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AUTOMATION IN WATER BOARD USING PLC WITH SCADA

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***Abstract*-The Rapid growth in wide urban residential areas, therefore it is a need to provide better water supply. To fulfill the customer's requirement as well as to avoid faulty conditions there must be a better water supply management. Problem arises in the water supply management system due to pressure drop creation in channel or pump used to suck the water directly from the channel of their home street. This project presents a proto type for water distribution system comprising a control system, communication means, piping, actuators, sensors and valves. This system utilizes a communication bus for controlling and monitoring water flow through the piping via control of the actuator and valves. Control System is further coupled to Supervisory Control and Data Acquisition (SCADA) unit. This project focuses particularly to a control system for controlling and monitoring components within a water distribution system.**

***KEY WORDS*- Automation, Control, Sensors, Actuators, PLC, SCADA**

1. INTRODUCTION

Water is said to be another basic need for all living beings. Water which is in need must be with appreciable quality and quantity. In residential areas water has to be supplied properly at appropriate time without wasting it and with quality. Entities which examine the efficiency of water supplying networks are Continuous supply, water, maintaining water quality, Controlling technological parameters, Availability and storage capacity of water tanks [1]. Water distribution systems are an integral part of all the communities around the world. Maintenance of biologically safe drinking water is one of the goals of the system. Wireless sensor networks are mainly used for this purpose. The main challenges faced in the sensor networks will be quality faults, and hydraulic faults. Hydraulic faults are related with pipe breaks, leakages or pump/valve malfunctions; they can be abrupt or incipient. Quality faults can occur due to natural contamination (e.g., bacteria growth) or due to equipment failure in the disinfection system; they pose a significant threat to the water supply system, as they may affect the health of the consumers.

Here I have explored an idea as solution for the issues such as improper water supply, water quality and over consumption by people. Solution focuses with automated supply of water, over consumption alert and usage of various sensors to monitor water flow and to check water quality. The system comprises of water distribution unit which is an integrated component of main unit for distribution and home units for consuming. Automated water supply can be done by embedding the details into programmable logical controller (PLC). Such as time and place to which water have to be supplied. Sensors are employed in this idea because they are capable of experiencing even small changes and act accordingly since they are task specific. Network which Water quality can be assured by utilizing pH sens1or which consists of measuring electrode and reference electrode. Water is said to be with perfect quality if its pH value is 7. In the proposed idea, water supply is stopped if water is not with desired quality.

The quality of the water can be measured by using pH sensors, salt level sensor, uv sensor and flow sensor in the pumping a system. The sensors used for quality fault detections are not always reliable. There are chances of these sensors failing. Checking integrity of the sensors involved is one of the important issues. Not many papers have been focused on checking their integrity. A novel scheme for fault-tolerant control [3] is proposed in this paper. As the name indicates, it is not a full control system, but rather focuses on the supervisory level. As such, it is a purely software package that is positioned on top of hardware to which it is interfaced, in general via PLC.

2. PROBLEM STATEMENT

As residential area grows, all the needs of people have to be satisfied for an issueless life especially in case of water. Water Distribution Networks are said to be the most interesting domain for research activities. It focuses on distributing water to all channels (connections) in a particular area. Various actions performed with this activity are, checking whether all channels gets water supply, evaluating the amount of water flow in appropriate channels, intimation on over consumption by the users, ensuring that the supplied water is with good quality[2]. Every area is provided with a centralized water distribution unit which distributes water to all home units in that particular area. This unit contains overall amount of water needed to provide proper supply to all home units. To assure perfect supply, connections to all home units have to be made very clearly [4]. Automated supply ensures that supplied water is not wasted. The water supply systems are part of the urban infrastructure which must assure the continuity of the water distribution and the water quality control [5]. In earlier developed systems, urban water is supplied to the home with the help of some man power. Allocated person will go to that distribution unit and will initiate the system to supply water to all home units [6]. This type of operation needs man power. Time consumption is very high in this method. Also if operator does not do the proposed task perfectly then the output of the task will not be good. Because of this supply people will use enormous water if it is supplied beyond time limit which leads to scarcity of water. Over consumption of water is termed as water theft [2]. When water is supplied there will be huge usage and when there is no supply normal life will be spoiled due to absence of required water quantity. Water is the basic needs of the humans. It has to be provided at correct time to fulfill the daily activities [5]. The theft can be avoided only when people are aware of water usage and when they report about water theft. It will be done only when water usage is reduced by the people so that there will be less demand for water.

