AUTOMATED HOUSEHOLD SEWAGE WATER TREATMENT – A SOLUTION FOR WATER SCARCITY

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Abstract : - This paper presents an automation technique for sewage water treatment using advanced controller like Allen Bradley PLC(programmable logic control) and SCADA(supervisory control and data acquisition). Some of the current techniques used for sewage water treatment are Sewage treatment plant(STP),Effluent treatment plant(ETP) and Common effluent treatment plant(CETP). The STP technique will reduce water pollution and encourage water reuse. The Sewage Treatment Plant developed by Envicare Technologies Pvt Ltd is one good example. This is a containerized STP installed at mainly hotels and restaurants but it requires more space for installation and is semi automated. The technique discussed in this paper includes processes like filtration, chlorination and oxygenation leading to low cost and easy implementation. The process can handle the water capacity of 100 liters. The purification process takes approximately 16 to 20 minutes. The pH of the impure water can be brought down by 0.5 to 0.8 pH after the completion of the process.

Keywords- PLC, SCADA, Tanks, Solenoid Valve, Level Sensors, AC pump, DC pump

I. INTRODUCTION

Water is one of the most essential natural resources available on our planet. 71% of the Earth is covered with water. Despite having this huge availability there is still scarcity of water. This scarcity is a consequence of impure water which is not suitable for our domestic or industrial purposes. India is one of the most densely populated countries in the world and so its consumption is also high. The basic problems related to water in India are due to unawareness of the water treatment facilities, dense population and absence of capital for the investment purpose. It is equally important to maintain the water treatment system which is not properly done. Currently, maximum of the waste water is getting discharged into the local water bodies without proper treatment thereby polluting water bodies. Therefore it is very important to come up with a solution in order to recycle and reuse water for various purposes.

Various conventional methods includes Automatic Demineralization, Reverse Osmosis-Electro-deionisation and water treatment using carbon. In Automatic Demineralization the system comprises of automated twin bed deionisers incorporating superior counter flow ion exchange technology. These methods are adopted at places where high purity is required with resistivity greater than 0.2 μ S-cm. The RO/EDI system is a compact skid mounted unit which comprises pre-treatment including softener/activated Carbon, reverse Osmosis, electro-deionisation, and post treatment
including ultra filtration. Water treatment using carbon works in cycles. The treatment cycle consists of fill-aeration, settling and decantation which is completed in the same tank in 4 hours.

II. Literature Survey

White paper[1]discussed about different types of water treatment techniques available in the market, their principals and their expenditures. It also discussed about various automated systems available in the market.

Y.V Satyanarayana[2], discussed about the previous manually water treatment system which had lots of disadvantages and the benefits of automation systems. They also discussed about reduce in the probability of error which used to happen in manual systems including the quality of water. Manual system includes various processes that need accuracy which is not completely expected from humans. Therefore Automation is the standard approach to go about this process. Benefits of automatic system are Enhanced item quality, Increase in Reliability, Eco-friendly operation, Increase in profitability etc.

Zhao L.J et al[3] proposed an integrated automation system consisting of Process Manage System (PMS) and Process Control System (PCS) to overcome the problem of high production costs in wastewater treatment plant in China due to low automation level. The proposed system was successfully applied to the wastewater treatment plant in the southern suburb of Shenyang and acheived great benefits for both economy and society.

From above papers we have conclude about the importance of water reusability and various water treatment techniques used, manually used systems in the market, automated systems their advantages and disadvantages. The existing system that is used for the automation is Building Automation System (BMS). A Building Management System (BMS) or a (more recent

terminology) Building Automation System (BAS) is a computer-based control system installed in buildings to control and monitor the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems, waste water treatment system and water overflow alarm system. Building Management Systems are most commonly implemented in large projects with extensive mechanical, HVAC, electrical, and plumbing systems.
The disadvantages of microcontroller are programming language like C, C++. For all this the programmer should have deep knowledge of languages but on the other side PLC is very easy to use along with more advantages over microcontroller. Along with his Microcontroller also cannot work as a standalone controller. Thus comparing both of them, it is observed that PLC is more advantaneous than microcontroller except one fact that PLCs are costly. But on a long run, it works efficiently and its reliability is high. This is one of the factor due to which the cost can be neglected. The paper focuses on automation using PLC & SCADA for the design and develop household sewage water treatment plant.

