International Journal of Aquatic Science
ISSN: 2008-8019
Vol 12, Issue 03, 2021

An Investigation On Automatic Domestic Water Distribution Management System Using Plc Control

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Abstract. In process control, flow control is an immense challenge and conventional linear P+I+D controllers cannot control it. Because of this, a campaign is launched to create a better auto-tuning PID controller design for water distribution systems for the domestic's needs. The first order process model was found using the process reaction curve method and GA optimization techniques for each stable operating point. It is done using a real-time PLC from Allen Bradley. According to the experimental results, the proposed control scheme is capable of keeping set point tracking, rejecting disturbances, having nominal time domain specifications, and lower integral square error.

Keywords: Water Management System, SCADA, Hybrid Power, Domestic Water Distribution. PLC

1. INTRODUCTION

The main aim of this proposed paper is to reduce water waste while ensuring that the water is of excellent quality. Bringing the benefit of good health to everyone today, in an age where water is increasingly polluted and supplied to everyone due to neglectful employee behavior and pipe damage, is an excellent idea. In this case, an automation system would have avoided these difficult situations. This system prevents unwanted water contamination. When the tank is full, the water flow is turned off in the inlet line. The Eco-Enzymes tank cleaning system is also assisted by a software programme that scans the sprayers to ensure that no error in the cleaning system occurs. The Rationing System serves as the main application for the project.

When it comes to water scarcity, in the 21st century, it is currently the world's most pressing problem. It's well known that water is an absolutely essential necessity for human survival. Such water is indeed a pity, as it is almost impossible to find. A whopping 70% of our planet is water. This fresh water we can use is only 3% of what is available. A total of 10 billion people in the world lack access to clean water. Approximately 240 million people on Earth are water-scarce for at least a month of the year. One in four people on Earth (over 240 million people) are at risk of water-borne diseases such as cholera and typhoid because of the

quality of water they are drinking. Using contaminated water results in 20 million child deaths each year, according to the World Wildlife Fund. The number of people affected by water scarcity will reach two-thirds of the global population by 2025. This impact could have a significant impact on the environment and the ecosystem. Sagar Khole and TusharKolape (Mar, 2015) proposed an automated drinking water supply system and theft identification system utilizing embedded technology. It is imperative that each customer be provided with an embedded based water flow monitoring system, consisting of a microcontroller, a flow sensor, and a wireless transmitter, as well as an electrically operated solenoid valve, in order to implement the proposed water supply system. If the flow rate exceeds a predefined limit, the valve will turn on/off to stop the water supply. The real time clock is also used to control the solenoid valves to control water flow for a pre-set duration of time. In order to make a faster transfer of information, a GSM modem will be used to supply a wireless connection to particular responsible officers' cell phones. Mohammed Moin Ahmed and ShubhamSrivastav (Jan,2016) Design and development of a cylindrical water tank cleaner, which involves mechanical components, has been proposed in the International Journal of Emerging Technology and Advanced Engineering. There are two main mechanisms within the mechanical system: a gear mechanism and a reciprocating four-bar linkage mechanism. In order to reciprocate the whole mechanical system, which involves the movement of entire cylindrical tanks, the gear is worm gear. A four-bar linkage is used to connect the main shaft to the PVC brushes. Four-bar linkage is made in a way that it will automatically adjust depending on the tank diameter. When the A.C. motor is turned on, the main shaft rotates, which rotates the linkage, and the wall and bottom of the tanks are cleaned with the help of brushes. Reduction of cost and labour is one of the project's goals, as there will be illnesses or injuries to the person who goes inside and the water will affect the health of others.

1.2 CAUSE OF WATER SCARCITY

When there is a shortage of water in a particular area, people's daily needs cannot be met. Water scarcity can occur even with plentiful water levels because of poor water management.

1.2.1 Population growth

Because of population growth and industrialization, we will see an increase in the use of fresh water. As a result, more and more people are utilizing surface and ground water. Failure of water resources to maintain and grow in line with population growth is the primary cause of water scarcity.

1.2.2 Wasteful water use

Factories and irresponsible people create excessive water use, making water supplies vulnerable. Improper water level maintenance results in the inability to prevent water use deficits.

