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Controlling Process of a Bottling Plant using PLC and SCADA

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Abstract

This paper presents basic stages of operation of a bottling plant, i.e. the filling and capping process. The main aim of our paper is to control the filling and capping section of a bottling plant simultaneously. At first a set of empty bottle is run by using a conveyer towards filling section, after the operation, the filled bottles are sent towards the capping section. After successful capping operation, the sealed bottles terminate towards exit and a new set of empty bottle arrive, in this way the process continues. This paper includes the method using which, a bunch of bottles can be filled and capped at one instant of time. This method has made the operation more flexible and time saving. The filling and capping operations are controlled using Programmable Logic Controllers (PLC), as the PLC's are very much user-efficient, cost-effective and easy to control. By using PLC automation the whole process is kept under control. SCADA (Supervisory Control and Data Acquisition) is used to monitor the process by means of a display system.

Keywords: *PLC, automation, SCADA, ladder Logic, HMI*

1. Introduction

Industrial Automation is the use of Control Systems to control Industrial Machinery and Processes, reducing the need for human intervention. If we compare a job being done by human and by Automation, the physical part of the job is replaced by use of a Machine, whereas the mental capabilities of the human are replaced with the Automation. The human sensory organs are replaced with electrical, mechanical or electronic Sensors to enable the Automation systems to perform the job.

Higher level of human intelligence like planning, analysis, prediction and intuitive decision making is not done by this Level of Automation.

Automation plays very important role in today's world economy. One of the most important applications of automation process is in beverages and soft drinks industries, where continuous filling and capping process is carried out. If human effort or mechanical effort is used in this field then it is very much tough to perform this long and continuous process and so it is being substituted by automation process which completes the task with very much ease.

As mentioned above, our paper is also an application where the automation process is used to control the filling and capping operation in a bottling plant to reduce the human effort using Programmable Logic Controllers and SCADA (Supervisory Control and Data Acquisition).

To develop the programming to control a bottling plant by using PLC Automation we must first develop the ladder logic, after that the programming part can be developed. After successful completion of the programming part, we have to animate the HUMAN- MACHINE INTERFACE or the HMI or SCADA.

2. Construction

The basic construction of the aforesaid processes of a bottling plant i.e. filling and capping is consisted of various steps. At first a conveyer belt is installed which will run the set of bottle through different stages. After that, in the filling section the necessary arrangements are done so that the filling process can take place by means of some filling pipes, containing the beverage or soft drink. In case of capping section also, some arrangements are done so that the capping process can be done without any error. To implement this steps, sensors are used so that in filling section, the pipes can sense the presence of the bottles and they can be filled. In

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capping section also, the sensors are used to cap the set of bottle with ease. The filling process is based on the preset value of a counter, depending upon which the pump is switched on for that particular period of time.

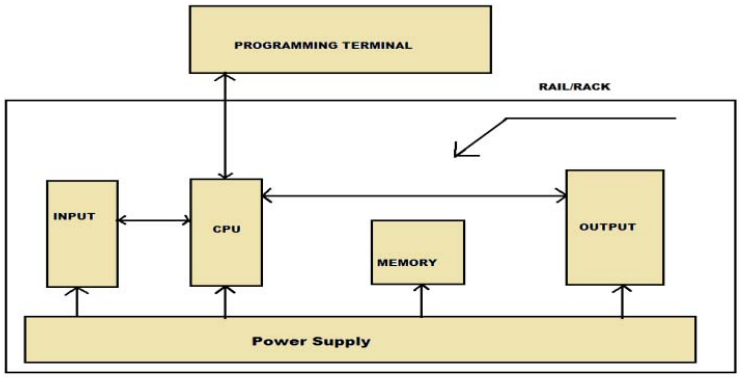


Figure 1. Rockwell Plc Structure

3. Process Description and Case Study in Factory

In our paper we have specialised on ROCKWELL PLC, in which the RSLOGIX 5000 software is the main platform to control the basic operations. The ladder logic, i.e. the programming part is done with the help of the above mentioned software. After successful completion of the programming, it is transferred to a virtual emulator which is already installed on the same workstation. As in case of a bottling plant, huge manpower is needed and as it is also very costly to implement the plant, we have given the basic priority to its security. The virtual emulator gives us the output whether the programming is correct or not. After the programming is made error free, it is installed on the main plc in the bottling plant.

