Automatic Integrated Filling and Mixing of Different Heights of Bottles using PLC

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***Abstract*—Filling and mixing are major tasks which mainly happen in all types of Beverage industries, soft drink industries, water plant, chemical and pharmaceutical industries to fill and mix one or more products. If these processes are done automatically, then it will definitely increase the production rate and also mixing operation can't be done accurately by the humans. Even Small scale beverage manufactures can get additional benefits since it has high degree of flexibility and cost effective. This paper proposes an integrated bottle filling and mixing system of different height of bottles for two different types of products using Sensors and PLC (Programmable Logic Controller). This idea will become a great solution for small and medium scale industries because they can produce different types of products at different heights in a single conveyor line. Here sensors acts as the input device. PLC acts as the real time decision maker, so it makes the decision according to the control logic fed in to it based on the respective input signals. PLC actuates the field instruments to perform specified operation in accordance with the program.**

Keywords*—PLC (Programmable Logic Controller), Sensors, Integrated system, Beverage industries, Automation.

I. INTRODUCTION

Automation technology has a significant impact in much type of industries beyond manufacturing. Automation is the use of various control systems and technologies to reduce the requirement for human effort in the manufacture of products and services to increase productivity, accuracy and to lower costs, manufacturing time [1]. Particularly filing and mixing of bottle demands automation in almost of the industries. Because filling activity can't be done precisely in manual method. Industries like soft drink industry, chemical industry, Pharmaceutical industry, mineral water plant mainly involves this filling activity for filling of bottles either with liquid or semi-solid products [2]. Hence most of the industries are now concentrate in automation for demands in production, accuracy, flexibility in programming and to minimize downtime. If the bottles are filled manually and in unhygienic conditions, contaminate the products and also huge amount of labors are required to perform these operations [3]. By converting the conventional process into automation process, production rate increases and manufacturing lead time also get greatly reduced. This is achieved through low cost industrial automation. To achieve these conditions in small and medium scale industries, this paper proposes an integrated system.

Most of the small scale industries produce seasonal products with different heights of bottles according to the demand, for that if they use separate production lines then it will become costlier, waste of money, consumes vast area also. Production line for different heights of products is also adjusted manually. To bring it cost effective and automatic, we can go for integrated system with PLC, based on our I/O requirements [4]. In the integrated system, filling and mixing can be done for different types of products with different heights in a single conveyor.

II. PROBLEM IDENTIFICATION IN EXISTING SYSTEM

i) The problems that are existing in the traditional methods are the system can fill only fixed height of containers. They cannot be used to fill different heights of bottles. If filling is carried out for another size of bottle, then operator has to change the time for filling and program also must be changed or separate production line must be preferred for another height.

ii) Small scale industries produce different types of liquid products, in that some may be produced only in particular part of the year and are seasonal. If each one of the products is produced in different conveyor lines, it requires vast area and investment cost also becomes high for such type of system.

III. SYSTEM DESCRIPTION

This concept of integrated system can be implemented by placing sensors at two different heights to detect the size of bottles coming in the conveyors [5]. Hereby, different heights of bottles can be filled in the single production line. Different types of products also used in this line and these different products can also get mixed in the same production line. This system has two filling stations and three Modes. For filling of bottles Mode 1 and Mode 2 are used and Mode 3 is used for Mixing. During filling process, by interlock these two products; one product is used at a time. This type of filling system will be useful for industries producing seasonal products. Mixing of these two products also can be done using this system.

This type of mixing system will be useful for chemical and pharmaceutical industries [6]. In traditional system, separate conveyor lines are required for different types of liquid systems. This may consume large area, and hence for small and medium scale industries it becomes too costly. If an industry produces two different types of products and in that one type is produce only in a particular part of the year(i.e. seasonal products), separate lines for the two products becomes a huge waste. Model for the integrated system is created in SCADA software and is shown below.

