Automation in Urban Drinking Water Filteration, Supply Control & Water Theft Indication Using PLC & SCADA

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Abstract **- Drinking water supply is one of the prime services to be provided by government in any nation. Our survey shows that in Ahmadabad, Gujarat, India the water reservoir near filtration has capacity to intake raw water and delivers aprox. 50 MLD (Million Liters per Day) of filtered water. And also there is frequent problem of tapping water illegally by making use of suction pumps. Hence an efficient water distribution system is prime necessary to meet every demand for water supply. In this paper an improved method of water distribution system by automization using PLC (programmable Logic Controller) and SCADA (Supervisory Control and Data Acquisition) is explained. And also water theft monitoring is implemented using flow variation sensed by flow switch mounted on the water pipes. The power for the system is generated by making use of thrust of water flow in the channels. The above process is implemented in a prototype panel model and tested.**

Index Terms **- PLC, SCADA, Solenoid valve, Flow sensor.**

I. INTRODUCTION

The present drinking water supply control system is facing many problems related to testing of water, filtration, pumping of water, storage and distribution of water. Conventional water supply department comprises five different sections for water supply. First is the pumping station, which does the sucking of water from water source to aerator.

The second section is water testing laboratory in which turbidity and pH value is measured and find out the content of alum, chlorine and lime to be dosed . Third section is the filtration department contains clariflacculator and sedimentation for clarifying of alum and lime dosage, granular media filter for further filtering of water. Fourth section is storage section which will store the filtered water for distribution. Fifth section is the distribution section through which water is distributed in all the municipal wards. Currently these sections are working independently and manually. The major problems in water supply system are leakage or wastage of water and the majority public is using suction motors to suck water from main supply connection, which results decrease in water pressure and considered as theft.

To overcome above said problems an automated system has been proposed which enhances the water filtration, storage, distribution and reduces wastage of water as well as identify the theft of water. The water supply system is a part of the urban infrastructure which must assure the continuity of the water distribution, water quality control and the monitoring. The use of water diversity increases because of restriction imposed by the water availability, hydrological conditions, storage capability of tank, control and process parameters. The PLC's handle the direct control of the technological process

II. PRODUCTION

Here, the process is divided into three main process,

- Aerator (intake water from water source),
- Water filtration (clariflacculator and sedimentation, granular media filter),
- Pure water storage and pump house.

The raw water from aerator is mixed with alum and chlorine in flash mixture. The oxidized water is passed to clariflacculator for sedimentation of dust particles as sludge and gets pure water for filtration unit for further Purification. The sedimentation process is done for few minute so that fine dust particles get coagulated and thus because of force of gravity, centrifugal acceleration and electromagnetism heavy particles get settled at the bottom which can be guided to sludge pit. The water is filtered over rocksand bed in filtration unit. The filtration (rock sand) bed consists of 5-6 layers formed by jelly stones & sand

particles of varying size. The bottom 3 layers consist of jelly stones of different sizes the top layers are filled with fine sand material. The filtered water from the sand bed is collected in the pipe with pores on the top. The backwash process is done to remove accumulated dust particles in the spaces between jelly stones in rock sand bed due to continuous filtration. When the backwash process is to be done to remove accumulated dust particles on rock sand bed, the output valve from granular filter to storage is closed. Conventional water distribution system comprises mechanical valves to distribute water. Since process is controlled manually, it requires more time and man power, with significant amount of wastage of water. Solenoid controlled valves will be incorporated to avoid wastage of water. Selection of solenoid valve depends upon size of water supply pipe and pressure of the water. The purified water is chlorinated to required amount and stored in storage tank.

III. PROPOSED SYSTEM

In this paper, it is proposed that the usage of atomization in water supply control and anti-theft control system for drinking water supply.

1. The Fig.1 shows the proposed system. The working process is as follows, the raw water from the aerator is mixed with alum and chlorine. The opening and closing of valve from alum tank is done manually in existing system which results in less or more release of alum into raw water channel by manually controlling the % of opening of valve which can be further opened automatically. This overcome by automatic open and close of valve by using PLC.

2. After this process a water is stirred in a stir tank by stirrer so that the alum and chlorine will mixed up properly. Then it is dispatched to sedimentation tank using valve which is automatically operated by PLC.