2.1 WHY USE PLCS? 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.
- Trouble shooting aids make programming easier and reduce downtime.
- Reliable components make these likely to operate for years before failure.

3. INTENTION OF DEVELOPED IDEA

In this work the disadvantages of existing system are overcome by certain techniques. To avoid the wastage of water during supply to water distribution unit related areas, automated supply has been formulated. It involves the process of supplying water to a particular area at particular time. Water supply will be stopped automatically after reaching fixed value limit. Over consumption can be intimated by measuring the flow of water to every connection in water supplying network. This measurement can be done by using flow sensor at every channel (connection)[7]. On the basis of this measured value,

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usage of water by every home unit is calculated. By comparing fixed value and measured value overconsumption can be easily formulated [8]. Automated supply also focuses proper supply of water to all connections. Water quality can be assured by employing pH sensor. If the supplied water is with desired quality then many issues will be avoided. Automated supply avoids the wastage of water and the quality of supplied water can be assured by utilizing pH sensor. Flow measurement on each channel enhances the method to intimate over consumption alert.

3.1 OPERATION PHILOSOPHY

In order to make system more efficient the concept of automation is included in system. Storage tank contain field instruments connected to device being controlled and monitored. They convert physical parameters to electrical signals .These field instruments are connected to PLC. PLC controls field devices and provide data to control room. Control room contains SCADA server which stores data from PLC and regulate the control system. Connection between the PLC and SCADA server is established using direct technique. For switching on/off a man should always be present in the office. But in the system what we are going to undertake needs no manpower, PLC acts as a man here for supplying water to the streets.

Here, the quality parameter of water is focused that is pH value which stands for "potential of Hydrogen". Exposure to extreme pH values results in irritation to the eyes, skin and mucous membrane. The pH of the water entering into the distribution system must be controlled to minimize the corrosion of water mains and pipes in household water systems. Failure to do so can result in the contamination of drinking water and its adverse effect on its taste.

SCADA systems are widely used in most industrial processes. It provides information on real time basis, which helps to identify the problem as they occur and take corrective action when needed. Proper monitoring of process can maintain operations at an optimal level by identifying and correcting problems before they turn into significant system failure. This particular SCADA system consists of a primary control center and three field sites. A second backup control center provides redundancy in the event of a primary control center malfunction. Point to point connections is used for all control centers to field site communications, with two connections using radio telemetry. The third field site is local center site above the primary control center and uses the Wide Area Network (WAN) for communication. A regional control center site above primary control center for a higher level supervisory control.

The advanced system is three layer of architecture which not only monitors and control water distribution but also finds out water theft and takes preventive and corrective action to obtain proper distribution of water. This system mainly consists of PLC. This is the central and important part of the system. All the logic functions are carried through PLC, by developing a ladder logic program. Sensors and Actuators included in the water distribution network are interfaced to PLCs input and output module. The logic can be easily stored on a disk so that it can be loaded into a PLC.Program logic can be changed according to the requirement of system.

PLC is again interfaced to SCADA unit so as to monitor and control the water distribution network. SCADA system is designed in order to realize the automatic controlling of valve and parameter transformation such as pipeline pressure and water quality. Actual process takes place within water supply and distribution network. Water supply systems consist of one storage tank consisting level sensor, pH sensor. Distribution network consist of pipeline for water flow and pressure switch in order to open and close the valve and the equalized volume of the tank. All of these can be changed during run time. The one input that will be needed from the DAQ is the set ppm that should be able to change and affect the amount of chlorine added to the tank. The equations that are used to track the ppm in the tank and PSI and GPM in the pipe [8]. The variables that will need to be specified at startup should be the tanks max volume, the Solution's ppm, the elevation height of the reservoir, the pipe diameter from there reservoir, the flow percentage open.

