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AUTOMATION OF WATER TREATMENT PLANT

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Abstract: This paper presents technical communication of automation industry which describes the technical issues of automation control system in operation development, improving management level and high efficiency process in water treatment system. Today's water treatment plants are applied for water conservancy projects, emerged by the technology of automation control system to ensure safe, continuous, high quality water supply to municipal and for multi-purpose usage. There are many fields where the water treatment is needed so that it can be used for various processes besides industrial processes (viz. gardening, washing etc). There are easily over 50 environmental acts, which must be followed by industries. The Government of India has made it mandatory for all industries to treat the water and reuse it for other industrial process like gardening. In the water treatment plant various processes need to be controlled and monitored regularly. Thus it becomes tedious job to handle the plant manually. PLC automates the sequence of operation to avoid human interference so accuracy is improved and speed of process has been increased. The aim of this paper describes implementation of PLC to existing real-time model of the water treatment plant. Using PLC the status of the parameters can not only be continuously monitored but also the operation of the required parameters can be controlled.
Index Terms: Automation, Programmable Logic Controller, Reverse Osmosis.

I. INTRODUCTION

Over the years the demand for high quality, greater efficiency and automated machines has increased in the industrial sector of water treatment plants. Water treatment plants require continuous monitoring and inspection at frequent intervals. There are possibilities of errors at measuring and various stages involved with human workers and also the lack of few features of microcontrollers. PLC applications are extensively used in industry to control and facilitate repetitive process such as furnace, bottle filling plants, elevator systems or nuclear plant shutdown systems. One of these applications in industrial automations which include numerous automated processes. This includes automation of water treatment plant using PLC. Controlling high pressure is critical task, so here automation plays vital role. There are many fields where pressure and water level control need to be done simultaneously. Thus it becomes tedious job to handle the product manually and also processing time may vary due to human handling errors. This might not give expected results. Thus automation plays an important role in this process. Automation rectifies the human errors, increase the repeatability and accuracy of the system and decrease time consumption.

1. Problem Statement

Our aim is to implement PLC to existing model of Water Treatment Plant. The capacity of this plant is $1m^3$/hr i.e. in one hour we get maximum of 1000 liters of purified water.

2. Objective

- To improve efficiency.
- To reduce human errors.
- To improve reliability.
- To save precious resources.

3. WATER TREATMENT METHODS

A. Boiling: It is one of the oldest methods known for purifying water. It can be used under most circumstances, even in emergency situations, with no special equipment needed. The heat will kill off any harmful bacteria. For this method to be effective, it's recommended that the water be allowed to boil for at least three minutes.

B. Distillation: Distilling water is another common purification method. It requires the use of a distilling tank. Water is placed in the bottom of the tank, where it is heated to its boiling point. The heat creates steam, which is collected in a separate portion of the tank, where it eventually condenses into liquid water again, without impurities. The water is then placed into a storage container until it is needed.

C. Reverse Osmosis: It is a purification process that requires special equipment. The system consists of a two-part tank that is separated by a membrane. Untreated water enters the tank on one side and is forced through the membrane. The membrane allows clean water to filter through while holding back contaminants. The treated water enters the second half of the tank and then is collected and stored for consumption.

D. Ultraviolet Light: In this method, water is placed in a clear container and then subjected to ultraviolet light, which destroys harmful organisms in the water. One of the drawbacks to this method is the power required to generate UV light. If insufficient UV light is applied to the water, it may not kill the organisms. The process depends on numerous factors, including the amount of water being purified, the initial condition of the water, and the size and intensity of the light.

4. OVER VIEW OF WATER TREATMENT PLANT

The goal of all water treatment process is to remove existing contaminants in the water so that the water becomes fit for its desired end-use. One such use is returning water that has been used back into the natural environment without adverse ecological impact. The water is treated by any of the four methods stated in the water treatment methods. We have implemented the processes using the Reverse Osmosis.

II. BLOCK DAGRAM

Figure 1 shows the block diagram of the project. The Block Diagram mainly consists of the power supply, inputs, outputs, hardware and PLC.

A. *Power Supply:* The required power supply for various circuits is provided by the power supply block.
B. *Inputs:* The inputs used in the system are Level sensors used to check tank levels, Flow sensor to check the flow of water, Low Pressure and High Pressure Switch to check the pressure.
C. *Outputs:* The output devices are motors, pumps, alarm and a LCD display.
D. *Programmable Logic Controller:* PLC is used to control the sequence of operation.

III. BLOCK DIAGRAM DESCRIPTION

The Figure 1 shows the Block Diagram of the system. The Start and Stop buttons are used to switch ON and OFF the system. The Level Sensor 1 will check the water level in Raw Water tank. If the level is low in it then it will display an error LPS fault and Low Pressure else the Raw Water Pump will be activated.

