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AUTOMATED PROGRESSED SILO PROCESS INTEGRATED WITH PLC AND SCADA

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Abstract- A novel method of integrated SILO process using PLC and SCADA is being proposed in the paper. The proposed system integrates the two units that are production and packaging and hence the integrated system is located at the same location. This will reduce time as both the processes are in the same place. The process is cost-effective as well as the place used for storage is eliminated. The proposed system uses PLC (Programmable Logic Controller) to control the entire prototype with minimum human intervention. As there is minimum human intervention, the risk of accidents taking place in the industries is also minimized. Since the system uses PLC, it is ready to work under any circumstances. The proposed system is highly reliable and user-friendly. Software SCADA (Supervisory Control and Data Acquisition System) is used to monitor the process remotely. Ladder programming is used to program the PLC. Ladder programming is a type of graphical programming with no need to write the code line by line. Hence it is a comfortable means of programming the PLC. This system is a step further towards the development of small-scale industries. The prototype was tested successfully and when implemented by the industries will bring higher productivity as well as meet all the market demands with a maximum speed of operation.

Keywords-*SILO, Intregrated, Automated, SCADA, PLC.*

I INTRODUCTION

India is a developing country. The number of small scale and medium scale industries is more than large scale industries in the country. Most of these industries still use traditional methods of production and packaging. This makes it difficult to meet the high demand for the good quality products. Since manpower is involved there is a compromise with efficiency and maintenance. Moreover, the production, as well as packaging, take place according to the ability and willingness of these manual laborers. The accidents taking place in the industry is another factor to be taken into consideration. Human life is constantly at a risk. Hence automation is becoming a buzz word in the upcoming industries. Automation takes a step further mechanization that uses a particular machinery mechanism aided human operators for performing a task. Mechanization is the manual operation of a task using powered machinery that depends on human decision making. On the other hand, automation replaces human involvement with the use of logical programming commands and powerful machinery. Hence the bottom line is Industrial Automation facilitates to increase the product quality, reliability and production rate while reducing production and design cost by adopting new, innovative and integrated technologies and services the paper is divided into two sections namely Production and Packaging. The production section involves the production of fluid/syrup/soft drink/chemical in a fixed proportion. The packaging involves filling the product in the bottle with accurate volume and capping them. This automated system reduces labor and production cost and increases reliability. The fluid is filled in the bottle in hygienic conditions with accurate volume, this reduces wastage of fluid. The small-scale industries can easily cop up with the market requirements. Hence the proposed system is time-saving and works in a synchronized and systematic manner. This synchronization is achieved by using PLC which is the brain of the control system and SCADA as visualization software.

II METHODOLOGY

The Functional Block Diagram of the proposed system is as displayed in Fig.1. The entire process is controlled by PLC (Programmable Logic Controller). PLC is the brain of industrial automation. The PLC used is MITSUBISHI GOC35. PLC requires 24VDC as operating voltage which is provided by the SMPS (Switched Mode Power Supply). The inputs to PLC come from the start and stop push-button and capacitive proximity sensors. The PLC drives three solenoid valves, blending motor, conveyor motor and the piston of a pneumatic cylinder as its output devices. The three valves are connected to three tanks (tank A, Tank B, and Tank C) respectively. The blending motor is used to mix the ingredients uniformly. The conveyor belt s driven by conveyor motor. The pneumatic cylinder and the compressor together are used for the capping mechanism of the bottles. SCADA (Supervisory Control and Data Acquisition System) a visualization software is used to monitor this entire prototype remotely. HMI (Human Machine Interface) along with control keys is used to manually control the PLC.

