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A Case Study on Process Automation Using PLC In Soft-Drink Manufacturing

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Abstract:-- **Industrial Automation uses control system such as computer or robots and information technology, for controlling different type of processes and machinery and is the process of integrating industrial machinery to automatically perform task such as welding, material handling, packaging, blending etc. Using hardware and soft-ware automation increases productivity, safety and profitability which are the need of any manufacturing industry loading for sustenance in the global competition.**

The conventional processes are time consuming, less accurate and involve more human interference and thus automation offers an advantage of making the jobs easier and reducing the risk and defects in these process. Soft drink manufacturing is one such process which may involve multiple outputs at every next instant. The mixing of the ingredient must be accurate according to recipe selected and must the display the problem if any encountered automated through alarms. The paper describes the soft-drink manufacturing built using PLC for accurate and faster control.

Keywords :- **PLC, SoftDrinkManufacturing, IndustrialAutomation, HumanIntervention.**

I. INTRODUCTION

The field of automation has had a notable impact in a wide range of industries beyond manufacturing. One of the important applications of automation is in the soft drink manufacturing. The various processes are controlled using PLC and it is monitored using SCADA. Mechatronics is a multidisciplinary field of science that includes a combination of mechanical engineering, electrical, computer engineering, electronics engineering, telecommunication engineering system and control engineering.

Soft drinks are enormously popular beverage consisting primarily of carbonated water, sugar and flavoring. Operations in concentrate manufacturing plant can be derived into five basic process:

1) Treating water
2) Receiving raw materials
3) Concentrate manufacturing
4) Concentrate and additional filling
5) Shipping finished product

Each of these processes has safety hazards that must be evaluated and controlled.

II. RAW MATERIAL :

Carbonated was constitute up to 94% of soft drink. Carbon dioxide adds that special sparkle and biter to beverage and also act as a mild preservative. Carbon dioxide is a uniquely suitable gas for soft drink, because it is inert non toxic and relatively in expensive and easy to liquefy.
The second main ingredient is sugar, which make up 7-12% of a soft drink. Sugar is used in either dry or liquid form, sugar adds sweetness and body to the beverage, enhancing the Mouth –feel. The overall flavor of a soft drink depends on an intricate balance of sweetness, tartness and acidity (pH).Very small quantities of other additives enhance taste, mouth-feel, aroma and appearance of the beverage. Emulsions are added to soft drink primarily to enhance “eye appeal” by serving as a clouding agent. To impede the growth of microorganisms and prevent deterioration, preservations are added to soft drinks. Anti-oxidant such as a BHA and ascorbic acid, maintain color and flavor.

III. PROBLEM DEFINATION:

Problems with conventional system are as fallows,

1) Time consuming.
2) Accuracy and ease of control is not assured.
3) Operator fatigue.
4) Difficult report generation and record keeping.
5) Clear visualization and monitoring of process is difficult.

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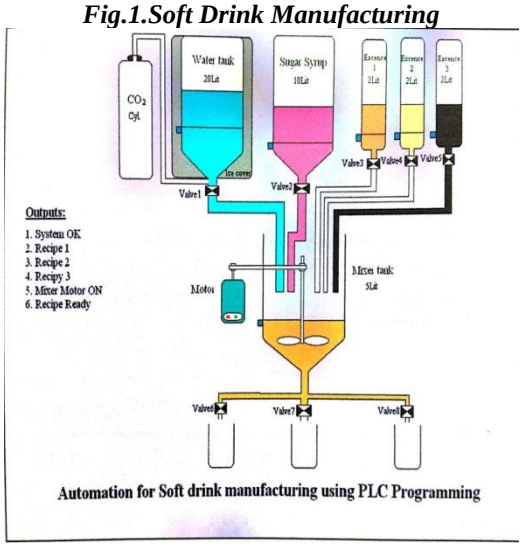
IV. METHODOLOGY:

1) *System Diagram:*

Fig.1.Soft Drink Manufacturing



2)*Flow Chart*:

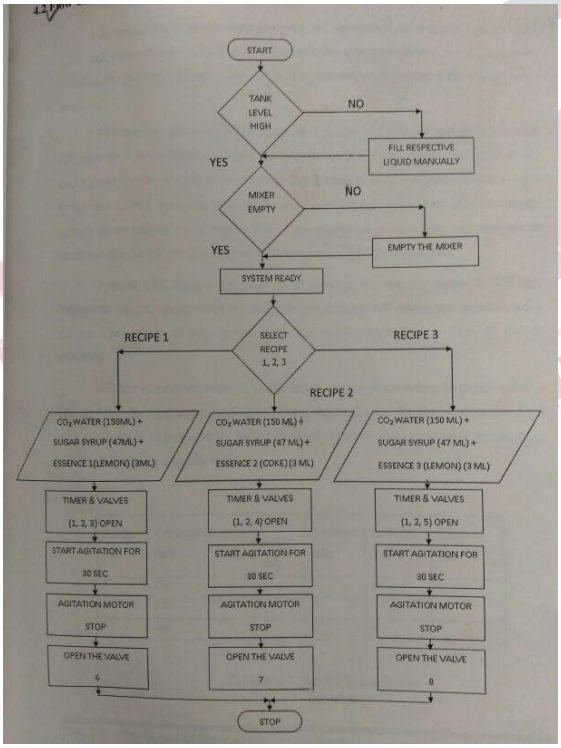


Fig.2

3) *System Operation:*

The flow chart shown in fig. 2 gives a detailed explanation of the various processes taking place in complete system. Automated soft drink manufacturing set up firstly constitutes of pressurized CO2 thank connected to cold water storage tank surrounded with ice, sugar syrup tank , 3 flavored colored essence tanks, a mixer assembly and piping with valves and sensors.