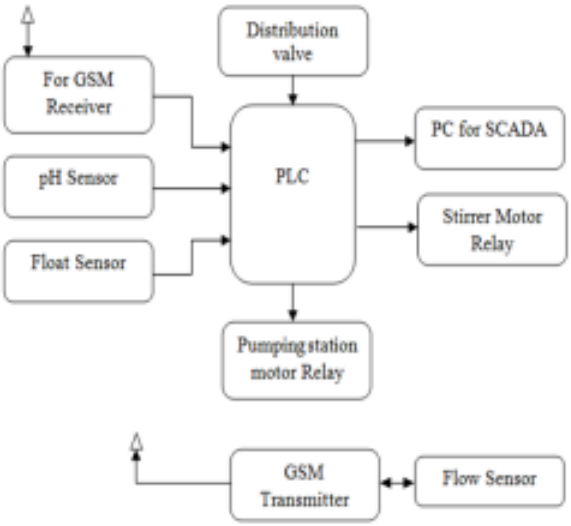

Figure 2 Block Diagram of Proposed System

4. AUTOMATION SYSTEM

Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat treating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications with minimal or reduced human intervention. Some processes have been completely automated. The biggest benefit of automation is that it saves labor. It is also used to save energy and materials and to improve quality, accuracy and precision.

4.1 Water treatment section:

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The specific layout of the water treatment system that is being modeled consists of a reservoir, a tank, a flow valve, and the pipe. Figure 3 is shows the process for water purification, because the water supply system uses ground water and raw water.

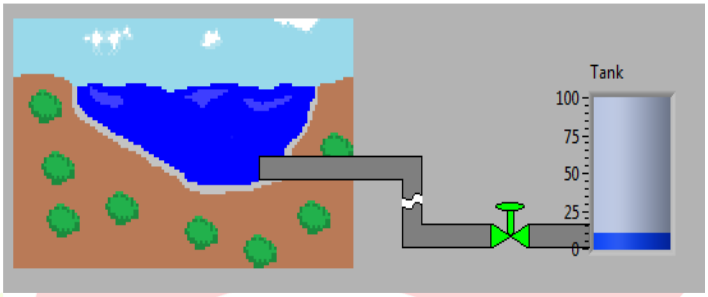

Figure 3 water treatment sections

The reservoir will have the assumption that it won't ever run out and that it is gravity fed. The elevation of the reservoir in relation to the tank will help to determine the GPM that will be flowing into the tank. It will also help in showing a very rough estimate of PSI out of the reservoir. The GPM calculated will help add chlorine to the tank. This same GPM will be assumed as the out flow. Since the in and out flow will be known, this will make it easier to find the actual ratio of chlorine in the tank. Chlorine is done. Third section is the distribution section through which water is distributed in all the areas.

4.2 Pumping and distribution section:

These technology equipment installed in the pumping stations are controlled by PLC based equipment which acquires all the hydraulic parameters (pressure, flow, reservoirs water level, free and residual chlorine, pH) and the electrical parameters for all the electric drives. The pumping function module is connected in the PLC includes a schedule optimization tool based on the following criteria: the hourly electrical energy tariffs, the water demand dynamic and inflows constraints, maintenance planning related to the market demand.

In the system have three different sensors for corresponding application. It used for tank level detection. One is at bottom of tank, second will be positioned at middle position of tank and third will be kept at the top of tank. If water level detector detects a level at low or mid level thus PLC will turn on pump station motor. We consider water supply department has two motors in pump station, one of these motor is for regular use and another motor is for emergency purpose which is shown in Figure 4. In this section did two processes like a pumping the ground water or raw water and purified the input water.