The component description is as follows:

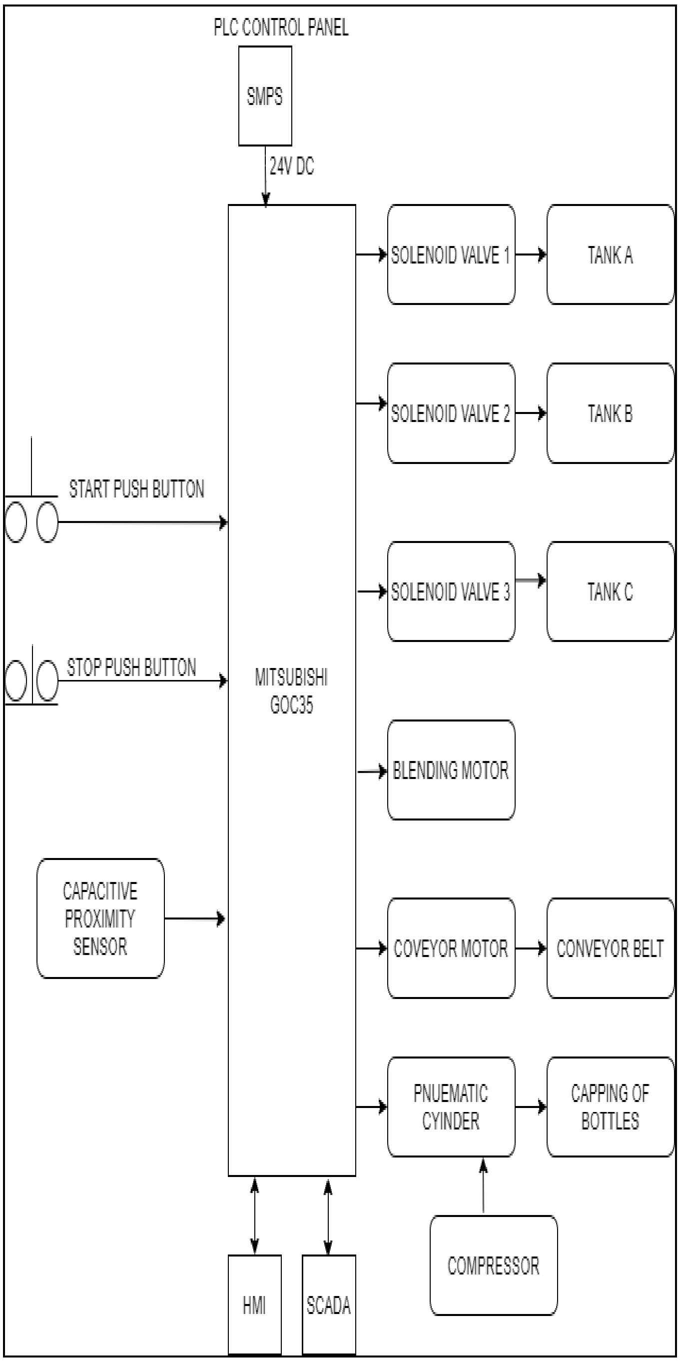

Figure 1 Functional Block Diagram.

A. CONTROLLER

GOC (Graphic Operation Controller) is used to control the process. The supply voltage is 24VDC with 48ports as input/output ports. MITSUBISHI is used as is it cost-effective for automation processes. Moreover, the PLC is easily available in India. The basic units of the PLC are the power supply and rack, the Central Processing unit and the I/O section.

Power supply and Rack: The rack is the component that holds everything together. The power supply plugs into the rack as well and supplies a regulated DC power to other modules that plug into the rack. Central Processing Unit: The CPU is the heart of the PLC. The CPU consists of a microprocessor, memory chip and other integrated circuits to control logic, monitoring, and communications. The CPU has different operating modes. In programming mode, it accepts the downloaded logic from a PC. The CPU is then placed in a run mode so that it can execute the program and operate the process. The I/O Section: The I/O system provides the physical connection between the equipment and the PLC.

B. SOLENOID VALVES

Solenoid valves act as switching elements in fluidics. They control the amount of fluid passing through the tank. There are two kinds of valves namely normally closed and normally open. The proposed system uses normally open solenoid valves which are electrically actuated.

C. PROXIMITY SENSOR

A proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. A capacitive proximity sensor is used in the proposed prototype so that it can detect any type of material (Metallic or non-Metallic).