Using plc programming the process of capping and filling is done simultaneously and as it is controlled by automation there is no need of constant manpower to handle the plant. There is one control room where the SCADA output is constantly observed by a person from where he can keep his close eye on various stages of the plant by using SCADA display. In case of emergency, the whole plant can be controlled from that control room only.

In this paragraph of our paper a detailed explanation of the various basic operations of a bottling plant is given. The filling and capping processes take place simultaneously.

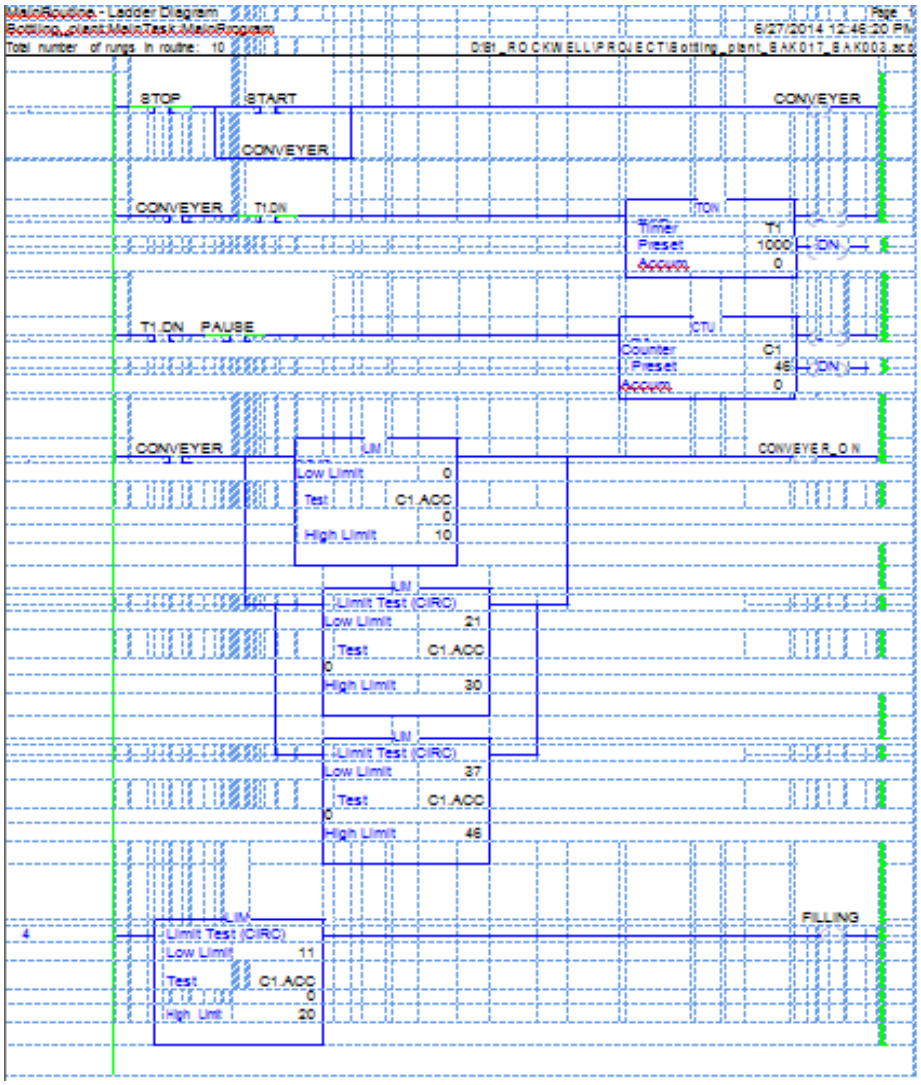
At first an empty set of bottles are placed on a conveyer belt. When the conveyer is started, the empty set of bottles starts moving towards the filling section. After reaching the filling section the conveyer is stopped and the filling pipes then start filling the empty bottles. When the bottle filling is done then the conveyer again gets motion and the filled set of bottles move towards capping section. The set of bottles when reach the capping section again the conveyer gets stop and then capping process takes place. Completion of the capping process brings the conveyer again into motion and the set of filled and capped bottles move towards exit for further modification. This is a simultaneous process which is totally handled by PLC programming and in this way continuous filling and capping process takes place in a bottling plant.