- Pumping and filtering processes have six inputs in input module, like start push button, stop push button chlorine tank lower level sensor and higher level sensor.
- Allen Bradley PLC controls the process and Wonder ware in touch software SCADA tool is used for monitoring the process.
- Pumping and filtering process outputs are chlorine outlet valve and first tank solenoid valve

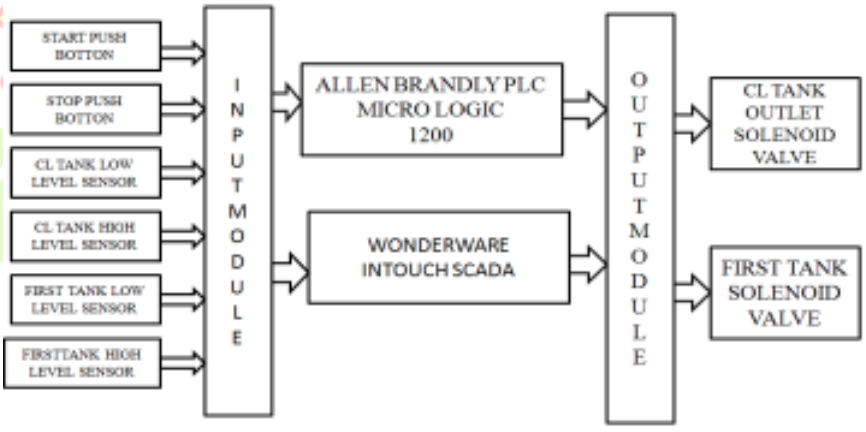

Figure 4 Block diagram for pumping section

In traditional drinking water supply system is facing many problems related to filtration, pumping of water, distribution of water and testing of water. Water supply department comprises three different sections for water supply. First is the pumping station, which does the sucking of water from water source. The second section is
a filtration department in which measurement of pH. By using proposed system both the motors will be included in the system and controlled as per need using PLC. Current status of the entire sensor will be displayed on Personal Computer. Figure 5 shows the SCADA software will used to developed program for graphical user interface.

The optimization module facilitates the move to the preventive or predictive exploitation of the water resources and storage capacities based on intelligent

control algorithms for specific purposes. They represent the support for electrical energy cost optimization by real time monitoring the pumping schedule and, maintenance planning based on the functional wear and the on/off electric drive transient load reducing loading constraints. To avoid the flow of water during pumping to water distribution unit related areas. Here using flow sensors, level sensors. The automation system control automatically. So water level monitored level indicator. In this indicator send the water level value to PLC also monitored by SCADA system.

Distribution section is a need to provide better water supply. To fulfill the customer's requirement as well as to avoid faulty conditions there must be a better water supply management. Problem arises in the water supply management system due to pressure drop creation in channel or pump used to suck the water directly from the channel of their home street. This project presents a prototype for water distribution system comprising a control system, communication means, piping, actuators, sensors and valves. This system utilizes a communication bus for controlling and monitoring water flow through the piping via control of the actuator and valves. The distribution control system is further coupled to supervisory control and data acquisition unit. Figure 6 shows particularly to a control system for controlling and monitoring components within a water distribution system. This system includes man machine and electrical interfaces to PLC for transmitting/receiving control and status data over communication bus.

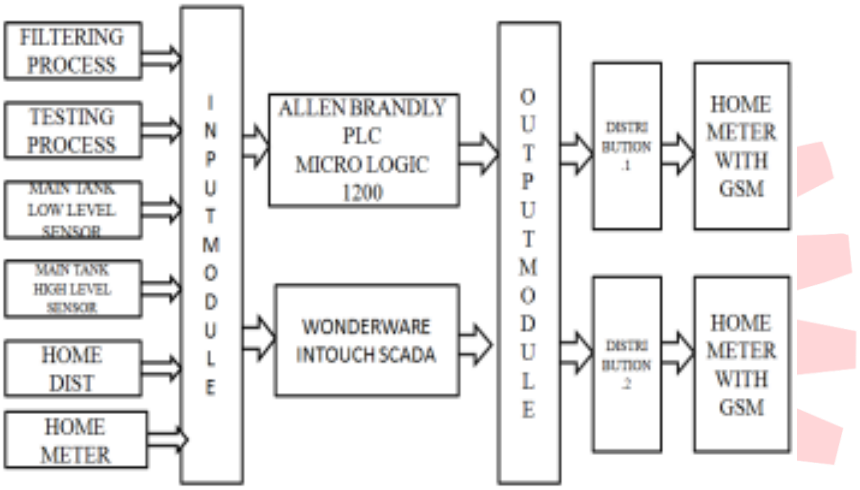

Figure 6 Block diagram for distribution section

4.3 SCADA communication process

The data acquired from the remote site panels RTU pole mounted to avoid vandalism. Figure7 shows the pumping stations program and the water reservoirs are transmitted to the dispatching units of computer installed in the water distribution plant company's headquarter among any one of plant. To avoid the wastage of water during supply to water distribution unit related areas, automated supply has been formulated.

