids, any number of liquids may be mixed in varying proportions. It is true that the use of PLC is a costly affair particularly for small industries but it offers many advantages that overcome its cost.

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