D.CONVEYOR AND BLENDING MOTOR

DC motor is used as a conveyor motor to drive the conveyor belt at the required speed. DC Motor with high RPM is used as Blending Motor to mix the ingredients in a definite proportion.

E. PUSH BUTTON

A push-button is a basic switch system for controlling some part of a machine or a procedure. The surface is generally level or molded to suit the human finger or hand to be effectively discouraged or pushed. Buttons are regularly one-sided switches, albeit numerous un-one-sided Buttons (because of their physical nature) still require a spring to come back to their un-pushed state. Terms for the "pushing" of a button incorporate squeezing, discouraging, pounding, hitting, and punching.

F. CODESYS

Ladder programming can be done using instruction list (IL), ST (structured text), LD (ladder diagram), functional block diagram (FBD), SFC (sequential function chart) and continuous function chart (CFC). Ladder Diagram is used as it provides ease of programming. The software provides programmer controller applications as indicated by the global modern standard IEC 61131-3. The same software is used to design SCADA.

III SYSTEM DESIGN

Integrated SILO Process is a combination of Production and Packaging units. The Production unit consists of 3 tanks (tank A, tank B, and tank C). The tank A and Tank B have the two main ingredients filled in them. The tank C is the main tank where the two fluids blend with each other. The main fluid/Chemical is produced in tank C. Later this fluid is packaged in bottles of prescribed sizes. PLC is used to control the entire process. The START Push button on the Control panel of PLC is pressed to start the process. The solenoid valve 1 which acts as a switch for opening and closing of the tank A gets activated. A timer gets activated for a certain amount of time. Hence the ingredient for tank A falls in-tank C. As solenoid valve 1 gets deactivated, solenoid valve 2 gets activated. Solenoid valve 2 acts as a switch for opening and closing of Tank 2. Second Timer gets activated and after a delay, the Solenoid valve 2 gets deactivated. Similarly, the ingredient for tank B falls in-tank C. The blending Motor gets activated as the solenoid valve 2 gets deactivated. As a result, the two main ingredients get stored in tank C. The two ingredients get mixed until the main fluid is produced. The bottles are placed on the conveyor belt. DC Motor is used as Conveyor Motor. The conveyor belt is driven by a conveyor motor. A Proximity Sensor is a use to sense the presence of bottles on the belt. Once the bottle is sensed, the solenoid valve 3 gets energized and the fluid from C is filled in the bottle. The amount filled in the bottles is decided by the delay which is programmed in the controller. The filled bottles are then packed in the packaging unit. The pneumatic cylinder is attached to a compressor to provide capping of the bottles. After the STOP push button is pressed the entire prototype stops functioning. Hence using PLC, the Entire process is automated. Using SCADA (Software Visualization) the process is monitored remotely. With the help of SCADA, we can monitor the process, count the number of bottles filled and store this gathered data for further data analysis.

