HYBRID METHOD FOR AUTOMATICALLY FILLING OF THE CHEMICAL LIQUID INTO BOTTLES USING PLC & SCADA

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 ABSTRACT- In today's fast-moving, highly competitive industrial world, a company must be flexible, cost effective and efficient if it wishes to survive. In the process and manufacturing industries, this has resulted in a great demand for industrial control systems/ automation in order to streamline operations in terms of speed, reliability and product output. Automation plays an increasingly important role in the world economy and in daily experience. A prototype of commercial " Hybrid method of automatically filling the bottles using PLC&SCADA and show its visualization on SCADA screen" , 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. One of the important applications of automation is in the soft drink and other beverage industries, where a particular liquid has to be filled continuously. The objective of this paper is to design, develop and testing of the "Real time implementation of PLC,SCADA system for ratio control based bottle filling plant". This work will provide low operational cost, low power consumption, accuracy and flexibility to the system and at the same time it will provide accurate volume of liquid in bottle by saving operational time.

KEYWORDS -**PLC, SCADA, Sensors , Automation,VFD, Conveyor,**

I. INTRODUCTION

This research is to design and develop the " Hybrid method of automatically filling the chemical liquid into bottles using PLC&SCADA and show its visualization on SCADA screen. We can operate & control   automatically filling of bottles sitting far away from the plant(for example 500km distance from plant) and we can change all the parameter of the process using SCADA technology because SCADA system is used as supervisor or monitor the process. The purpose of this   research is to apply filling 2 type of chemical liquid into bottles randomly by using PLC as a controller. This is a batch operation where a set amount of inputs to be process is received as a group, and an operation produces the finish product. In many automation Processes it is necessary to achieve a desired demand in some specified time. Ex- If the production rate is 35 bottles per minute and the demand increases to 65 bottles per minute, the operating speed needs to be increased, whereas if the demand drops abruptly the production rate needs to be decreased. Thus the research deals with overcoming the problems of speed control in order to have improved operational parameters.

II. PLC AS SYSTEM CONTROLLER

Programmable logic controller or programmable controller is a digital computer used for automation of industrial process, such as control of machinery on factory assembly lines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output unlike general purpose computers, the PLC is designed for multiple inputs and output. Arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to controlled machine operations are typically stored in the battery backed or non –volatile memory.
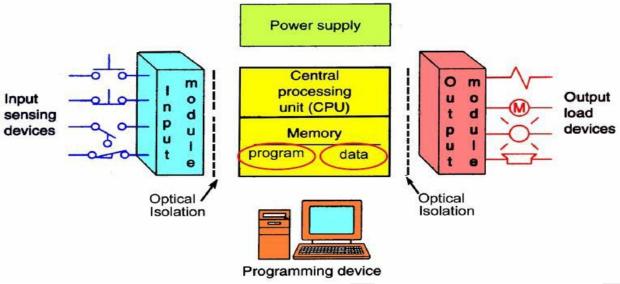
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Figure 1: Basic PLC Operation Process

Unlike a personal computer though the PLC is designed to survive in a rugged industrial atmosphere and to be very flexible in how it interfaces with inputs and outputs to the real world. a programmable logic controller is simply used in many industries such as oil refineries, manufacturing lines, conveyor systems and so on. Where ever there is a need in control devices the plc provides a flexible way to "soft wire" the components together.

III.Fundamental Principles of Modern SCADA Systems

SCADA refers to the combination of telemetry and data acquisition. SCADA encompasses the collecting of the information, transferring it back to the central site, carrying out any necessary analysis and control and then displaying that information on a number of operator screens or displays. The required control actions are then conveyed back to the process. The PLC or Programmable Logic Controller is still one of the most widely used control systems in industry. As needs grew to monitor and control more devices in the plant, the PLCs were distributed and the systems became more intelligent and smaller in size. PLCs and DCS or (Distributed Control Systems) are used as

The advantages of the PLC / DCS SCADA system are:

• The computer can record and store a very large amount of data.

• The data can be displayed in any way the user requires.

• Thousands of sensors over a wide area can be connected to the system.