The computer software system integrates an SCADA application program specifically developed for water distribution management. The dispatching unit SCADA system elaborates daily, monthly, yearly diagrams, tables and reports related to the operator requested parameters. The system stores the acquired data in a specific database for later use analysis and retrieving.

5. SIMULATION STEPS:

1.Initial Position
2. Salt Level Test
3. UV test
4. pH test
5. Distribution
6. Message to users

5.1 Initial Position :

Initial position first tank lower level is ON. The water raw water motor pump will ON. The water first going to the water tretment plant. Its get on some of testes such as salt level test, UV test, pH level test, chlorine level test, then its will going to the distribution section this section is having an distribution tank. Figure 8 shows the system equpiment intial poision .The distribution higher level sensor ON means the distribution valve will be opeaned. The water may be used in home, industries, schools colleges… etc. It can be measued by water meter. The water bill payment sent throgh mobile phone using GSM.

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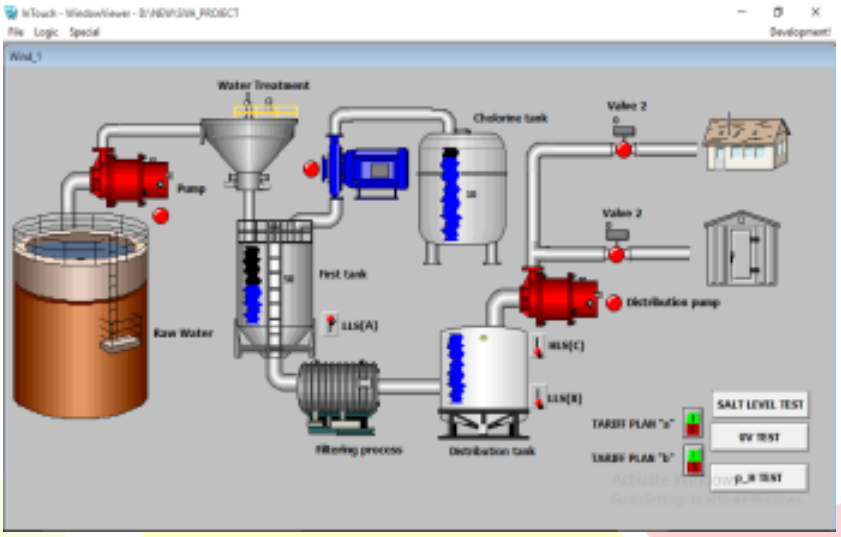

Figure 8 Initial position simulation diagram

5.2 Salt Level Test:

Red color in first tank is indicating the salt testing. Salt water is desalinated to produce fresh water suitable for human consumption or irrigation. One potential by-product of desalination is salt. Desalination is used on many sea going ships and submarines. It shows in Figure 9 salt level simulation diagram. Most of the modern interest in desalination is focused on developing cost-effective ways of providing fresh water for human use. Along with recycled wastewater, this is one of the few rainfall-independent water sources. Due to relatively high energy consumption, the costs of desalinating sea water are generally higher than the alternatives (fresh water from rivers or groundwater, water recycling and water conservation), but alternatives are not always available and rapid overdraw and depletion of reserves is a critical problem worldwide.

