Automatic Filling Management System for Industries

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Abstract — In this era of industrialization, technological revolution/automation is fast shrinking the need of humans to assist machinery. Looking at the current industrial scenario, birth of new products and private brands is sharply raising the competition among industries. In order to hold out the promise of timely delivery of product, high tech automated production is essential. The concept of automation is so versatile that it can bring radical development in almost every field. Keeping view of present requirements, this paper proposes a filling management system for industries which is a complete application of automation. The notable thing about this project is its high degree of flexibility and its remote control. A prototype of commercial bottle filling system, controlled using programmable logic controller (PLC) is proposed and the whole process is monitored using supervisory control and data acquisition (SCADA). This system provides the provision of mixing any number of liquids in any proportion. It’s remote control and monitoring makes the system easily accessible and warns the operator in the event of any fault.

Index Terms— Automation, Bottling Plant, Programmable logic control, PLC, Supervisory Control and Data Acquisition, SCADA.

I. INTRODUCTION

Beverage market 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 [1].

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 [2]. Although PLCs are costly, still those are also used in industries. The implementation of PLC for commercial bottle filling plants is not discussed widely in literature, therefore in this work an endeavor is made to bring out the important facts about its commercial use. In addition the use of SCADA is also implemented in this project work which is a high-tech tool for providing monitoring through the remote location. The system developed in this work is a complete package of filling management system for industries. It provides flexibility with reliability. It also provides an extra advantage of production flexibility and ability to extend or modify an existing plant. It provides remote monitoring of the entire plant that makes it easily accessible.

The paper has been discussed mainly in four sections: first section gives the introduction followed by the system description where the general block diagram and process flow is discussed. The complete prototype description is discussed in section III and finally conclusions are given in section IV.

II. SYSTEM DESCRIPTION

This project is a complete application of automation. The various process of this system is controlled by PLC and is remotely controlled using SCADA. PLC and SCADA are heart of the system. The system is controlled according to the programmed PLC. To monitor the processing of the entire plant SCADA is used. Figure 1 shows the block diagram of the whole process.

There are two inputs to the PLC out of which one 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 two dc motors to start the mixing process and deliver the mixture to the third tank. In real time systems AC drives may be used for the purpose. Depending upon the need, proportion and amount of liquid to be filled in bottle, the closing and opening operation of valves connected to motors is controlled through PLC.
This section further broadly discusses the main parts of the system:

### A. Programmable Logic Controller, 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 a 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 [3].

### B. Supervisory Control And Data Acquisition, SCADA

PLC & SCADA combination gives the advantage of better monitoring and control of the plant. SCADA enables engineers, supervisors, managers and operators to view and interact with workings of entire operations through graphical representation of their production process. SCADA runs on a PC and is generally connected to various PLCs. SCADA constantly gathers data from plant in real time, stores and processes it in the database, evaluates and generates alarms, displays information to plant operators, supervisors and managers and can issue instructions to PLCs on the plant floor [4].

#### C. Filling System

The filling system consists of three tanks where liquids are kept and mixed according to proportion given in PLC program. For large industries any number of tanks can be used to mix any number of liquids. Hence the system using PLC provides large flexibility. AC drives for main motors with valves and conveyor belt arrangement is used in industries for filling operation. At the appropriate timings motor connected to valves is made ON and accordingly the valve opens. The filling system consists of subsystems that include Conveyor system and Sensors. A sensor is a device, which responds to an input quantity by generating a functionally related output usually in the form of an electrical or optical signal. Sensors are designed to have a small effect on what is measured; making the sensor smaller often improves this and introduces other advantages also. Here sensors are used to detect the bottles so that there is no wastage. Hence system has also given the advantage that even if the program is running and there is no bottle on the conveyor the motor 3 will not start and thus valve 3 will also not open, so no spill of liquid takes place. The valve 3 will open only when there is a bottle and filling will be done. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of material. The conveyor system is used to transport bottles from one end to other. At the initiating end the bottle is empty while at the destination end filled bottle reaches.

### III. Prototype Description And Control Implementation

In this project, a prototype illustrating the commercial bottling plant automated using PLC is developed and the whole process is monitored using SCADA. The sensing mechanism used in the system takes care of unnecessary spill or wastage. The system provides best accuracy and precision in the mixing any number of liquid in any proportion. The system is completely monitored using SCADA and plant may be stopped or controlled through SCADA in case of emergency.
In this system, liquids can not only be filled but this system can also mix liquids in desired proportion. In this system, there are two different liquids in two different tanks which are mixed in third tank (final tank). The mixing can be done in any proportion, say 2:3; 5:5; 4:6; etc. Motor 1 and Motor 2 shown in Figure 1 control the proportion which gets mixed up in the third tank. Finally, this liquid is filled in the cans or bottles and the biggest advantage of this system is with automation, it provides remote monitoring and controlling. That is, the entire working of the system or filling plant is displayed on the SCADA screen from where the whole plant can be monitored and controlled.

The plant can be started from the SCADA screen as well as it can be stopped from the same screen only, in case of any fault. Thus no waste or harm to the plant if any fault occurs. Figure 2 shows the process visible on SCADA.

PLC is the main part of the automation plant. The plant is automated by the programmed PLC. PLC used is MICROLOGIX 100 and supply to PLC is provided through SMPS. Ladder programming is the main programming method used for PLC. Ladder programming is done using software RS LOGIX ENGLISH. The program is then downloaded on PLC. As per the program written for this work, when the system is switched on, motor 1 starts and runs for stipulated time and valve 1 opens and liquid reaches in tank third. Then when motor 1 stops, motor 2 starts and in the same way liquid from tank 2 reaches third tank. The liquids get mixed up in the third tank. When the bottle is present in front of third tank motor 3 starts and valve 3 opens to fills the bottle. 24V solenoid valves are used for the purpose and proximity sensor in used for sensing the bottle. The bottles are placed on the conveyor belt which is moved using dc motor drive in this case. In industrial systems ac drives are used. When the bottle is sensed by the sensor, a signal is sent to the PLC which stops the drive motors and after the filling process is over, the PLC again starts the drive motors to move the conveyor. The conveyor moves till the presence of other bottle is sensed by the proximity sensor.

This complete working is monitored on SCADA screen interfaced with the PLC. RS 232 cable is used for the interference of PLC and SCADA and wonderware Intouch software is used for SCADA. SCADA screen shows all the working of the plant i.e. the whole movement of the conveyor/filling system is visible on the SCADA screen. Here SCADA provides the remote control operation of the system. It is not necessary that the SCADA screen be placed near to PLC. If there is any error in the working of the plant, like if any motor does not start at its set time or runs for more time, will be displayed on the screen and the plant can be immediately stopped from the SCADA screen itself. This feature also helps the system in avoiding any spill or wastage.

IV. Conclusion

This paper has proposed an application of automation illustrating a PLC based fully automatic untouched liquid filling 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 liquids mixed. 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. One of the additional features of the proposed system is the use of SCADA that makes it controlled through a remote location. Complete monitoring of the system is possible through SCADA and in fact the process may be stopped or started by SCADA screen. This feature is particularly very useful in case if some fault occurs in the system.

REFERENCES


