

Smart Water Management Using SCADA at Water Treatment Plant

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ABSTRACT: Water, quite aptly called the Elixir of life is abundantly found yet only one fourth of the water available is suitable for human consumption. It is henceforth necessary to judiciously use the water that is available to us. By enabling the use of water management techniques such as the use of a monitoring system like SCADA helps in conserving the water that is available to us. The conventional method of water treatment at a Water treatment plant involves collection of water samples manually and sending it to the laboratory for testing. In the proposed system, the use of sensors such as pH, TDS, Turbidity and Level sensor at the raw water sump, along with a PLC, helps in providing the water quality data every second. By interlinking the sensors and PLC with SCADA, helps in monitoring the water quality parameter from a common station. With the available data, a graph can also be viewed via the SCADA denoting the change in water quality. This study helps in monitoring and providing data regarding the water quality at all times reducing man power and human errors resulting in proper water management.

KEYWORDS: Water treatment plant, SCADA, sensors, PLC, water quality parameters.

I. INTRODUCTION

Water is considered to be essential for survival to every living being. The availability of fresh water is very low and hence judicious use of it is very necessary. With the people preferring to migrate from rural to urban areas, proper water management plays a vital role in making sure that the water is equally available for all the urban dwellers. Water management means reducing the wastage and providing right quality of water to every single individual which can be achieved by proper planning and distribution. The water is treated at treatment plants before being distributed for human use. At many treatment plants, no proper water management is done nor there is a proper monitoring system to check the water quality parameters at all times. The daily water demand for the localities surrounding the plant must be met and to achieve this the water must be properly treated, stored and distributed.

The review focuses on the use of SCADA along with innovative technologies resulting in the improvement of water management at water treatment plants and also monitoring the live water quality parameters.

II. OBJECTIVES

To recommend the use of SCADA in water treatment plant to monitor the water quality parameters and the level of water that is sent to the plant from the reservoir.

III. LITERATURE SURVEY

A. International Status

W. P. CHENG et.al, (2014) presented a paper where he built a real time model of a large-scale water distribution system. The real time model of water distribution system is hydraulic which involved the combination of on field data provided by SCADA systems. The hydraulic model comprised of three major parts which are supervisory control and data acquisition systems (SCADA), an estimation server for the state and a common client terminal. To estimate the real time demand, an algorithm related to local linear matrix transform and a least square scheme based on recursive state estimation are applied. The built real time water distribution system model was applied in the city of Guangzhou, China. The city is considered to be one of the largest in the entire country of China and the model made sure that the proposed nodal demand correction algorithm are effective for real time water distribution model and proved it.

CORINA MARIA et.al, (2014) presented a paper on designing and implementing a software to carry out advanced control testing and assessment of data at a wastewater treatment plant. The created software is made to integrate with an already existing control platform like SCADA with the purpose of testing various control systems, analyzing the data for operation purposes and also providing tools which can be used for testing various advanced control systems. The created software is tested and implemented at the wastewater treatment plant.

PAUL F. BOULOSet.al,(2014) presented a paper in which a case study was done on real time modelling of water distribution systems. The case study involved on how, many countries faced a daunting task in preserving the water quality along the water distribution networks because of the sudden increase in population and migration of the people. Hence the need for Supervisory control and acquisition system is very much necessary for proper management of the network pipes. This system enabled transformation of the water network towards planning and design in order to increase the efficiency of the system. The increased efficiency resulted in proper management of energy and quality of the water, tackling the issues related to disruption of services and rectifying the cause of disruption. The entire case study was done in the Las Vegas valley Water District in Las Vegas, Nevada.

I. E. Karadirek et.al, (2012) conducted a study on how to implement Hydraulic Modelling to reduce water loss by Pressure Management along the Konyaalti Water Distribution Network in Antalya, Turkey. The study involved dividing the network into 18 district metered areas so that the water losses can be properly managed. A SCADA system was used to monitor the level of water in reservoirs, the rate at which water flows and the pressure of the water. These data are transmitted online to the SCADA system. A calibrated hydraulic model was used to measure the water flow and it was understood from the results that the water was transmitted at higher pressure levels, the flow of water at night throughout the year was high and also the leakages along the distribution lines were deemed to be high. A pressure reducing valve was installed along the district metered areas and by the use of hydraulic model, the results were calibrated once again. The predicted savings in water were considerably high and hence it was concluded that the hydraulic model was necessary for applying pressure management strategies.

MIRCEA DOBRICEANU et.al, (2010) presented a study on the use of SCADA system for monitoring the water supply networks. The theoretical paper stated that water monitoring can be achieved by the use of systems implying automations and monitoring architectures comprising of supervisory and control systems, PLCs (Programmable logic controllers), communication systems, measuring devices etc. The system analyzes and process the data resulting in optimum functioning of the water supply networks. SCADA incorporated all the monitoring and automation systems thus helping in optimum functioning of pumping systems, equipment's safety, and hence resulted in management of the water supply networks.