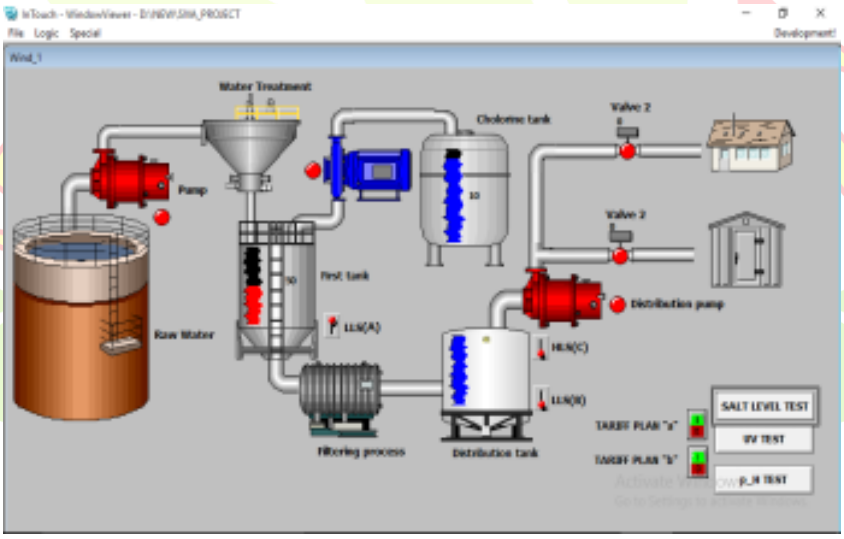

Figure 9 Salt Level Test simulation diagram

5.4 UV test:

First tank in green color is indicating the UV testing. Ultraviolet germicidal irradiation used to be thought that UV disinfection was more effective for bacteria and viruses, which have more-exposed genetic material, than for larger pathogens that have outer coatings or that form cyst states that shield their DNA from UV light. However, it was recently discovered that ultraviolet radiation can be somewhat effective for treating the microorganism Cryptosporidium. UV test result shows in Figure 10 simulation diagram.

The findings resulted in the use of UV radiation as a viable method to treatment drinking water. Giardia in turn has been shown to be very susceptible to UV-C when the tests were based on infectivity rather than excitation. It has been found that protests are able to survive high UV-C doses but are sterilized at low doses.

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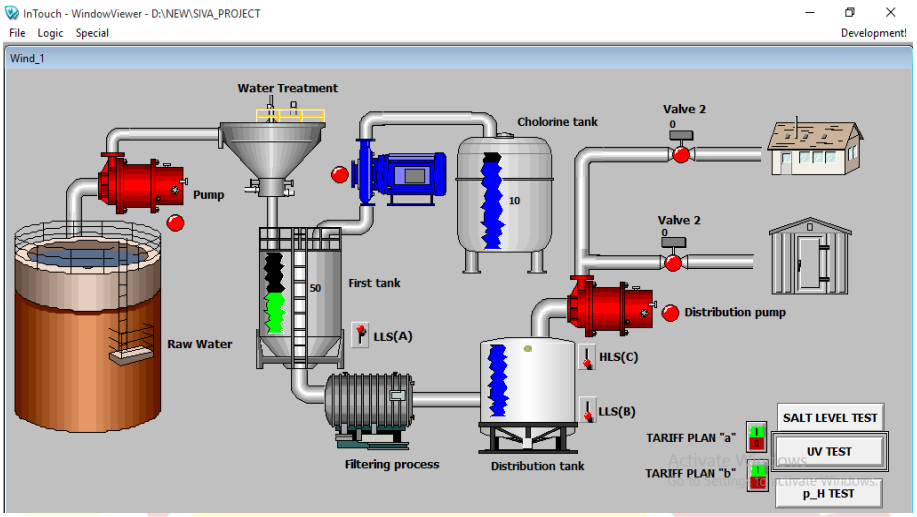

Figure 10 UV test simulation diagram

5.3 pH test:

pH measurement reveals the hydrogen ion concentration in water. It is used to determine both the deposition and corrosion tendency of water. The most widely used type of pH measurement is the electrode meth a glass pH electrode, a reference cell, a temperature compensation element, a preamplifier and a sensor body.

Because of the difficulty of maintaining good pH control, manual systems are being replaced by continuous monitoring and automatic control of pH in many water treatment applications. In cooling tower systems, pH has been particularly difficult to control manually because the response curve of pH to acid addition is not linear. Results of random plant tests were plotted to show the number of occurrences of each test value. First tank in violet color is shows in Figure 11 simulation screen, it is get another color means the process going to stop. And getting reprocessed.