Figure 2. Coca Cola Bottling Plant [11]

4. Control Philosophy

a) In a bottling plant there are two sections in it, Filling and Capping.
b) For the operation of the plant there will be 3 push-buttons.
c) The push-buttons will represent START, STOP, PAUSE.
d) The proximity sensor will sense the finished bottles as it passes by it in the conveyer belt.
e) The START button will start the whole system and also reset the counter to zero.
f) The STOP button will stop the whole system but it won't reset the counter value to zero, the numeric display will show the last counted value.
g) The RESET-COUNTER will reset the counter to zero.
h) If the PAUSE button is pressed then the system will hold its position and stop, and when it is pressed again the system will resume.
i) Further modification can be done, i.e. a numeric display can be implemented through which the number of filled bottles can be monitored.

5. Ladder Logic



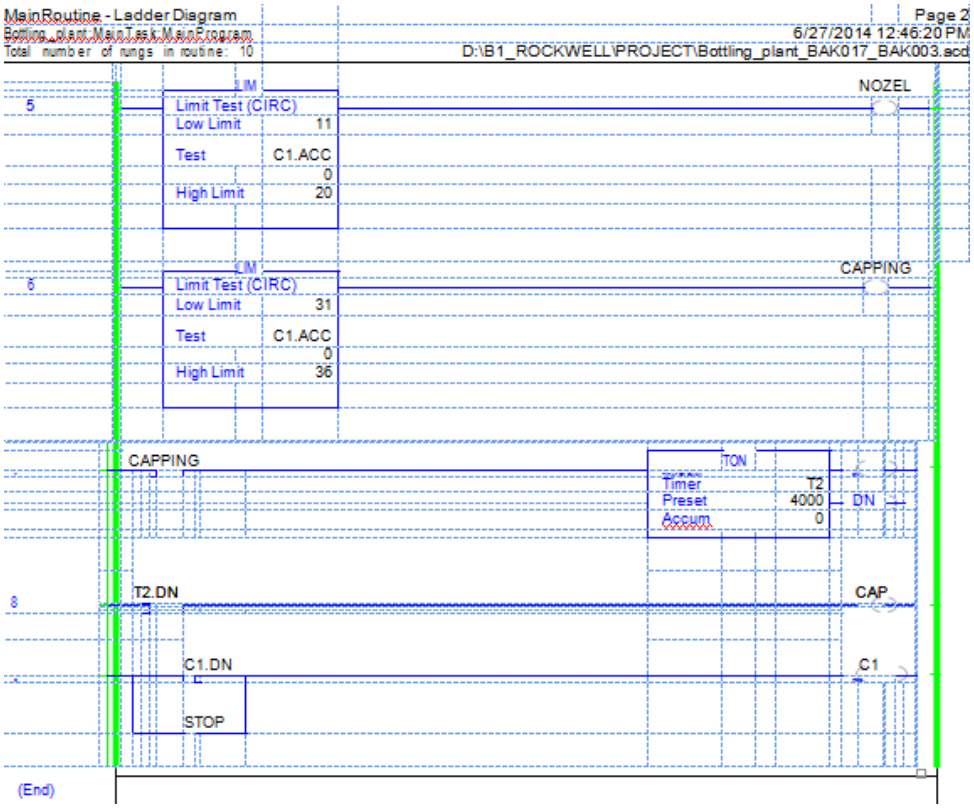


Figure 3. Ladder Diagram

6. SCADA Design

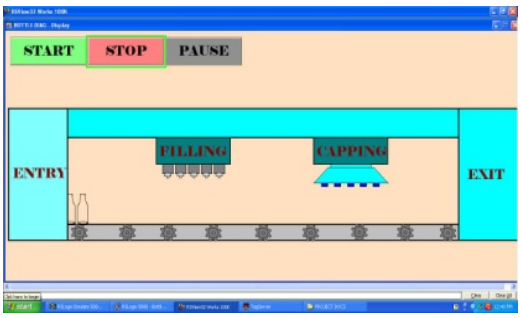


Figure 4(a). Conveyer On

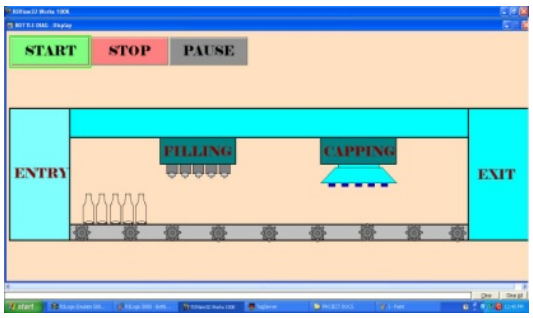


Figure 4(b). Empty Bottles Running

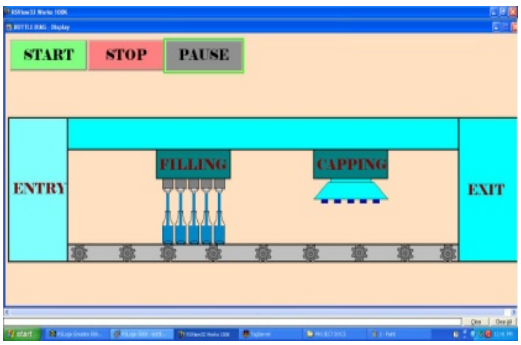


Figure 4(c). Bottles Filling