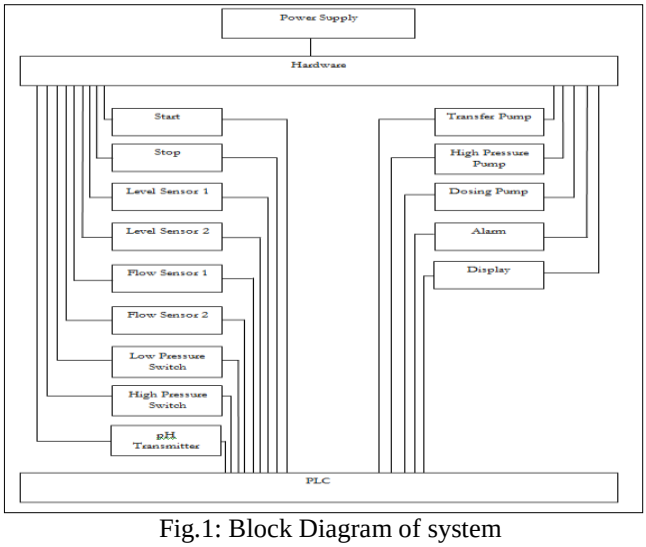

Fig.1: Block Diagram of system

The Low Pressure Switch also helps in keeping a check on the pressure of water to the High Pressure Pump. If the pressure is low then the High Pressure Pump will dry run and there are chances of it being damaged. The High Pressure Switch keeps a check on the higher end of the pressure of the High Pressure Pump. If the water pressure through the High Pressure Pump pressure is very high it will damage the membranes of the Reverse Osmosis unit, therefore the pressure should be within limits.

The Flow Sensors 1 and 2 are used to monitor the flow of product and reject. The product is the treated water and reject is the waste water. The Level Sensor 2 gives us the level of the water in Treated Water Tank. If the tank is full, the plant will be stopped and will show a message TWT Full on the display. This also avoids the wastage of treated water. The Dosing Pump will not be switched on until and unless the High Pressure Pump is switched ON. The Alarm goes on whenever the system accounts an error. The pH transmitter continuously displays the pH of the product.

IV. ANALYSIS TABLE

The analysis of the water sample at the inlet and outlet of the system is done and the results have been tabulated below. The standard values are stated by the *Bureau of Indian Standards* for drinking water.

1. Sample A:

Sr.No	Parameter	Unit	Result		IS 10500:2012 Stds
			WTP Inlet	WTP Outlet	
1	pH	-	7.79	7.12	6.5 to 8.5
2	Total Dissolved Solids	mg/ lit	400.00	52.00	500.00

Table 1: Analysis of Sample A

2. Sample B:

Sr.No	Parameter	Unit	Result		IS 10500:2012 Stds
			WTP Inlet	WTP Outlet	
1	pH	-	7.84	7.48	6.5 to 8.5
2	Total Dissolved Solids	mg/ lit	450.00	64.00	500.00

Table 2: Analysis of Sample B

Fig.2: Final Implementation of system

V. PROGRAMMABLE LOGIC CONTROLLER

Programmable Logic Controller (PLCs) has initiated the success of automation in industrial systems. Due to their

flexible programming frequent changes in automation system are feasible. PLCs are rugged and inexpensive, and offer many options for interfacing with process equipment. This flexibility allows the PLC to control all the processes within the plant, as well as to provide data to external systems via analog signals or serial strings. A PLC interacts with the external world through its inputs and outputs. Basics of a PLC function are continual scanning of a program. The scanning process involves three basic steps:

Step 1: Testing input status

In the first step the PLC checks each of its input to check the status if on or off. This means it simply checks if a switch or a sensor etc., is activated or not. The information that the processor thus obtains through this step is stored in memory in order to be used in the following steps.

Step 2: Programming execution

The PLC here executes a program instruction by instruction. Based on the program and the status of the input obtained in the preceding step, appropriate action is taken. The action might be activation of certain outputs and the results can be put off and stored in memory to be retrieved later in the following step.

Step 3: Checking and Correction of output status

Lastly, the PLC check the output signals and makes the adjustments needed. Changes are performed based on the input status that had been read during the first step and based on the result of the program execution in step two. Following execution of step three PLC returns a beginning of the cycle and continually repeats these steps. Scanning time = Time for performing step 1+ Time for performing step 2+ Time for performing step3.

Advantages offered by PLCs:

- Cost effective for controlling complex systems.
- Flexible and can be reapplied to control other systems quickly and easily.
- Computational abilities allow more sophisticated control.
- Troubleshooting aids make programming easier and re- duce downtime.
- Reliable components make these likely to operate for years before failure.

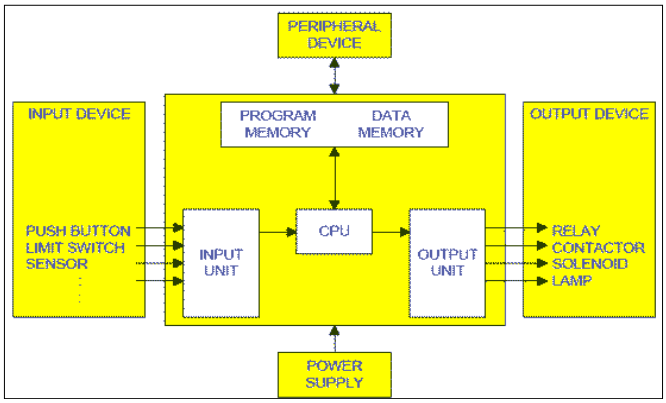

Fig.3: Basic Diagram of PLC

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VII. CONCLUSION

From the analysis done, it was found that water impurities are discarded through the filters and reverse osmosis system and it is supported by the analysis result. Using PLC we have automated the water treatment processes and overcome the limitations of manual processing. The biggest advantage of using this system is the efficiency is 98%-99%, thus saving the precious resource, Water.

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