1.2.3 Water scarcity has consequences.

Plants and animals need water to survive. The world's population uses approximately 70% of the world's water, while 10% is reserved for agriculture and irrigation. Famine occurs when food production is severely limited and water is unavailable. Cattle can die from starvation. Water scarcity causes economic starvation and hunger as well. The severe water scarcity that results from polluted water use causes even more pollution. Unhygienic water used for food can cause cholera, typhoid, and jaundice, which are diseases of water borne origins. Water that has been used for bathing, laundry, and the like is commonly contaminated, and this can lead to skin diseases and skin cancer. Therefore, unhygienic conditions result from a lack

of water.Water scarcity affects the production of agriculture, and yields are going down. In the event of water scarcity, starvation sets in and livestock perish without any kind of fodder. Water shortages and decreasing productivity is becoming a more common problem for factories. Individuals of all demographics are experiencing economic difficulty due to water scarcity. Deforestation and other losses of natural vegetation are a result of water scarcity. As a result, the animals lose both the habitat and the food supply. Aquatic life can die if it is deprived of habitat or food. In this way, affecting the ecosystem, when it comes to water scarcity, these are the primary reasons and effects. This system, called "Design and Development of Water Distribution Management System", has specific uses related to water rationing and preventing water theft. It was designed to implement a water rationing system for all, identify water theft, use water level controllers, use a water purchasing system, monitor the quality of the water, and offer regular tank cleaning.

2. HARDWARE REQUIREMENTS

2.1 Differential Pressure Transmitter

To produce an output signal that is directly related to the tank level transmitter, continuous level measurements are taken. Depending on the application, various technologies employ various transmitter technologies like float, radar, ultrasonic, and capacitor. Differential pressure transmitters are used to measure the difference between two pressures. The differential transmitter compares two pressures called low-side pressure and high-side pressure. Low-side pressure is used as a reference point. The EJA 1190A 110A Differential Pressure Transmitter model is being used in this project. This model, which is used to measure pressure, density, liquid, gas, and liquid level, has an EJA 1190A 110A label. Differential pressure is applied to produce a 4-20mA DC signal. The following are the EJA 1190A 110A DPT standard specifications

Specifications include performance and calibration spans, with zero-based numbers and Silicon lubricant as output. Square root accuracy - If the output is 50% or greater, the accuracy will be the same as the reference accuracy. Over the course of three morning, noon, and evening caps, the percentage varies between 0.1 and 0.2. Under 60 months, about 0.2% of URLs per year. the electronic measuring device that can measure the flow and rate of flow of gases or liquids in tubes or pipes This flow sensors have various practical uses that can be found in fields like the chemical industry, the medical industry, and HVAC (heating, ventilation, and air conditioning). This flow sensor is used to identify pipes, leaks, and liquid damage. The water flow sensor enables the water to pass through. This sensor has the Hall Effect and there is a water rotor in this too. Rotating the rotor initiates the flow of water through the valve. There will be a pulse signal generator that measures the rotation speed of a whole rotation by means of the Hall Effect. Measuring the water flow rate with this device is possible with this setting.

2.2 Solenoid Valve

Solenoid valve is a mechanical device that converts electrical energy into mechanical energy. It is used in industries to control the flow rate and to direct fluids in specific directions. The core is magnetic, and the coil is a solenoid. When the coil is energized, the magnetic coil allows the liquid to flow through the valve. The illustration in Figure 4.4 shows a Solenoid Valve.

2.3 Sprinklers

Sprinklers are used on farms and water tanks, among other things. It is made up of networks with pipes, pumps, and the like. The sprinkler has rotating nozzles which shoot water out when water pressure reaches the sprinkler pipe. In figure 4.5, you can see a sprinkler.

WATER TANK AND SUMP CONTROL SYSTEM

A 1HP single-phase pump is used to transfer water from the sump tank to the overhead distribution tank. The ON-OFF Control are set using two methods in the PLC: quantity and time this overhead level control is in place to keep any wasted water from occurring. A level control system senses this and uses a PLC to control it. Sensors are used to measure the quality of the water, and if levels change, the system stops distribution.

