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Research Article

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Obtaining Solution for the Treatment of Wastewater using an Automated PLC

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Abstract This paper aims at providing a solution for the treatment of wastewater by using an automated PLC (Programmable Logic Controller) based water treatment system. It uses a small control system which runs the facility, Programmable Logic Controllers (PLC) continuously monitors the operation of pumps, valves, and other equipment, receives and execute commands given by operator or programmer, while PLC is used to control processes based on data and built-in program/Algorithm. In this paper, the use of PLC and SCADA in sewage water treatment plants is implemented. The obtained purified water is used for domestic and agricultural purposes based on ph.

Keywords solenoid valve, PLC, Automation

Introduction

As we know water is the most crucial natural resource available to mankind. Only 2.4% of water available on the earth which is suitable for human consumption out of which 1.6% in groundwater, 1.6% in form glaciers, and 0.001% in the air in form of vapor, clouds, and precipitates. Generally, residential water usage for a person is about 75 to100 gallons/day. When people had used water it becomes wastewater- also known as sewage that must be recycled or treated to avoid the problem of water scarcity. To clean up or treat this wastewater for recycling, it is important to understand what it contains, what problems it may cause, and X how to clean it up [1].

PLC Basics

A Programmable Logic Controller (PLC) is a kind of computer generally utilized in commercial and industrial control applications. PLC's differ from office computers by the tasks that they perform and so, therefore, the hardware and software they use to perform these tasks. As the applications vary extensively, all PLC's monitor inputs and other variable values and take decisions supported on a stored program, and control outputs to automate a process or machine. The fundamental components of a PLC are input modules or points, a Central Processing Unit (CPU), output modules or points, and a programming device. The type of input modules or points employed by a PLC depends upon the type of input devices used. Some input modules or points answer to digital inputs, also known as discrete inputs, which are either on or off. Other modules or inputs respond to analog signals.

The first function of a PLC's input circuit is to change the signals send by these various sensors and switches into logic signals which are employed by the CPU which assess the status of input, output, and other variables

as it executes a stored program. The CPU then send signal to update the status of output. The programming device is employed to enter or modify the PLC's program or to watch or modify stored values. [2]

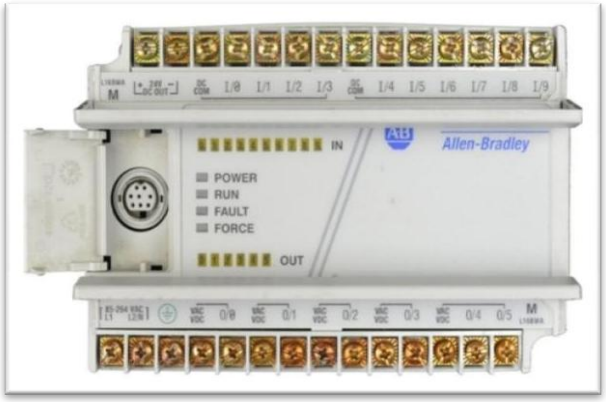

Figure 1: PLC (Allen Bradley) [3]

Component Specification

1. **Water level indicator (Magnetic Float Sensor):**

Figure 2: Water Level Sensor

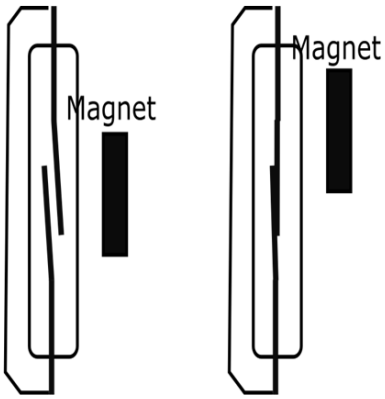

Figure 3: Reed Switch in Open Condition and Close Condition [4]

The water level indicator consists of a magnetic reed switch, which consists of two contacts sealed in a glass tube. When a magnet remains at the top position the contact remain attracted to each other and touch, allowing current to pass through them. But when the magnet moves at the bottom, the contacts will be attracted outwards and will separate breaking the circuit. Float Sensor which we have used is Normally Opened type. So, when the water level goes down float sensor breaks the circuit and energizes the hardware connected with it (mostly the water pump is connected).

2. **Activated Carbon Filter:**

Activated carbon is a form of carbon that is modified so that it becomes extremely porous and thus has a very large surface area that adsorbs and retains a wide variety of chemicals. Properties and functions of activated carbon filter include:

- It has a capacity for virtually any vapor contaminant; it'll adsorb kind of almost any vapor.
- Has a large capacity for absorbing organic molecule, especially solvent.
- It has a huge capacity to catalytically destroy ozone, a major component of smog.
- Adsorbs smells and chemicals preferentially to moisture.

Figure 4: Activated carbon filter [5]

3. Solenoid valve:

A solenoid valve is an electromechanically operated valve. Its function is to close, open, mix fluids paths.Solenoid valve have very simple working principle. The fluid passes through a small orifice which can be shut off by a plunger with a rubber seal on the bottom. A small spring retains the plunger down to close the valve. The plunger is composed of a ferromagnetic material. An electric coil is wound around the plunger. As soon as the coil is electrically charged, a magnetic field is generated which pulls the plunger up towards the center of the coil. This opens the orifice so that the fluid can pass through.