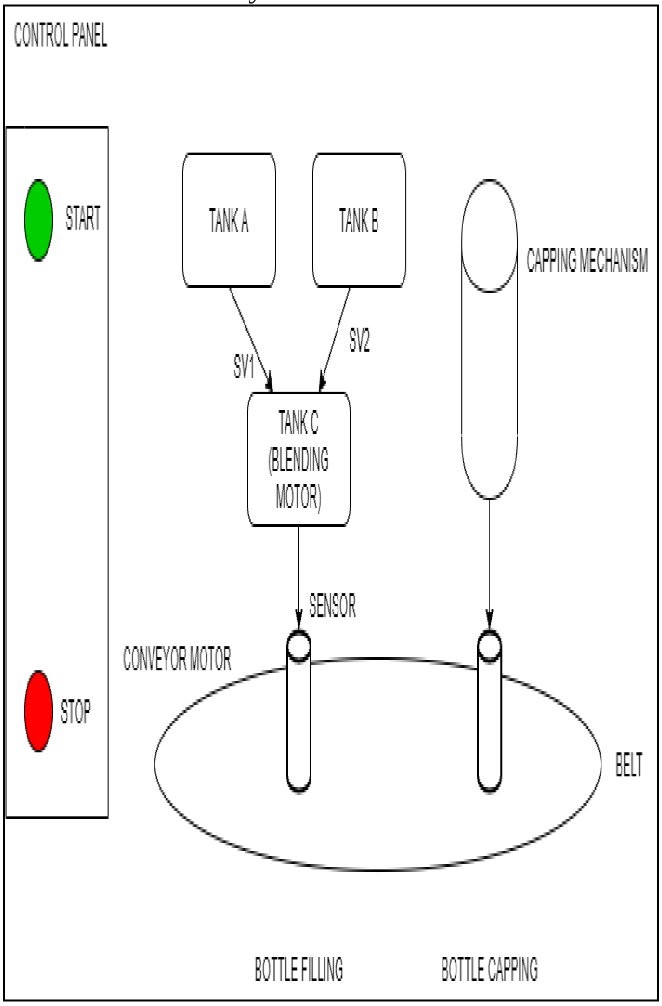

Figure 2. System Working

IV EXPERIMENTAL SETUP

Figures below show the experimental set up of the proposed system. The three tanks are clearly shown along with solenoid valves attached to it. The upper two tanks are secondary tanks (A and B). The lower tank is the main tank. The blending motor used for the stirring mechanism is also shown in Tank C. The capacitive proximity sensor attached to the mechanical stand arrangement is also seen. The conveyor belt on which the bottles are placed is also seen above. The figure beside portrays the PLC control panel with start and stop pushbuttons. The connectors are shown alongside which interface the I/O system to PLC. The pneumatic cylinder further connected to a compressor is used for capping of the bottles. HMI (Human Machine Interface) window is seen on the PLC Control panel to control various functions. SCADA is used to monitor the process remotely.