• The operator can incorporate real data simulations into the system.

• Many types of data can be collected from the RTUs.

• The data can be viewed from anywhere, not just on site.

IV. Block Diagram

This deals with the key components used in settling up the complete plant and thus explains the use and working of each component. The block diagram of the experimental set up is illustrated. The following configurations can be obtained.
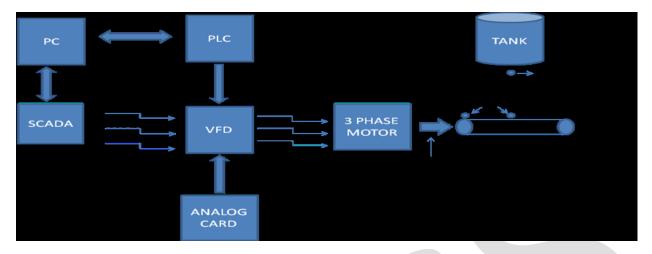
Figure 2: Block Diagram

The digital computer is used as an interface between PLC and SCADA. The PLC is a micro processor based system controller used to sense, activate and control industrial equipments and thus incorporate a number of input output/modules which allows electrical system to be interfaced. SCADA is a centralized system used to supervise a complete plant and basically consists of data accessing features and controlling processes remotely. The communication protocol used is Ethernet. The Variable Frequency Drive connected to the PLC receives AC power and converts it to an adjustable frequency adjustable voltage output for controlling the motor operation. The analog module converts analog input signals to digital output signals which can be manipulated by the processor.

The output of the VFD is given to the 3-phase induction motor which in turn with the help of a pulley mechanism is used to vary the speed of the conveyor belt. An inductive sensor is an electronic proximity sensors used to detect metallic objects without touching them. The solenoid valve is a normally closed direct acting valve used to pour the liquid in the bottle whenever it gets a signal from the proximity sensor

V.PLC AND RELATED SOFTWARE'S

The PLC used is Micro Logix 1200 as it has 10 inputs and 6 outputs and has an interface for Ethernet. The Micro Logix 1400 system offers higher I/O count, faster high-speed counter/PTO, and enhanced network capabilities The programming software used is RSLOGIX 500 and the communication software used is RS LINX 500.

Features of MicroLogix 1200:-
 Ethernet port provides Web server capability, email capability and protocol support Built-in LCD with backlight lets you view controller and I/O status Built-in LCD provides simple interface for messages, bit/integer monitoring and manipulation Expands application capabilities through support for as many as seven 1762 Micro Logix Expansion I/O modules with 256 discrete I/O . As many as six embedded 100 kHz high-speed counters (only on controllers with DC inputs) Two serial ports with DF1, DH-485, Modbus RTU, DNP3 and ASCII protocol support .

Proximity Sensors
Proximity Sensors are available in two types namely;
1) Inductive sensors
2) Capacitive Sensors
Inductive Sensors are cheaper and allow detection of metal objects whereas capacitive sensors are costly and allow detection of metal, plastic and glass objects as well.

VI.Variable Frequency Drive

When an induction motor starts, it will draw very high inrush current due to the absence of the back EMF at start. This results in higher power loss in the transmission line and also in the rotor, which will eventually heat up and may fail due to insulation failure. The high inrush current may cause the voltage to dip in the supply line, which may affect the performance of other utility equipment connected on the same supply line.

Adding a variable frequency drive (VFD) to a motor-driven system can offer potential energy savings in a system in which the loads vary with time. VFDs belong to a group of equipment called adjustable speed drives or variable speed drives. (Variable speed drives can be electrical or mechanical, whereas VFDs are electrical.) The operating speed of a motor connected to a VFD is varied by changing the frequency of the motor supply voltage. This allows continuous process speed control. Motor-driven systems are often

designed to handle peak loads that have a safety factor. This often leads to energy inefficiency in systems that operate for extended periods at reduced load. The ability to adjust motor speed enables closer matching of motor output to load and often results in energy savings

The components of the drive system are broken into four major categories: source power, rectifier, dc bus, and inverter. Other components exits such as resolver and encoder feedback devices, tachometers, sensors, relays and help supplement the system.