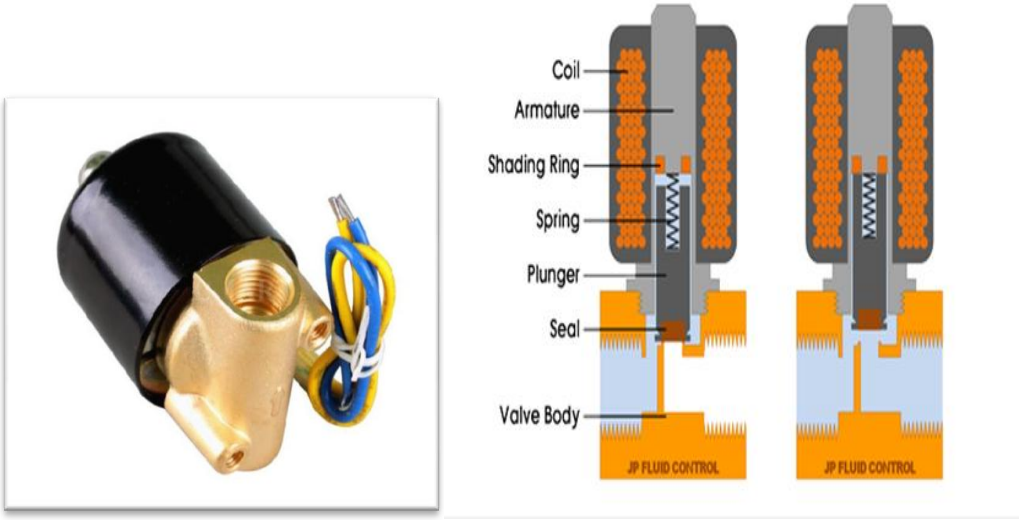

Figure 5: Solenoid Valve [6-7]

4. Submersible pump

Figure 6: Submersible pump [8]

A submersible pump is a device which has a hermetically sealed motor closely including the pump body. Electric submersible pumps are multistage centrifugal pumps that operate in an exceedingly vertical position. Liquids, accelerated by the impeller, lose their K.E. within the diffuser where a conversion of kinetic to pressure energy takes place. This is the mechanism on which radial and mixed flow pumps operate.

- **Process :**

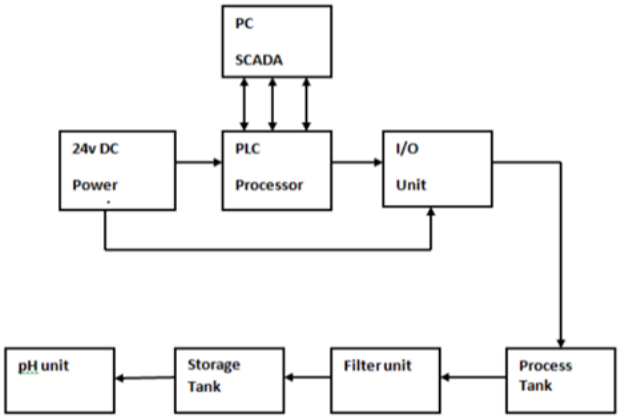

Figure 7: Project Diagram

a) Power Supply Unit: It supplies 24v dc power to both plc processor and input-output unit of the plc.
b) Primary Pump Room: The status and data signals of the pump motor, electronic butterfly valve, and on-site instruments are received and control signals are sent to this equipment. The motor running frequency and electric solenoid valve opening are automatically adjusted by pre-installed PID regulation programs.
c) Chemical adding and Chlorination Room: The status and data signals of on-site equipment and instruments are received and control signals are sent to this equipment and instruments. The operations of chemical adding and chlorination equipment are automatically controlled by automatic control programs.
d) Process Tank: The wastewater will fill in the process tank to remove the floated impurities as well as the sediments. The sediment removal is automatically operated under the sediment removal cycle. The cycle time and sediment removal time of sediment value can be modified in the control room. The filled water will be agitated and the floated impurities, as well as the sediments, will be removed through the dust valves.
e) Filter Tank: After the completion of process 1 & process 2, the water will get filtered in this filtering section. A filter tank is an important part of the water, used to filter water and suspended solids in the filtration process. During the filtration process, it needs to achieve the filter constant water level adjustment, filter backwash (air washing – water washing - gas-water mixed washing), and other functions. And the filtered water will send to the pH measurement process & for industrial usage by selecting the switch.
f) Storage Tank: The water will be stored in a storage tank after filtration [9].

Advantages

Maximize energy savings using integrated, real-time process and equipment information and coordinated, enterprise-wide energy management program.

Reduced operating costs, achieve higher productivity, and better utilization of staff with advanced process communication, automation, and information management.

Reduce potential environmental problems such as overflow, with early identification of failures and weather warnings.

Track and control manpower costs using a centralized monitoring and control system that reduces the amount of time and energy utilized on auxiliary equipment operation and maintenance.

Limitations

Fail-safe operation. Does not start automatically when power failure (can be programmed into) not "Fail-safe" - Failshorted rather than OPEN.

Although Cost of PLC is a one-time investment it can be a problem because of weak financial support.

Multiprogramming is not possible in PLC as it is not capable of holding more than one program at a time.

Skilled labor workforce is required to operate the newly designed automated system.

Conclusion

This work deals with Waste Water treatment. The recent era is of PLC programming because of higher programming flexibility and ease, scalability, more memory, smaller sizes, very high-speed (gigabit) Ethernet, and built-in wireless features.

In the future, PLC's will continuously evolve while adapting technology enhancement in communications, hardware, and software.

This project has been done using process control and monitoring of a Sewage water treatment plant. It has been designed to provide an expert system for total control of the process. It has shown a real-time operation state of the process, which allows us to monitor the process and rectify the error. The use of a PLC as a control instrument helps us in transmitting the control signals to various field devices, it enhances the compatibility of various equipments through interfaces and protocols, also make the interoperability with the SCADA implementation [10].

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