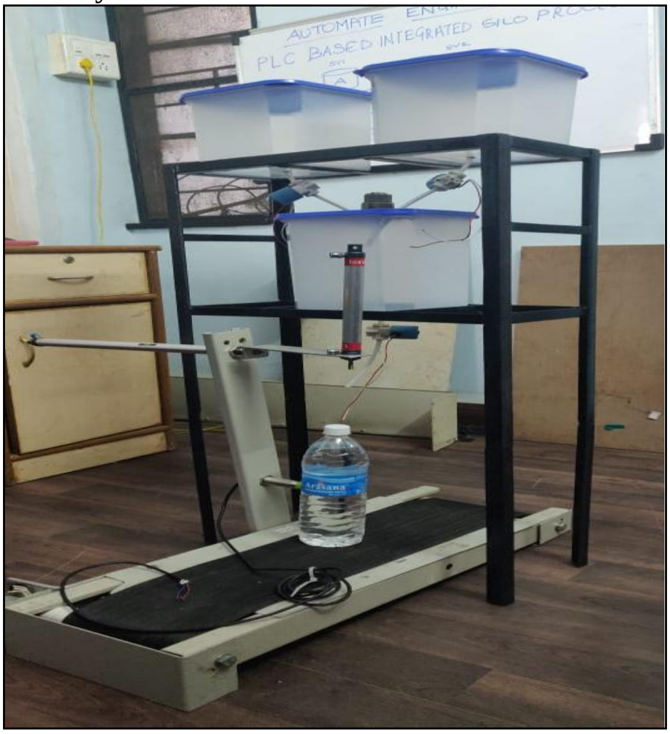

Figure 3. Complete Model

Figure 4. System Control Panel

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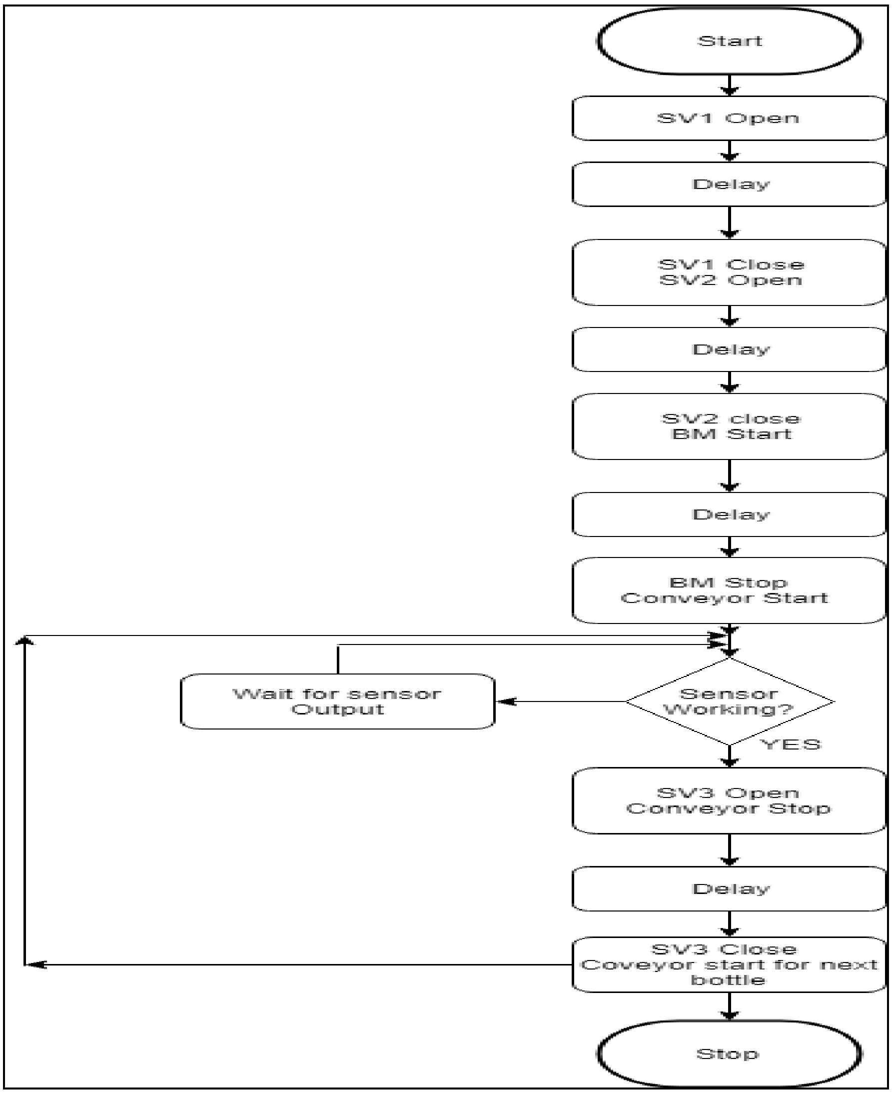

Figure 5. System Flow Diagram

V CONCLUSION

Although the proposed system illustrates the mixing of two liquids, a process that contains 'n' number of tanks with 'n' number of different fluids can be mixed in the main tank. The proposed system aims at reducing complexity with certain advantages over traditional methods of production and packaging. The same set up can be used for the production and packaging of different materials. With proper cleaning and sterilization, the tanks can be cleaned and used for the production of cold-drink/syrup/chemical. The proposed prototype will reduce storage, production and labor cost. This increases the reliability of the system. The fluid gets filled with inaccurate volume avoiding wastage of fluid. The storage place as well the time required to transfer fluid from production to packaging unit is eliminated. The proposed system is time-saving and works in a sequential, synchronized and systematic manner. The PLC can work in any temperature and pressure conditions; hence the production does not stop in any circumstances. The proposed prototype provides safety resulting in a reduced number of accidents. Hence Human safety is given priority. The system requires minimum human intervention. However, one person is required to monitor the SCADA. With the help of SCADA, we can count the number of filled bottles and send the data to further units for data analysis. Up-gradation in the proposed system can also detect the number of faulty bottles. Thus, with the technologies mentioned above the prototype will implement a completely new mechanism for production and packaging units at the same location. This will be a step further to develop small-scale industries.

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