



pH Control in Effluent Treatment Plant Using PLC

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ABSTRACT

In this paper, A few automated processes for a partial automation which can be mostly used in residential areas and industries. It is developed using PLC. It has explained the process of ETP in industries. The process include different parameters like flow, level, pH, DC motor, solenoid valves, pump are controlled by using PLC (Allen Bradley Micrologix 820) and simulated by using software CCW (Connected Component Workbench). As we know that effluents emitted by industries contains harmful chemicals which could lead to effect on environment and society. So by retreating these effluents could be a blessing in disguise. This process can't be going through using manual process so here we need some automotive tools for that. That is why we make use of PLC (programmable logic controller). PLC is recommended instead of other automation devices because of its versatility, robustness, reprogrammable nature and many other significant features.

Keyword: Allen Bradley PLC, solenoid valve, DC motor, float sensors, pH sensor.

I. INTRODUCTION:

Water treatment is collectively, the industrial-scale processes that make water more acceptable for an end-use, which may be drinking, industry, or medicine. Water treatment is unlike small-scale water sterilization that campers and other people in wilderness areas practice.

These processes involved in treating water for drinking purpose may be solids separation using physical processes such as settling and filtration, and chemical

processes such as disinfection and coagulation. The treatment of contaminated water can be done with the ETP, which is an (effluent treatment plant) clean up the industry effluents, polluted water from rivers, lakes, etc. So, they can be recycled for further use. Thus, water is recycled and stored. Automatic systems are being preferred over manual system because they reduce individual's effort. Similarly talking about apartment automation, by use of PLCs everything seems to be more accurate, reliable and more efficient than the existing controllers.

Automation is basically the delegation of human control function to technical equipment. It uses controlled systems such as computers, PLCs, Microcontrollers to control machinery and processes to reduce the necessity of human involvement and mental requirements. Different types of controllers can be used to operate and control the equipment such as machinery, processes in factories, heat treating ovens and boilers, and other applications with minimal or reduced human intervention. Food/Beverage, Chemical industries, Power, Machine Manufacturing, etc. are the few examples where we see the mechanization today. PLC is robust and can be programmed using ladder programming, structured text programming and functional block diagram programming which can be done easily and also it can be reprogrammed i.e. connections can be same but programming can be changed as per requirement.

II. OBJECTIVE:

The main goal of this project is to design, develop and implement an "Automation based ETP" and advanced

form of controller. The work for this objective mainly concerns the use of a feedback system as an overall control structure and the implementation and testing of programmable logic controllers within this control scheme. The study focuses on the pH maintenance process but some aspects of this work also have relevance for other process applications

III. PLC ARCHITECTURE:

The internal architecture of a PLC is as shown in Figure.1

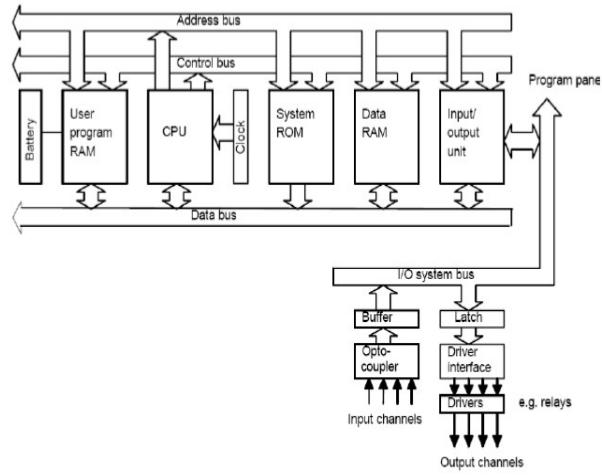


Figure.1: internal architecture of PLC

A. Central Processing Unit :

At the very basic, the internal architecture of a PLC consists of a central processing unit (CPU) containing the system microprocessor, memory and input/output circuitry. The CPU is supplied with a clock which determines the operating speed of the PLC and provides the timing and synchronization for all elements in the system.

The information within the PLC is carried by means of digital signals which flow along internal paths called *buses*.

B. Memory system :

This is the area in the PLC where all of the sequences of instructions, or *programs*, are stored and executed by the processor to provide the desired control of field devices [7]. The memory sections that contain the control programs can be reprogrammed to adapt to any changes in process control requirements.

C. I/O Interfaces :

An *I/O module* is a plug-in-type assembly containing

circuitry that communicates between a PLC and field devices. These devices could be transmitting and/or accepting *digital* or *analog* signals.

D. The power supply :

The system power supply provides internal DC voltages to the system components (processor, memory, and input/output interfaces). The power supply is characterized by a maximum amount of current that it can provide at a given voltage level, depending on the type of power supply.

E. Programming languages :

Graphical languages:

- i. Ladder diagrams (LD) - uses a standardized set of ladder programming symbols to implement control functions.
- ii. Function Block Diagram (FBD) - a graphical language that allows the user to program elements in such a way that they appear to be wired together like electrical circuits.
- iii. Sequential Functional Chart (SFC) - a graphical language that provides a diagrammatic representation of control sequences in a program.