First, the source power must be converted from alternating current to direct current. This conversion is accomplished by means of a rectifier; a diode is used for more intelligent rectification. The power source that was 460volts ac, 60 Hertz now converted to 650 volts dc. This AC to DC conversion is necessary before the power can be changed back to AC at a variable frequency.

The diode bridge converter that converts AC-to-DC is sometimes just referred to as a converter. The converter that converts the dc back to ac is also a converter, but to distinguish it from the diode converter, it is usually referred to as an "inverter". It has become common in the industry to refer to any DC-to-AC converter as an inverter.
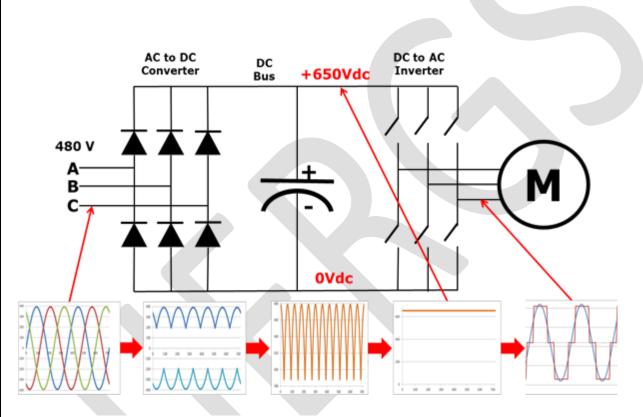

Figure 3: Block diagram of VFD ac to dc converter

VII. METHODOLOGY

This department of the plant works on distribution of any kind of chemical liquid into different tank to a main two buffer storage tank. This distribution takes place automatically using the Programmable Logic Controller (PLC).
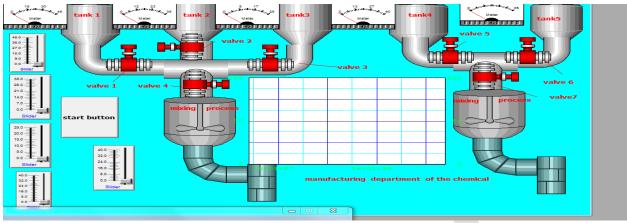
Figure 4:Screen shot of SCADA software of manufacturing department of the chemical liquid.

It commonly applied application of PLC where five different chemical liquids are mixed in required proportion to form a batch .Rate of the flow is already fixed. We only control the time of the flow. Level of the liquids in the tank is sensed by the level sensor switches. The ratio of five different liquids will decided as per the required mixed liquid that we needed in the bottle. There is a stirrer motor is also fitted to mix these two liquids of definite amount in the main tank.
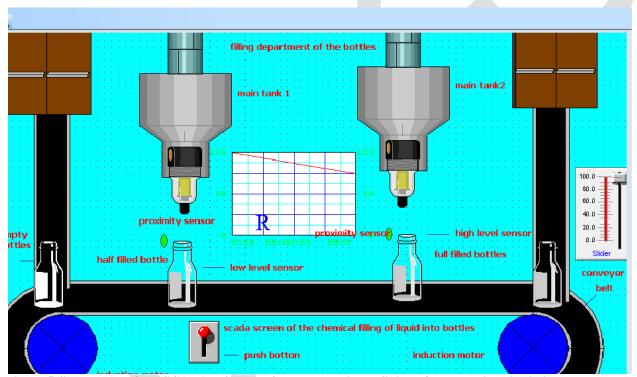

Figure 5:Screen shot of the SCADA software of the automatically filling of the chemical liquid into the bottles.