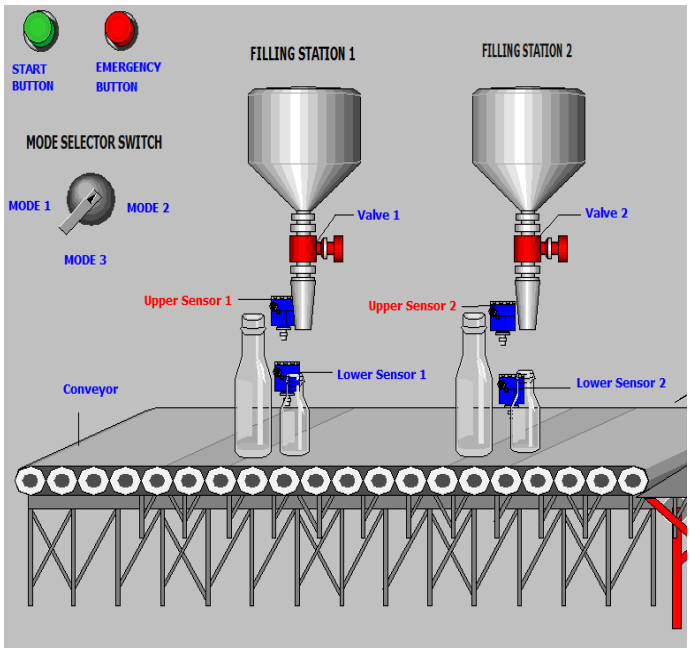

Fig 1. Model of Proposed system

The above picture clearly gives an idea and overview of the proposed integrated system. IR Proximity sensors are placed one above the other (at different heights) as in the design given above to detect various heights of bottles. Sensors and valves in the filling station 2 won't get energized when Mode 1 is selected for production and vice versa. So it provides flexibility and reduces area of working hence it can be useful for small and medium scale industries.

IV. WORKING

In this model, bottles move over a conveyor belt and IR Proximity sensors are placed at different heights to detect bottles of varying heights [7]. A program is created for various heights of bottles and varying time for opening of valve must be fixed for corresponding bottles heights. Filling and mixing process is based on timing and this is preprogrammed. Different types of products can be placed in the same conveyor line and mode selector switch is placed to select the mode (Filling or Mixing). When one mode is selected by the push button, sensors and valves in another product won't get energized i.e. they are interlocked with each other hence two products won't get activated simultaneously in the filling process.

A. Filling system

Bottles moving over the conveyor belt stops near the Filling station 1 by sensors [8] only when Mode 1 gets actuates then valve 1 will get open for respective time period after the completion of time valve get closed and conveyor starts moving so that bottles reaches the destination. The same procedure will happen for Mode 2.

B. Mixing system

If Mode 3 (Mixing process) gets actuates then, bottles in the line will stop in both filling stations for some period of time so that two products will get mixed. During mixing process only, Sensors near both filling stations gets energized.

V. SYSTEM INPUTS/ OUTPUTS

The input module comprises IR sensors, Mode selector switch, and Start/Stop pushbuttons. Two IR sensors are used to detect the position of bottles. These sensors kept near the input side, where the bottles are moving on the conveyor, are called detection sensors. There are two pushbuttons and one Mode selector switch is used. One push button is used to start the process and another push button is used to stop the process or act as emergency switch. Mode selector switch is used to select the mode i.e. Mode 1or Mode 2 for filling process and Mode 3 for Mixing process at the given time. DC Motor and solenoid valve are the two output devices used in this process. Motor is used to drive the conveyors, solenoid valve is used to open and close the valve of the tank containing liquids to be filled.

VI. PLC & SOFTWARE USED

PLC used for this system is Indralogic L20 of Rexroth Bosch. It is a compact 8 digital input/output PLC including a systematized Input/Output system and is designed for logical operations [9]. Operation is allowed only in defined order. Indralogic is the name of the software of Rexorth bosch PLC. There are different types of programming methods are available but here ladder logic is used. It is equivalent to drawing a switching circuit [10].