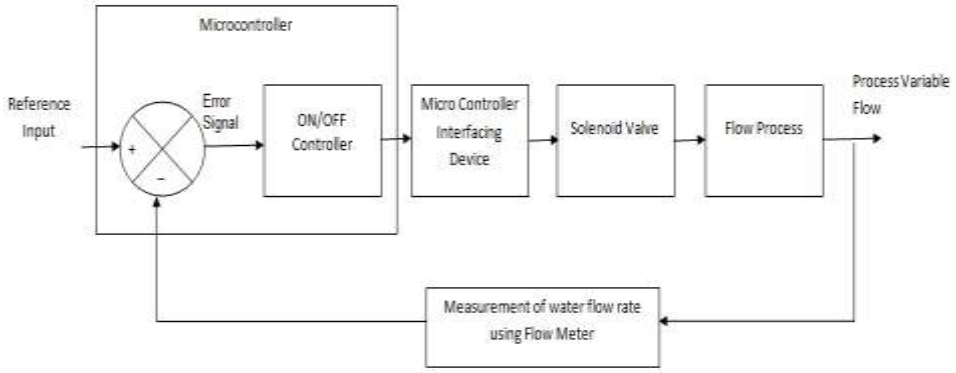

Fig.1. Basic Block Diagram of flow process

A total flow meter is connected to the outlet line and the amount of delivery is monitored. Leakage means that the flow and distribution flow rate are not equal. The process ensures that the delivery is constantly monitored and an alarm is triggered if water is wasted, such that no water is wasted. Sporadic closed-contact occurrences will occur when the supply is removed and the contact is opened again.This project has 8 delivery points, each with a different predetermined delivery volume. An example would be: House 1 may be set to 500 Lb/day, and the solenoid is controlled by a process that will cause the solenoid to switch OFF once the supply is delivered. Similarly, you can assign various values to the houses from 1 to 8. The PLC unit is the brain of every house; each house has its own ON/OFF solenoid valve that is controlled by the PLC. A single node is provided with a large LCD screen connected to a microcontroller unit to display the user's daily Maximum Delivery limit, current usage in litres, and total number of LTs shipped.

Every piece of data from the IoT system is transmitted over an RF link to the IoT data concentrator. This RF link can be used to control delivery as well as data transmission. If the flow rate is increased above the limit, this means a motor or other external device is pumping water. Until the penalty is paid, the OFF command will be sent to the line, and it will not be restored.To guarantee there is no theft of water, this facility has been installed. Any change in the flow rate from the main line and delivery lines is a sign of a leak between the lines. Until the problem is found and solved, the system will cease to operate. This depicts the proposed project, which includes the components, as well as the piping plan that will go to 8 homes.

DISTRIBUTION LINE MONITORING AND CONTROL

This Solenoid-controlled valve is attached to a manual control valve, and connected to an ON/OFF Solenoid valve. This handles delivery to the house. A total flow metre and a digital flow sensor are used to monitor the outlet flow of water. Digital pulses are produced in proportion to the flow rate, which is a turbine model.

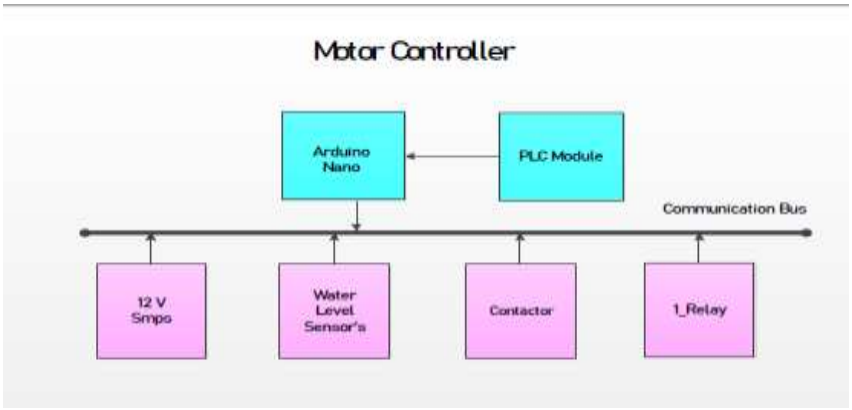

Fig. 2. Motor Controller

The current flow rate is detected by a sensor, which is connected to a Micro controller unit (MCU). The MCU calculates the total flow rate over time, which is then displayed on the LCD. In addition, the unit has a relay output that is connected to the PLC using a wireless network, and this connects the solenoid valve ON/OFF control to the network.

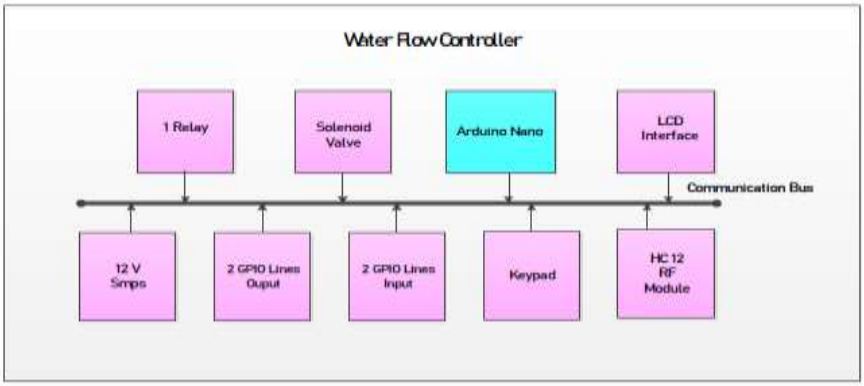

Fig. 3. Water Flow Controller

By using this system, water distribution can be performed in real time. Another good example of this is that the delivery can start at 7 A.M. and end at 9 A. It does not require additional manpower or machinery to operate the main gate valve, and it maintains a precise timing to ensure there is no loss of water due to time lag or lead.