III. SYSTEM IMPLEMENTATION

The block diagram of portable household sewage water treatment plant using plc & scada is presented below

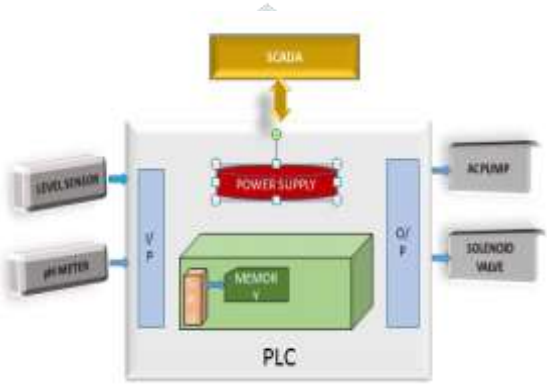

Fig:1 BLOCK DIAGRAM

The brief discription of the system blocks is given below
PLC : It performs logical and arithmetic operations. PLC automates the processes and controls the flow of the system. Allen Bradley PLC is easier to program.It has 20 digital inputs and 12 digital outputs. It also has 4 analog inputs and 2 analog outputs.

SCADA: It is basically a software application that monitors and controls the Programmable logic controller or discrete PID controllers interfaced with the system or machinery. The software used for SCADA is FactoryTalk. It provides the benefit of monitoring the process and controlling it from remote location. The animated view enables the operator to visualize and monitor the process.

Level switch: A level switch is a device for sensing the level of substances that flow in a system which directs the process to the next step. This switch is significant to avoid any case of overflow or to avoid any damage to the components. J R electrokits is a digital level sensor working effectively in the range of 0-60°C.

pH meter: A pH meter is device used to determine the nature of fluid. It tells the nature as to if the fluid is acidic or basic. It is essential to know whether the outlet water is fit for using for the household purposes. Phep pH meter is an inexpensive pocket device having accuracy of 0.1 pH.

AC pump: The AC pumps are designed to provide water to stand pipes and sprinklers in commercial and industrial facilities. Using Smart submersible AC pump provides the advantage of less noise and less vibration. It lifts water up to 5 ft which is exactly what is required in this system.

Solenod valve: It is an electromechanical device used to control the flow of the fluid and decides the path of the fluid on the basis of the program. Parker Hannifin's solenoid valve is acting like an outlet valve deciding the outgoing path of water at the end of the process. This solenoid valve is made up of plastic polymer material which does not easily gets corroded.

SMPS: An SMPS is an electronic power supply that consists of a switching regulator to convert electrical power. An SMPS can transfer power from a DC or AC source

IV.FLOW PROCESS

The flow process mainly consist of three stages for the treatment of sewage water which are Filtration, Chlorination and Oxygenation. These three processes will be automated by using PLC and controlled using SCADA.

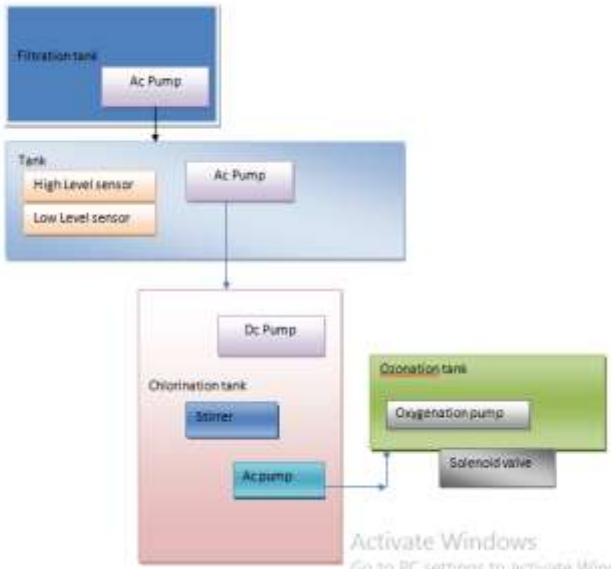

Fig:2 FLOW DIAGRAM

The process starts with the filtration process in tank 1. This separates the heavy particles from going into the other tanks, and the process of water lifting starts from tank 1 to tank 2.

There are two level sensors which are high level and low level sensor connected in tank 2. The moment water touches the low level sensor, this sensor will act like a switch and the process of water lifting from tank 2 to tank 3 will stop. This is done so that the process starts only after a certain level of water is achieved. Similarly is the level of water reaches the high level sensor, again the level sensor will act like a switch and it will stop the water lifting process from tank 1 to tank 2. This is done in order to avoid the overflow of water.