The system provides fully automated recipe selection and product out with efficient time and proportion. When the system made ON the level sensor of tank gives feedback of fulfillment of tanks. When the cold water tank (10lit.), sugar syrup tank (5lit.), 3 essences tank (2lit. each) are filled and mixer tank (1lit.) is empty; system gives indication of system OK. Then recipe selection comes. All recipes are same but flavor changes one valve will open out of 3 essence tanks. System ON, Recipe sensor, Level sensor etc. are the inputs to RSLogix ladder and valves, motor ON/OFF and LEDs are outputs. All valves operated using timers and recipe selection.

All the constituents enter in to the mixer, and then according to timer motor is ON/OFF for operating conditions. The consumed time for the product out from the recipe selection depends upon valves in timer and valve's accuracy, and product out valves open according to timer. The proposed system is a shown in fig. 1.

Recipe No.	Carbonated water (ml)	Sugar syrup (ml)	Essence 1	Essence 2	Essence 3
1	150	47	3	0	0
2	150	47	0	3	0
3	150	47	0	0	3

Table no. 1. Recipe Ingredients

V. MECANICAL COMPONENT:-

***1) Tank*:**Tank can be constructed from number of materials, including stainless steel plants and anodized aluminium.

***2)Pipes*:** Non-toxic PVC hose and tubes these are known for their high resistance to various chemicals, flexibility, light weight and excellent resistance to pressure and abrasion.

***3) Motor*:** Mixer consists of a stainless stirrer and an electric motor is used to drive it. Logical control of motors consists of switching low current motors directly with a PLC, or for more powerful motors using a relay or motor starter.

***4) Valves*:** The flow of fluid or air can be controlled with solenoid controlled valves. When selecting valves there are

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no. of details that should be considered that are pipe size, flow rate, operating pressure, electrical voltage and current, response time.

a) Valves used in this case study are NC Direct Acting Solenoid Valve1/4" 3/2 Way Pilot Operated Valve
b) Float Valve

6) ***Others*:** There are many other types of actuators such as heaters, lights, sirens or horns.

VI. SYSTEM CONTROL COMPONENTS:-

Programmable Logic Control (PLC):- PLC is a solid state device. These are well adapted to a range of automation task. PLC consists of input and output units, control processing unitand a memory unit. A digitally operating electronic system, designed for use in an industrial environment , which use a programmable memory for the internal storage of user oriented instructions for implementing specific function such as logic, sequencing, timing,counting and arithmetic, to control, through digital or analogous inputs and outputs, varies types of machines and processes.

VII. SOFTWARE USED:

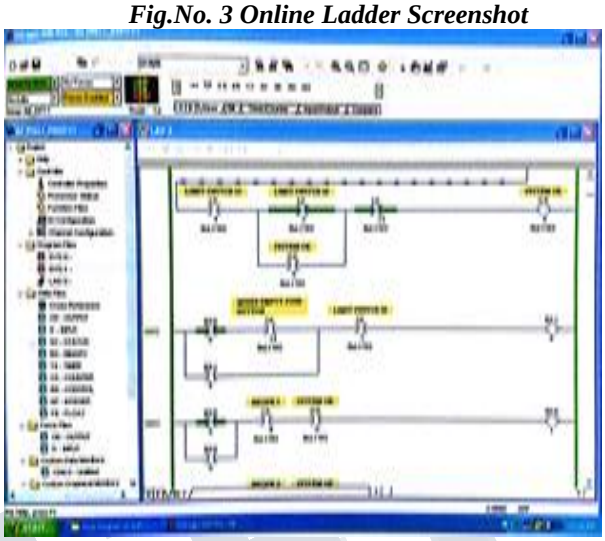
1) Ladder Programming: Ladder logic is main programmable method used for PLCs. Ladder logic has been developed to mimic relay logic. The decision to use the relay logic diagrams was a strategic one.

2) RSLogix500: RSLogix500 has been selected in the project for PLC programming. The RSLogix™ family of ladder logic programming packages helps the user maximum performance, save project development time, and improves productivity.

3) Supervisory Control and Data Acquisition (SCADA): SCADA is an acronym that stands for 'Supervisory and Data Acquisition'. SCADA refers to a system that collect data from various sensors at a factory, plant or in other remote locations and then send this data to a central computer, which then manage and controls the data. SCADA is term that is broadly used to portray control and management solution in a wide range of industries.

VIII. RESULT AND CONCLUSION:

Fig.No. 3 Online Ladder Screenshot



The main objective of this paper was to study the process automation using PLC in soft-drink manufacturing, which was successfully implemented. Most manufacturing companies are looking for automation competent engineers with basic aptitude towards and ability to work on varied brand of PLCs, Drives, MMI and SCADA. High level of technical skill is required to keep it going in operations and maintenance.

Automation of soft drink manufacturing plant enabled to complete a batch in almost half the time initially required, so that the output of soft-drink unit is increased, the consumptions of additives and electric energy is reduced, less attendance is needed, and the productivity of the workers and the conditions of manufacture are improved.

The comparison of automated system with conventional soft drink manufacturing system, gave some results as follows:
a) Reduced operator fatigue and system errors
b) Reduce cycle time
c) Easy indication and monitoring of system parameters
d) Ease of report generation
e) Flexibility
f) Energy saving
g) Accurate control

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