B. National Status

K. SARAVANAN et.al, (2018) presented a paper on how real time water quality monitoring is done by using IoT in SCADA system. With the increase in pollution all over the world, the need for checking the water quality is very much necessary. The paper involved the use of a SCADA system which integrates the use of Internet of Things for monitoring the water quality real time. Together, the water contamination, pipeline bursts or leakages were determined along with measuring the parameters such as pressure, quality and colour of water by using sensors like temperature sensor, flow sensor and color sensor. These sensors were incorporated with an Arduino Atmega 368 and a GSM (Global System for Mobile Communication module) module to transmit the data obtained by the sensor. The entire system was applied in the Tirunelveli corporation for automatic capturing of the data given by the sensor and it was concluded that the recommended system performed and fared better than the already existing ones and the use of SCADA helps in capturing the real time values provided by the sensors via GSM communication module.

ISAM ASSI ALI et.al, (2014) presented a paper on how to enhance the SCADA system for a water treatment plant in the city of Tikrit in Iraq. The paper involved in developing a wireless SCADA system which helped in monitoring and assessing the performance of water parameter sensor devices such as Temperature, water tank level and Gas at all times. To enable this system, a mobile setup was done which runs on the platform of GSM module. The already existing system in the city of Tikrit was studied and it was used to evaluate the functionality with the proposed enhanced model.

SUNIL L. ANDHARE et.al (2014) presented a journal on how SCADA as a tool is helpful in increasing the efficiency of a water treatment plant. In a water treatment plant, various processes were carried out which needed to be monitored continuously. These processes were also distributed along various remote sites. SCADA helped in monitoring, controlling and effective working of all these processes in a more efficient manner. The problems related to water

quality and distribution of the treated water were solved when automation is brought in into the treatment system and distribution system. By the use of automation and SCADA, the water treatment plant was operated in a more effective and efficient way.

GAIKWAD SONALI ASHOK et.al, (2013) conducted a research on how theft of water and quality of water can be monitored by the use of PLC and SCADA. The paper involved preparing a prototype for a water distribution plant which comprised of a system to control the water distribution, means of communication, the use of sensors, valves and actuators. A communication bus was used to monitor and control the flow of water along the pipe which was made possible by controlling the valves. The entire system was made to integrate along with SCADA making sure that the entire system helps in control and monitor of the components of the water distribution system. With the help of Programmable Logic Controller, the transmission and receiving of the data was carried out via the communication bus.

G.VENKATA RAMANA et.al, (2013) presented a case study on how water distribution can be done efficiently by using SCADA system. The case study involved Vijayawada Municipal Corporation in Andhra Pradesh, India where because of urban development the efficient usage of water is not taking place. Along with the inefficient water usage, because of improper design of water networks and ineffective water distribution, various losses in water takes place along with deuteriation of the quality and quantity of water that was supplied. By the use of SCADA and implementing it towards the respective municipal corporation, the water quality standards as per Indian norms was maintained along with the reduce in leakage of water in the distribution pipelines.

IV. SENSORS & SCADA IN A WATER TREATMENT PLANT

The water treatment plant gets its water from reservoirs or other storage tanks. The water is in an untreated state which must be treated according to water quality guidelines prescribed by the country. The treatment takes place in a Water treatment plant where the raw water samples are first analysed and checked whether they're suitable for human use. If the respected water sample isn't suitable, permissible quantities of chemicals are added to increase the water quality. To know the live water quality data, the use of sensors play a major role. These sensors are kept in the Raw water sump which play the role of input devices where they collect the information about the water. The sensors that are kept here include pH sensor, TDS sensor, Turbidity sensor and level sensor.

The functioning of sensors is achieved by the use of Programmable Logic Controllers (PLCs). The PLC assigns respective roles for the respective sensors used and controls the operation of these sensors. The data from the input devices i.e., the sensor, is obtained by the PLC and sent towards an output device to monitor the water quality data obtained by the sensors. The Fig 1., indicates the sensors to be kept in a raw water tank and relaying of data by programmable logic controllers towards a monitoring platform such as SCADA.

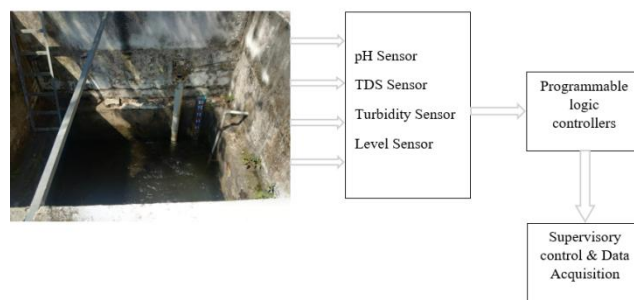


Fig. 1. The data flow from sensors to SCADA

The PLC is programmed where the respective inputs and outputs are provided. By using ladder diagram or ladder logic, the PLCs can be programmed to retrieve data from the field devices such as the sensors. The obtained data from the sensors are transmitted towards a monitoring platform such as SCADA. The ladder diagram is drawn in such a way that the sensors used such as pH, TDS, Turbidity and level transmits data towards the SCADA system.