Bottles are kept in position in a carton over conveyor belt; they are sensed to detect their presence. Capacitive sensors are used for sensing the bottles. Depending on the output of the sensor the corresponding valve switch on and filling operation takes place. If the particular bottle is not present then the valve in that position is switched off, thereby avoiding wastage of the liquid. The filling process is done based on timing. Depending on the preset value
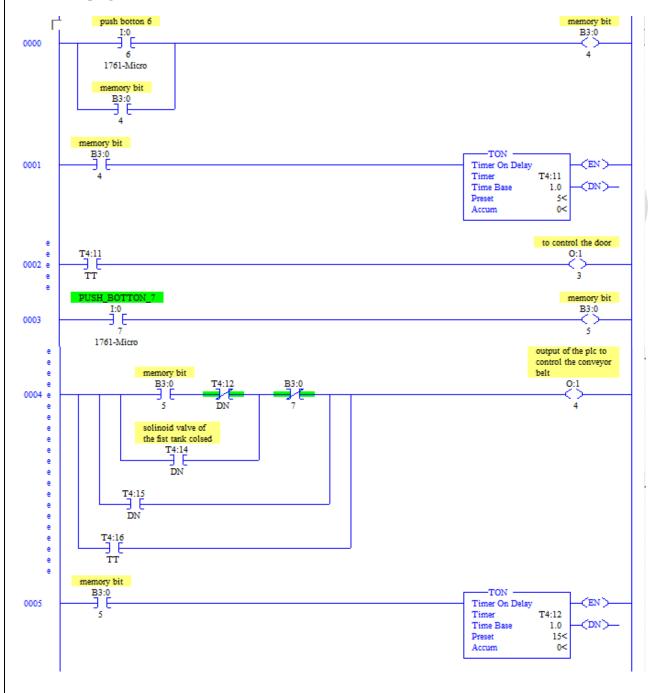
of the timer the valve is switched on for that particular period of time and the filling is done.

The motor continues to run even when the bottle moves away from the first sensors range, i.e. the output of the motor is latched as explained in the ladder logic section of PLC. When sensor 2 senses the bottle, it also gives a high output to the PLC. The PLC instructs the inverter to stop the motor. The high output bit of sensor 2 is also given to the timer for the solenoid valve. The timer used is TON. It counts for a predefined value of time (18 sec). It gives two outputs, Enable output and done output. The Enable output remains high while the timer is counting and the output goes high after the timer has finished counting. The Enable output of TON is

given to the solenoid valve, and so the solenoid valve is open for the predefined value of time (18 sec). The Done output bit is used to turn ON the motor again in the running   . And this all the process are repeat again and half the bottles fill again to in front of the second chemical tank and the bottles full filled and the done output bit is used to turn on the induction motor again. All this are described in this ladder programming of the PLC.
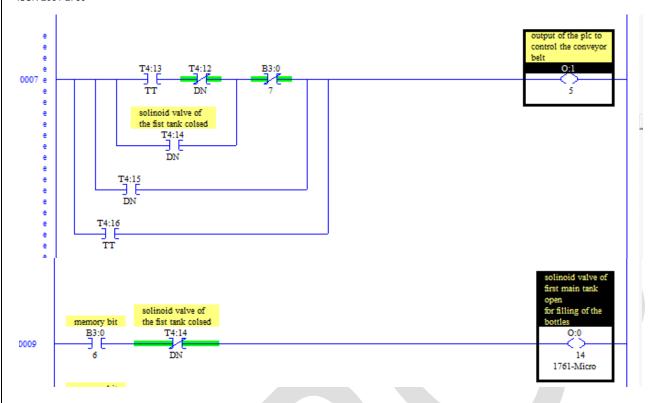
Plc ladder program.

Figure 6 :This is the plc ladder program for filling of the chemical liquid into the   bottles .

CONCLUSION

This paper presents a automated liquid filling to bottles of using PLC and SCADA. A total control is made in a filling is achieved. The present system will provides a great deal of applications in the field of automation, especially in mass production industries where there are large number of components to be processed and handled in a short period of time and there's need for increased production. The programming to this system developed is flexible, quickly and easily. This will increase the total production output; this increase in production can yield significant financial benefits and savings. This concept can be used in beverage and food industries, milk industries, medicine industries, mineral water, chemical product industries and

manufacturing industries. The present work is motivated to develop an online scheme to monitor and control a hybrid method of automatically filling of the chemical liquid into the bottles using PLC and SCADA.

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