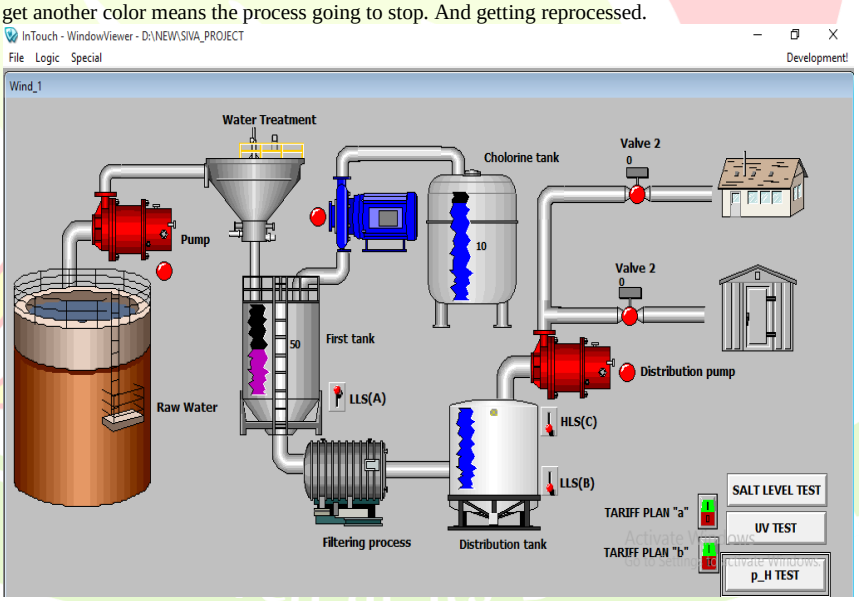

Figure 11 pH test simulation diagram

5.5 Distribution section:

Water storage and distribution system, controlling temperature, pressure and for every stage for measuring and analyzing, we can able to identify the robbery in urban drinking water supply. The distribution tank lower level sensor and higher level sensor ON condition means distribution valves open. Water will be distributed to all the places the same time. If there is any problem under the distribution control, then the valve changes automatically to manual control and the problem can be rectified.

Figure 12 and 13 is shows the distribution valves. The distribution simulation screen having status bulb. When the distribution is turn ON, the bulb glows in green color. Monthly once the water pill messaged to the users, also plc controller using GSM. The users did not pay the water bill means the connection valve automatically closed. Figure 14 shows message to user simulation diagram.

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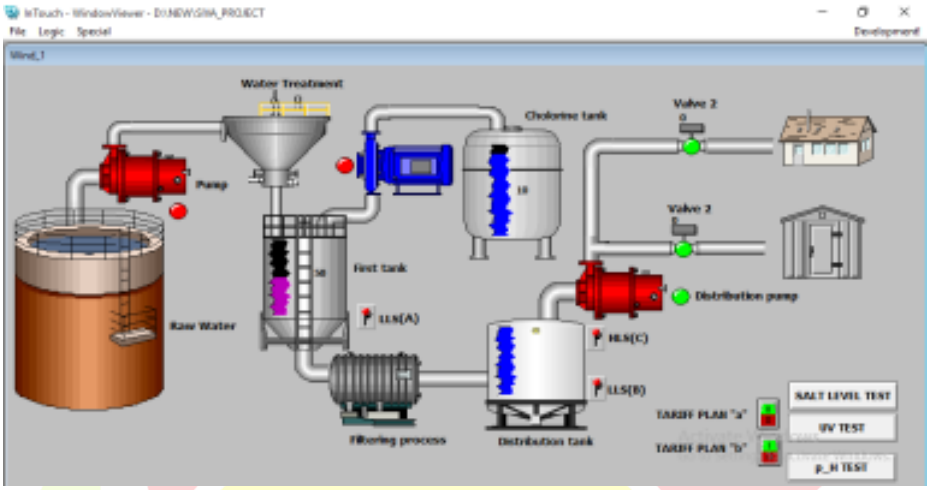