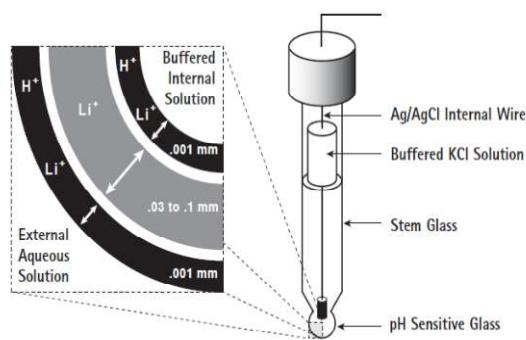
Text-based languages:

- i. Instruction list (IL) - a low-level language similar to the machine or assembly language used with microprocessors.
- ii. Structured text (ST) - a high-level language that allows structured programming, meaning that many complex tasks can be broken down into smaller ones.

IV. pH Electrode

pH electrode used to in this project is a glass electrode E-201C.

Figure 2 shows the internal construction of pH electrode. pH electrode E-201C is an electrode type combination sensor where an internal silver chloride is used Programmable logic Controller using CCW for pH maintenance as electrode to detect the amount of hydronium ions and generate potential accordingly. Here the tubular structure of glass is the sensing part. It makes use of salt bridge principle for getting the potential difference. This potential is compared with reference potential by a solution of KCl of pH=7.

**Figure 2:** pH probe (Electrode) construction.

This sensor comes with a BNC connector. Since the potential given by glass electrode is in millivolts, and this can't be recognized by PLC, hence electrode output is connected to voltage adapter which converts it to PLC compatible voltage of 0-5 V. and again using a booster circuit for converting 0-5 V to 0-10V to step up the voltage because Allen Bradley PLC is 10 bit resolution.

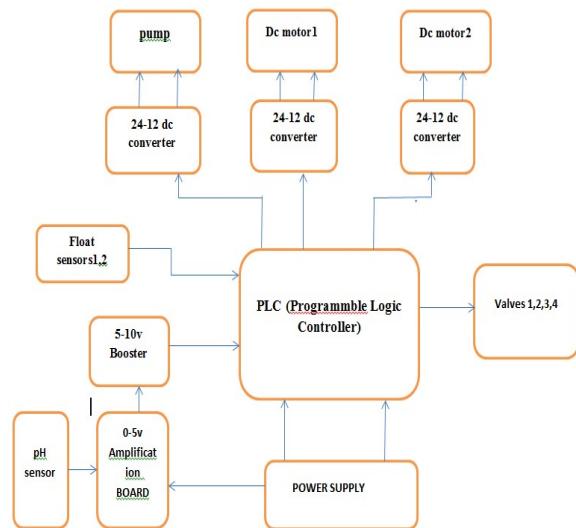
Before using in the main process pH electrode has to be calibrated. For calibration we need to place the electrode in at least three buffer solutions one acidic, basic and neutral each, and measure the voltage for each solution. Following table shows the voltages obtained with buffers solutions.

| Buffer solution pH | Voltage |
|--------------------|---------|
| 4.0 | 3.94 |
| 7.0 | 3.42 |
| 9.2 | 2.94 |

Table: Calibration voltages for pH electrode

V. WORKING PRINCIPLE

The Block diagram explains the ETP Automation process as shown in fig.3 the controller used is an Programmable Logic Controller which is interfaced to all the sensors and modules for getting the desired output. The power to the PLC circuit is given by a 24V, 1Amp battery. At the input side pH sensors is connected to 0-5V Amplification board, gives the pH value in terms of voltages, here using an 5-10 V booster circuit for suitable scaling. With that the required power supply is connected to pH sensor Amplification board. And also the PLC outputs are all 24v, here 24-12v step down circuit is used for to drive the pump and stirrer. All the Control valves and Float sensors are directly connected to PLC BOARD .

**Figure 3:** Block diagram

A waste water tank (Tank 1) the water is pumped to the Sedimentation tank (Tank 2) for the particular level .The Float sensor is used as level sensor once it reaches the value the pump will be switched off, Simultaneously the valve 1 is opened to add the Alum solution for the Coagulation and Flocculation/Sedimentation process here the motorized stirrer in Tank2 that is used to mix the solution and also for Sedimentation process, After some time the waste particles is settle down is the base of the tank.

Then Automatically the valve 2 will be opened i.e. pH process tank ,here again the Float sensor is used to measure the level of the tank, Once its reach that level the valve2 is automatically closed and Ph sensor is turned ON , Depending on the pH value ,The acid stream and base stream are pumped into the reactor tank by solenoid valve 3 and solenoid valve 4 respectively. There is a motorized stirrer in the reactor that is use do mix the solution.

**Figure 4:** Photograph of hardware setup for ETP Automation Process

A pH sensor (E201C) measures the pH value of the water in the reactor tank (Tank 3). All the valves, pump and pH sensor data are fetched from the PLC and controlled through PLC and is fed to the computer through Ethernet cable. Using CCW, coding to control the process and transmission of feedback signals to the computer through Allen Bradley PLC kit is achieved.

VI. CONCLUSION

The ETP has a great role to play in discharging the contaminated and polluted water before releasing it back to the environment. Without these water treatment plants, we would not be able to get clean water for domestic uses. By using PLC the cost effective automation system for residences can be developed and it is very user friendly for the operator or control engineer to troubleshoot the process

In this we have showed the prototype model and program through which one can be able to install this model at residencies and other platforms to treat water in a cost effective manner.

In future project we can include SCADA which will increase its efficiency as well as provide an operator to visualize, supervise and control the process.

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