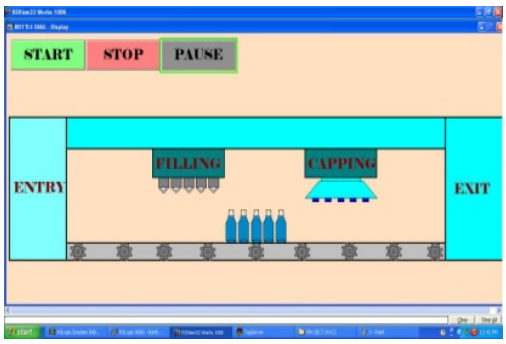


Figure 4(d). Filled Bottles Running

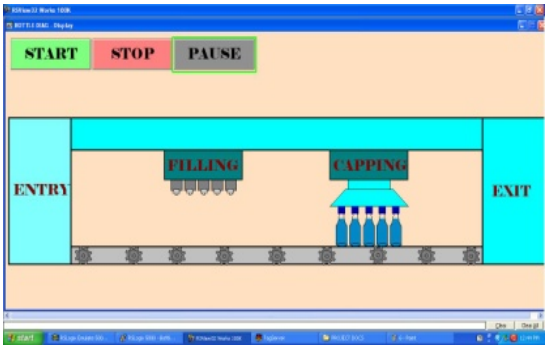


Figure 4(e). Capping Section

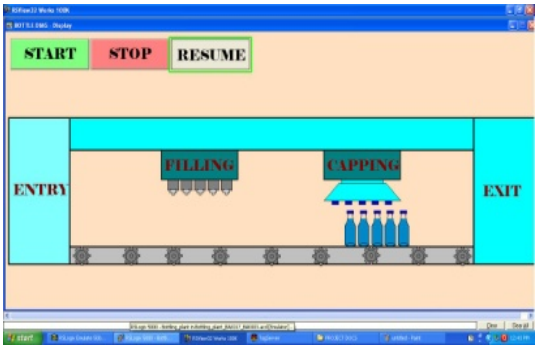


Figure 4(f). Capped Bottles Running

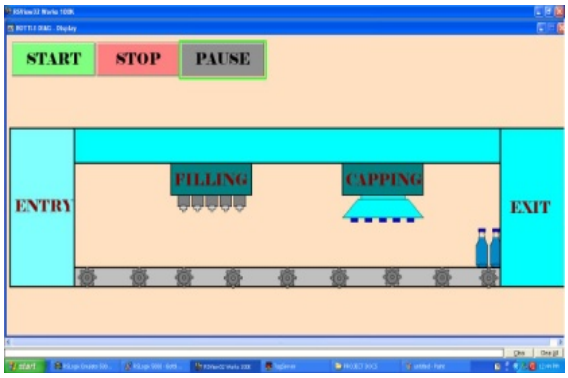


Figure 4(g). Set of Bottles Running Towards Exit

7. Conclusion

This paper has suggested the application of fully automated untouched plc controlled filling and capping operation of a bottling plant. The system works in high speed of production with very much accuracy and precision. This system meets the market demand with a few mechanical effort. The system has been proved working without wastage or spill out of the liquid. It is true that for small scale industries the installation cost ohf PLC is very much high but it has many advantages which overcomes the instllation cost. In this paper it is suggested how a set of bottle can be filled and capped at the same time. The other additional feature of this paper, here it is explained the SCADA design also. By using the SCADA the whole process can be monitored from a single control room only and necessary steps can be taken in case of emergency.

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