Figure 12 Distribution valve 1 simulation diagram

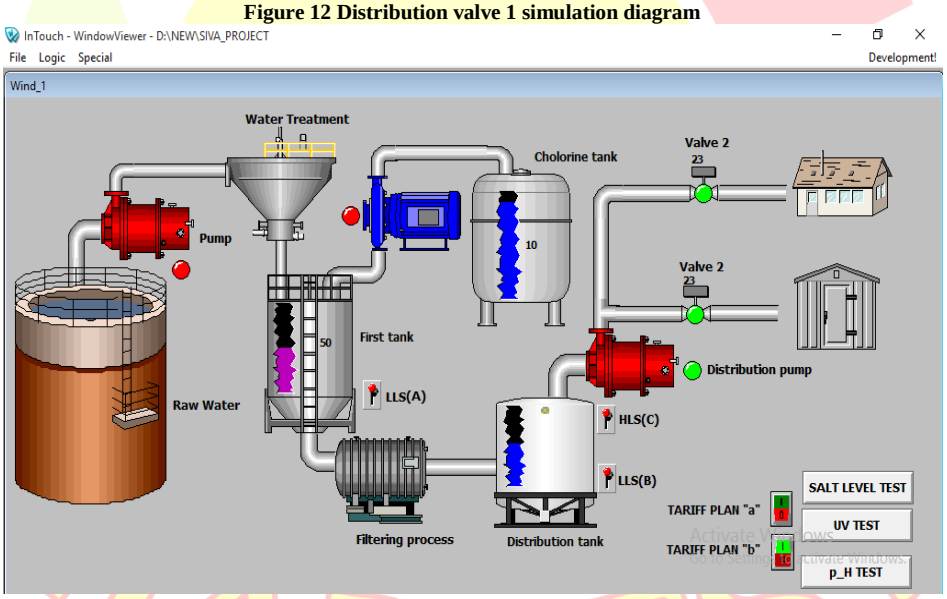

Figure 13 Distribution valve 2 simulation diagram

5.6 Message to users:

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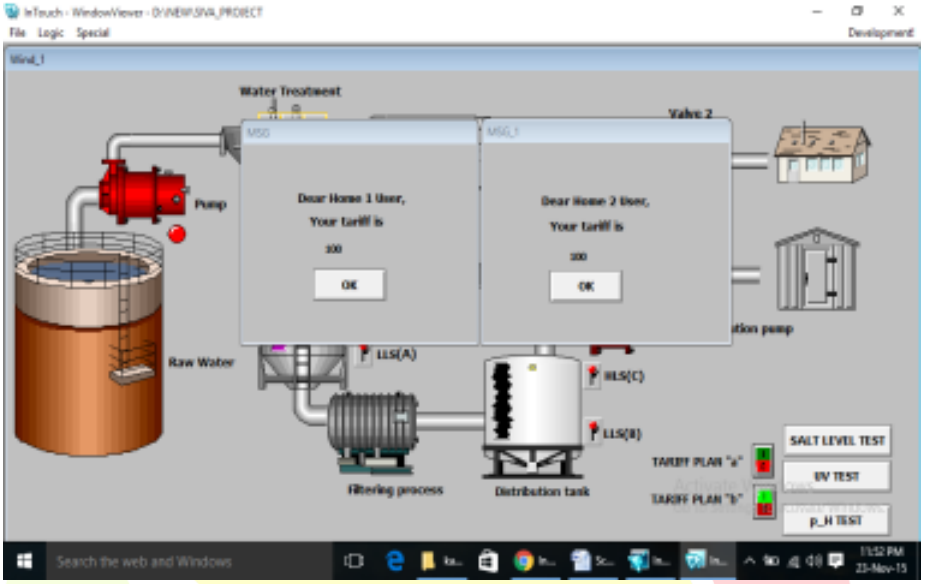

Figure 14 Message to user simulation diagram

6. CONCLUSION

The automation can be implemented in water distribution system ensures to avoid wastage of water and reduces time. Due to SCADA it is possible to monitor and control whole system from head quarters units. Distributed system is intelligences it monitoring all time without man power.

Automation system having following benefits: Uninterrupted water distribution according to water level**,** the real time indications are induced in these SCADA**,** when any components fail in distributed or pump station, they displaying databases can be enlarged throughout of year, month and daily report in Centralized PC. It Measures data functions by the entire monitoring of the network in the central dispatching unit. It shows automatic measurement of chlorine and pH and display in SCADA due to this quality of water Provide to consumer.

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