3. Here in sedimentation tank the water is kept in stilled position for few minutes so that dust particles in the raw water get coagulated and get become heavy so that it is settled at the bottom because of gravitational force. This is then guided to the sludge pit later The filtration process is controlled by PLC

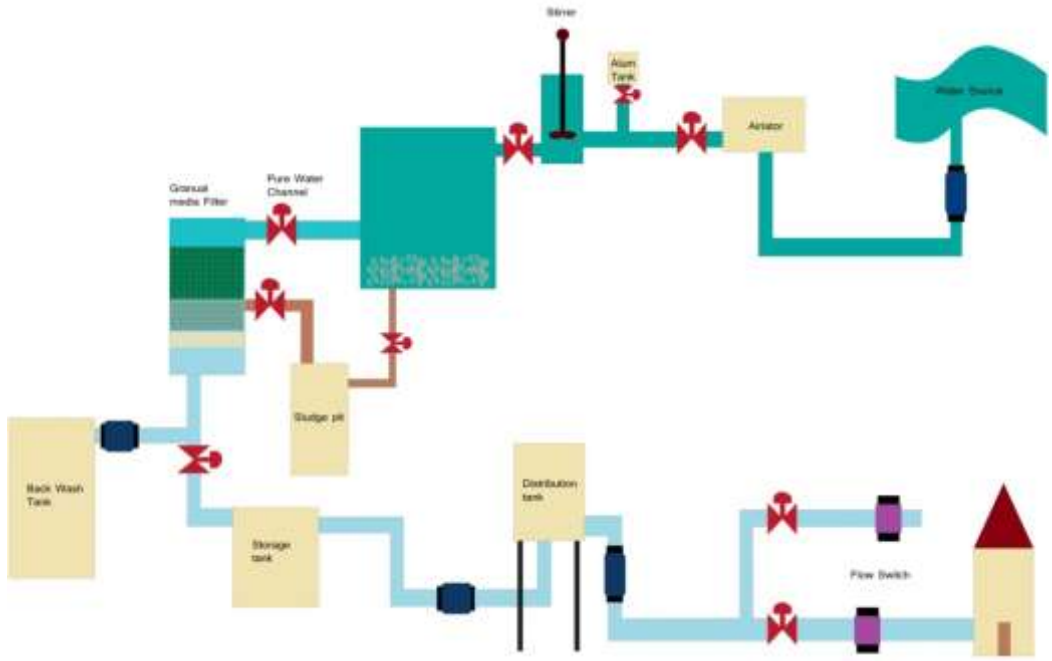

Fig -1 Schematic of Water Purification and water theft system

4. When the backwash process is to be done, the valve between granular filter and storage is closed and the opening of valve to sludge pit is controlled manually when the granule filter is to be clean. The water theft and leakage are identified using flow switch.

5. The PLC gets the signal from the flow switch when there is a difference in flow rate, if the difference exceeds the limiting value it is recorded as leakage or theft , and the valve behind the flow switch is turned off automatically.

6. And thus the message in the panel can be watched by the consecutive officer on duity at control room.

IV. SYSTEM DISCRIPTION

The Fig.2 shows the block diagram of the system. This system mainly consists of PLC (Programmable Logic Controller) which is the central and important part of the system.