SCADA or Supervisory control and data acquisition is a system that helps in remotely controlling and monitoring of field instruments such as sensors, flow meters, pumps, control valves etc. By establishing a valid and proper channel to communicate between the PLC and SCADA, the data obtained by the sensors which act as input devices can be monitored on SCADA. As per the PLC, the sensors begin to transmit live water quality data which can be monitored in the treatment plant at all times. The data can also be stored as an archive in the SCADA system and be retrieved after a period of time. With the help of the data collected from the sensors, a graph can also be plotted indicating the variation



in the water quality parameters. With respect to the obtained parametric values, the quantity of chemicals such as lime and alum to be added are calculated in the water treatment plant.

V. RESULTS AND DISCUSSION

The sensors relay the live data regarding the pH, TDS, turbidity of the water towards the SCADA. The sensors are capable of transmitting data every second but a hourly reading from the sensors are obtained indicating the variation in water quality parameters shown in the table below.

TABLE I. SUMMARY OF HOURLY WATER QUALITY SCADA OUTPUT

SCADA OUTPUT							
Signal	Description	Water Level(ft)	TDS	pH	Turbidity	Date/Time	Quality
DVP40ES2	Raw water sump	27	260	7.8	6	04/04/2020 10:00AM	Normal
	Raw water sump	27	260	7.8	6	04/04/2020 11:00AM	Normal
	Raw water sump	27	270	7.8	7	04/04/2020 12:00PM	Normal
	Raw water sump	24	265	7.8	6	04/04/2020 01:00PM	Normal
	Raw water sump	24	260	7.5	7	04/04/2020 02:00PM	Normal
	Raw water sump	24	260	7.5	6	04/04/2020 03:00PM	Normal
	Raw water sump	24	270	7.8	6	04/04/2020 04:00PM	Normal
	Raw water sump	24	270	7.8	6	04/04/2020 05:00PM	Normal
	Raw water sump	28	265	7.4	7	04/04/2020 06:00PM	Normal
	Raw water sump	28	260	7.4	7	04/04/2020 07:00PM	Normal

Using the values obtained, a graph can be plotted showing the hourly variation in water quality parameters. The raw water sample doesn't show much variation in the water quality. The parameters such as pH, TDS and turbidity is under the permissible limit and the data can also be stored and retrieved later by the SCADA system.

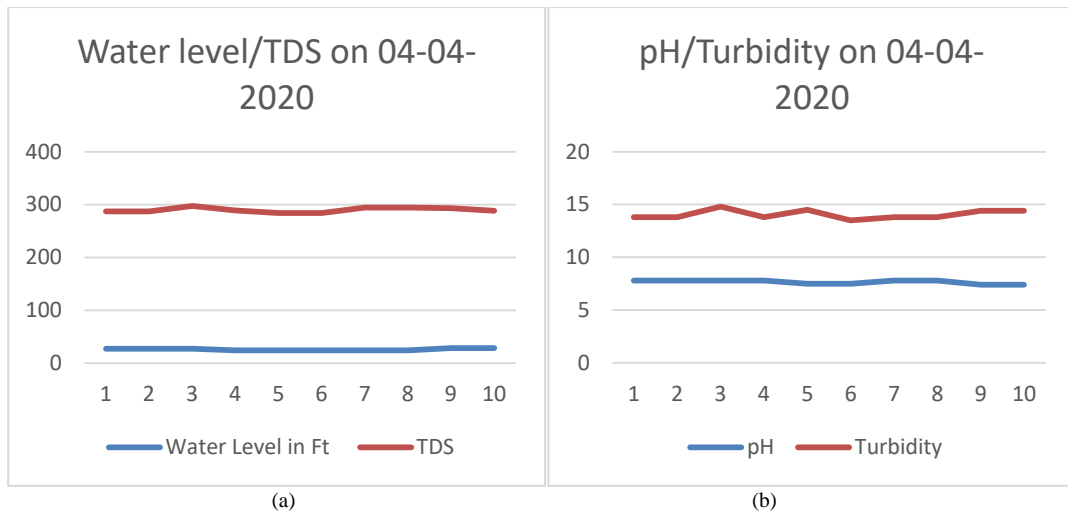


Fig.2. Variation in water quality (a) water level and TDS variation (b) pH and Turbidity variation

VI. CONCLUSION

By using the sensors required to monitor the water quality and recommending the use of SCADA helped in achieving the concept of smart water management. The use of SCADA resulted in live monitoring of water quality with minimal human intervention. The water treatment plant when following the use of SCADA and sensors leads to increased efficiency in the plant's functioning and also the data acquired and transmitted is very accurate when compared to the conventional method in treatment plant.

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