The tank 3 is connected with a small chlorine bottle which will be controlled according to the specific time limit offered through ladder logic program. The chlorine will get added to filtered water for disinfecting .it is necessary as this water can be used for gardening and infected water can damage the plants. There is a stirrer attached in tank 3 which will be switched on according to the timer set in the program.

After the mixing is done this water is transferred to tank 4 where the process of ozonation takes place. The oxygen pump is going to be continuously on and a timer is going to be set in the program. After ozonation pH of the water can be checked and can be reused it for various household purpose.

V. LADDER DIAGRAM

The design for implementation of the sewage water for various processes is given below

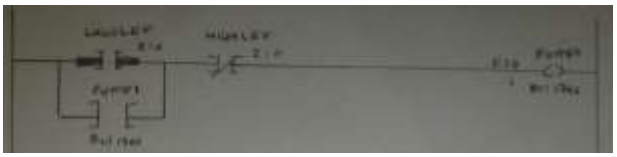

Fig:3 PUMP WORKING

This logic is drawn to lift the water from Input Tank via Pump1. Means here pump1 is being operated and pump1 stop its working as soon as high level sensor is sensed so as to prevent dry running of the pump.

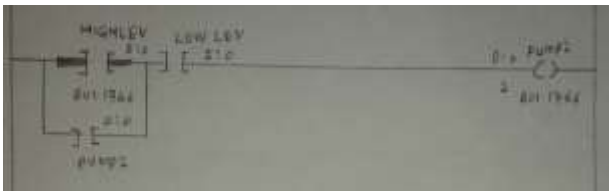

Fig:4 PUMP 2 AND LEVEL SENSOR

Here logic is drawn to operate pump2. That is to lift water from tank2 to chlorination tank. As soon as the high level sensor is sensed the pump2 starts operating.

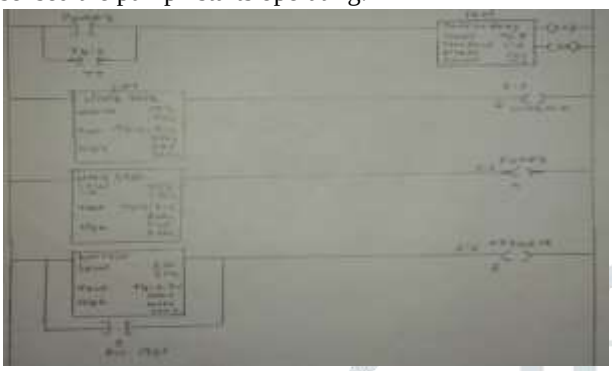

Fig:5 CHLORINATION AND MIXING

The Pump 2 will be in working state as per the timer set in the logic diagram. And according to this values of "Accumulator" of timing delay circuit pump2 stops. And also the timing delay is assigned to the Mixer part{ highest 230sec} of the setup and to the Oxygenation part { highest 345sec } and also for lifting of water from tank 3 to final tank via pump3{ 400sec}. Lim test here in the circuits indicates that the specified device will work from lower limit to the higher limit.

Fig:6 OXYGENATION

This logic gives its own timing delay of oxygen part of the setup. And the water is left out via outlet of solenoid valve.

VII.TESTING OF THE SYSTEM

The implemented system along with wiring diagram is shown in the figures below.
The system was tested for capacity, pH and time taken for purification. It can hold for upto 100 liters of water and takes approximately 20 minutes.

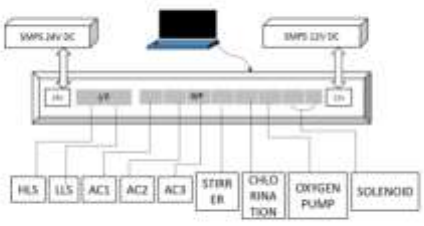

Fig:7 WIRING DIAGRAM

Fig:8 HAWARE CONNECTIONS

Fig:9 HARDWARE IMPLEMENTATION

VIII. Conclusion

The paper has presented the developed prototype of Waste water recycling technology which includes the process of chlorination followed by Ozonation in two different tanks for purification. This system will be dealing with the treatment of waste water and the resulted grey water will be useful for various household purposes like cleaning toilets, mopping, car washing and gardening based on its pH. The process can handle the capacity This system is cost effective as the products of similar type available to market are comparatively expensive as it is PLC and SCADA based which added more features like supervision and it can be used anytime anywhere.

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