VII. WORKING MODEL (*Model of proposed system*)

Fig 2. Working Model of proposed system

VIII. SEQUENCE OF OPERATIONS

The sequence of operations or Logic given in the program for this process is as follows:

i) Press the START push button to start the entire system.

ii) Select any one mode by mode selector switch i.e. to decide which process (Filling or Mixing) is going to occur at the time.

Filling system

iii) For Mode 1 or Mode 2, if lower IR sensor only gets ON (i.e. small size bottle comes on the conveyor) then conveyor stops and valve 1 in the tank will open for preset time.

iv) If both lower and upper IR sensors gets ON (i.e. large size bottle comes on the conveyor) then conveyor stops and valve 2 will open for preset time.

v) After the respective time period valve will automatically get closed. This process will takes place continuously.

Mixing system

vi) For Mode 3, If IR sensor near the filling station 1 senses object then conveyor stops and valve 1 will open for some period of time after that conveyor starts moving and bottles are stopped near the filling station 2 by the IR sensors. The valve 2 will open for some time through these two products will get mixed.

Mode can be changed by the mode selector switch at any time. If one mode is selected then valve of another mode won't get energized for filling process and while mixing process both valves will get energized. If STOP or Emergency button is pressed then the system goes to the idle state and all outputs will go to the Reset condition.

A. Flow Chart

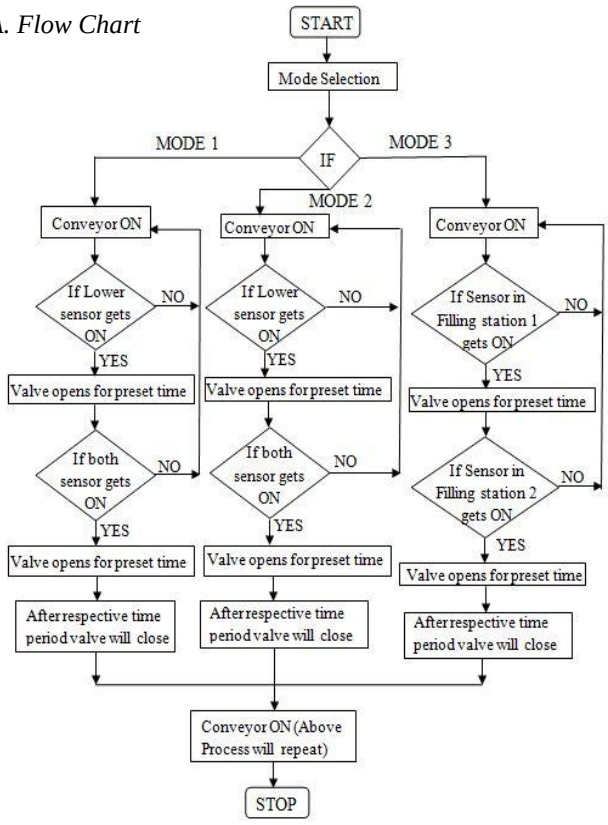

Fig 3. Process flow chart for proposed system

IX. ADVANTAGES

By this integrated system

- Working area will get greatly reduced.
- Different heights of products can be manufactured.
- Different types of products also can be produced.
- Mixing of two products can be done.
- By using PLC system, program can be changed.
- Separate production lines need not required by using this system.

X. RESULTS AND DISCUSSION

This method works very efficiently according to the logic in the PLC program and this concept was achieved by using IR sensors but Reflexive photoelectric sensors must be used while implementing in real time process for better accuracy. This system offers flexible method to manufacture different types of products in a single manufacturing line.

XI. CONCLUSION

This paper conveys a new method for a fully automatic integrated system using PLC to produce different type of products with different heights in a single manufacture line and this idea was illustrated by creating a working model and this will be very useful, economic and cost effective way for small scale beverage and soft drinks industries. Even though PLC is costly, this idea will definitely increase the production rate and provide flexibility for seasonal products. Since PLC can be easily reprogrammed it will give flexibility for users to suit any type of sequences in assembly line. This is just a prototype to check the working of this concept but when we go for real time implementation working voltage range of sensors should be selected according to the PLC configuration for better accuracy and results.

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