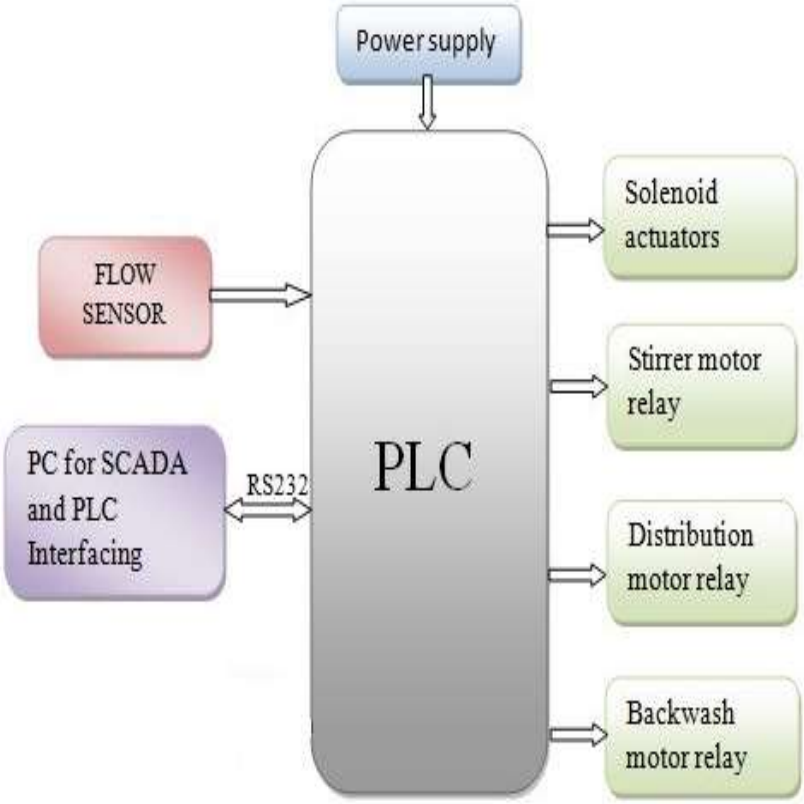

Fig-2 Block diagram of system

All the logic functions are carried through PLC, by developing ladder logic program. Sensors and Actuators included in the water distribution network are interfaced to PLC„s 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 (Supervisory Control and Data Acquisition) 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. Stirrer motor is used for oxidation purpose at filtration tank. These motors are turned on and off using PLC according to purification of water. When the backwash process is to be done to remove accumulated dust particles on rock sand bed, the output valve from granular filter to storage is closed using PLC. The stored water is pumped to distribution tanks from which water is supplied to individual home street lines using distribution motors. The PLC records the rate of water flow from the flow sensors located near distribution area. If there is difference in flow rates, it is recorded as leakage or theft then PLC automatically closes the valves to avoid unnecessary flow of water. The working of entire system can be viewed on SCADA screen and home street pipeline.

V. SOFTWARE DISCRIPTION

A. PLC programming:

PLCs are special computers designed to operate in the industrial environment with wide ranges of ambient temperature and humidity. They have a number of different programming languages which include Ladder logic, Mnemonic instructions, and Sequential Function Charts. Ladder logic is the main programming method used for PLCs. It is a graphical language which has been developed to mimic relay logic. The decision to use the relay logic diagrams was a strategic one. By selecting ladder logic as the main programming method, the amount of retraining needed for engineers and trades people was greatly reduced. A software tool called RS Logix as shown in below Fig.3 runs on a personal computer allows users to sketch the ladder diagram and then transfers its compiled code serially to the PLC. Such a software tool is more convenient and it supports mnemonic and SFC programming languages as well.

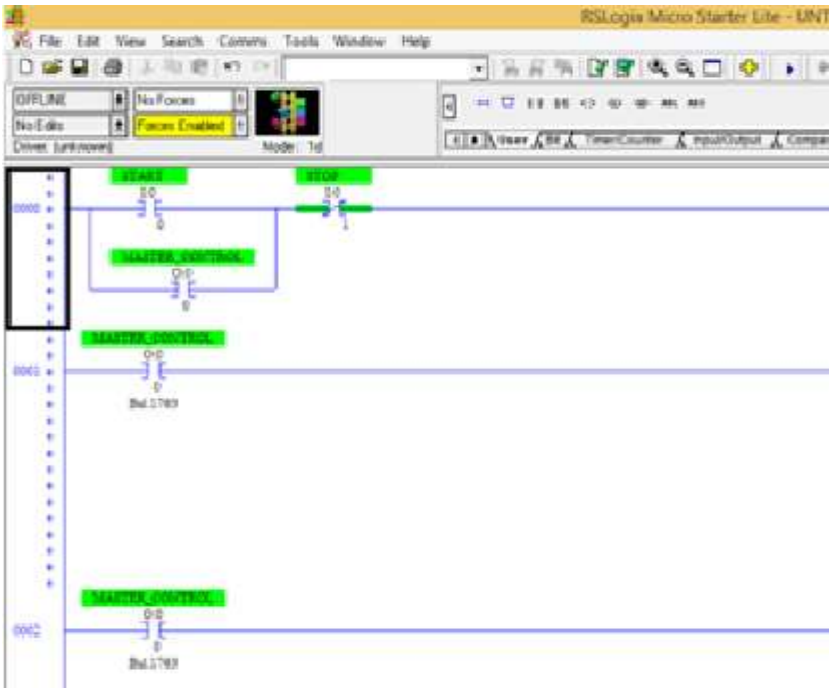

Fig -3:Ladder Logics

B. SCADA Communication:

The SCADA system implemented to the central dispatching unit manages the data communication with all the PLC's and which store the received data from measuring points and the pumping station. It offers advanced analysis functions as well as the remote control of the major technological parameters.

Wonderware SCADA – intouch offers a robust SCADA engine, rich set of connectivity options, open architecture, and highly scalable and distributed networking model. Used in a variety of diverse industries, it is ideally suited for many applications - ranging from typical HMI as simple as manual data entry and validation to very complex SCADA such as batch, filtration and distributed alarm management. Intouch is a proven scalable solution, which can operate on a single node or scale up to 200+ nodes. Although intouch has the to connect to most any device via an OPC server, intouch also comes with many standard built in native drivers addressing the need for connecting the major PLC brands . The fig.4 shows the SCADA Screen of the prototype model below.

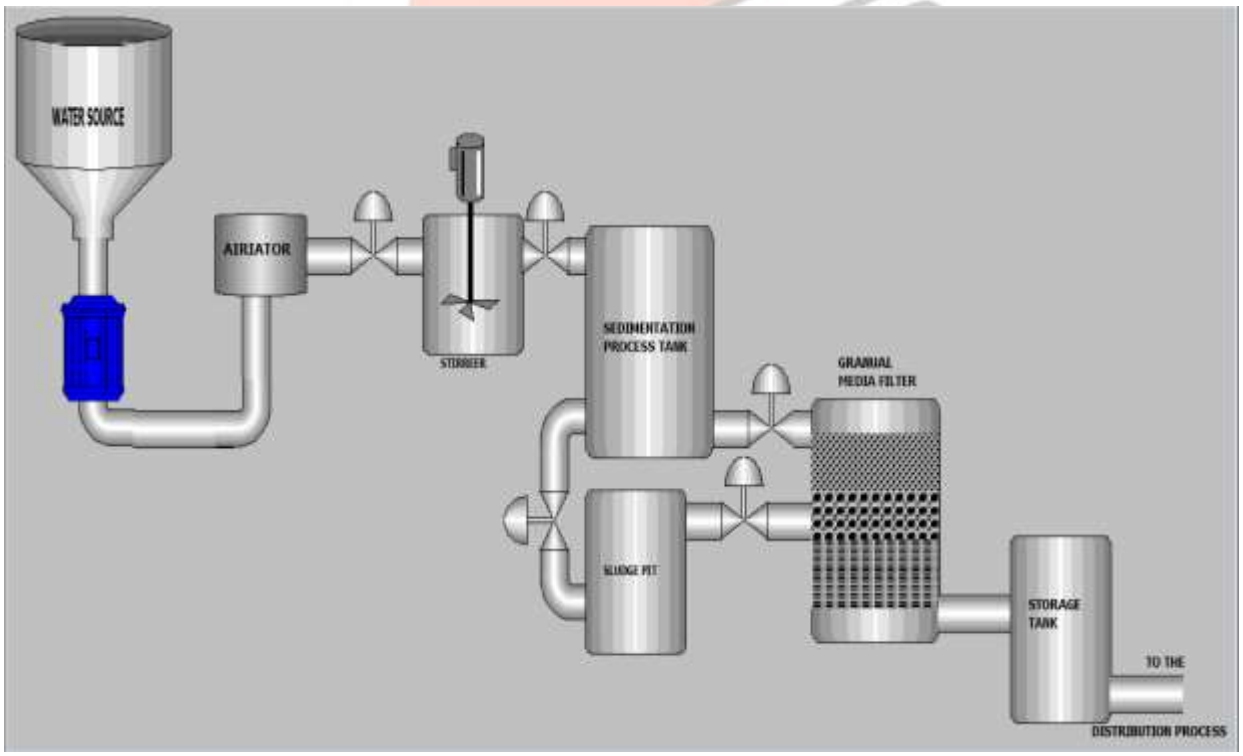

Fig-4: SCADA Screen

VI. RESULT AND CONCLUSIONS

The automation implemented in water distribution system ensures to avoid wastage of water and reduces time. Due to PLC and SCADA it is possible to monitor and control whole system from head quarters.

Fig-5:Real Time working proto type

The fig.5 shows the real time working proto type model. A test run of the system is done removing all the bugs if any, before actually implementing the new system into operations. It is an important phase of a successful system testing is done to check whether the output of the test is matching the expected result.

VII. REFERENCES

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