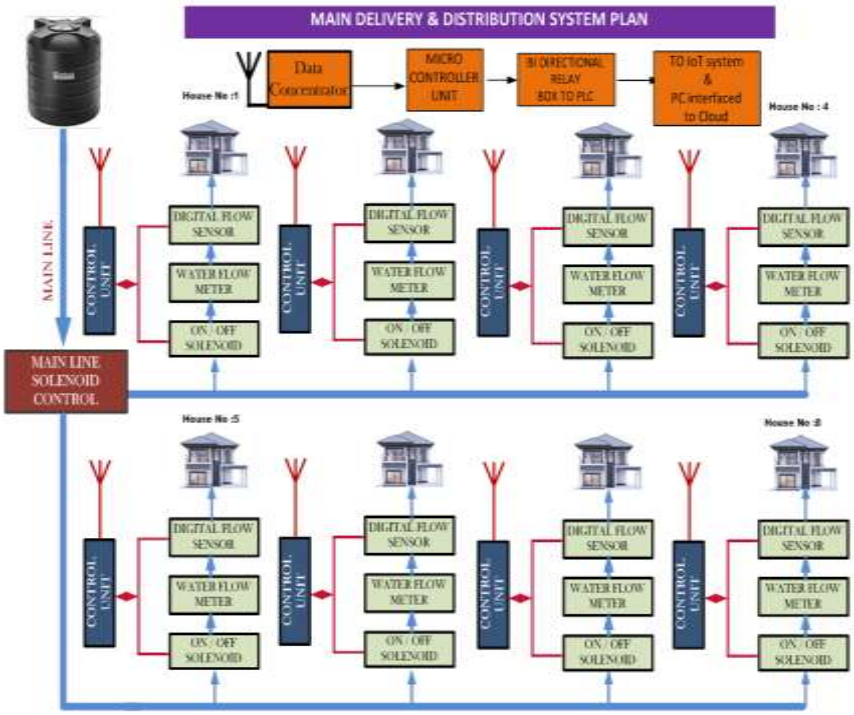

Fig. 4. Main Delivery and Distribution Plan

PLC (Programmable Logic Controller)

It is a special-purpose computer with no display, keyboard, hard drive, or any other peripherals, and it hides away in the control panel at the factory floor. The PLC was a replacement for relay panels, and as such, changing logic or the operation of the machine was both time-consuming and difficult. Re-lays also fail far more frequently than components that are based on programmable logic controllers (PLCs), thus requiring more downtime to keep the re-lays in operation. Additionally, relays utilise significant amounts of electricity, which makes heat and soot, and require lots of room. An I/O module and I/O devices, referred to as I/O, are in use. The I/O can be found in the CPU or in other modules.

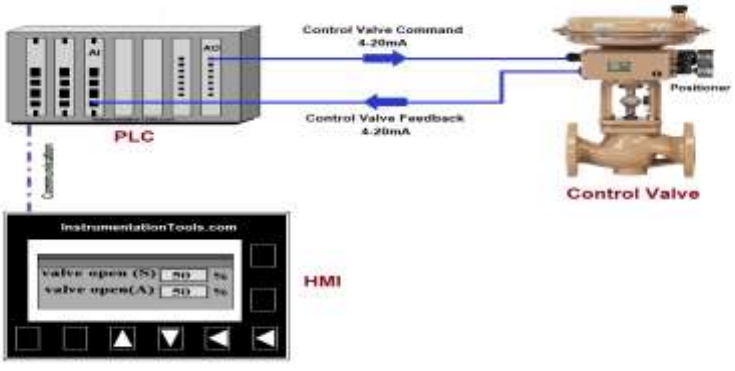

Fig.5. Interfacing of Controller Output with Flow Control Valve

Most systems utilise a backplane that physically holds both the CPU and the I/O to enable both to communicate. I/O modules are distant from the CPU and connected with data cables, allowing the PLC to be located in multiple locations. Manufacturers have steadily added analogue and numerical inputs and outputs over the years. So that we can use SPC values and PID controllers in the PLC programme, we created these numerical devices. Since this is the

PLC, we must programme it. Most PLCs are typically programmed on a desktop or laptop PC running an application. Depending on the manufacturer, they can use Ethernet or a proprietary communication bus to communicate with the PLC. For the most part, the current industry standard is either Ethernet or USB. In Figure 4.7, you can see a PLC.Closed contact will be opened when the supply is given to the Base of the PNP transistor (PNP transistor will operate in cut-off mode). When the supply is removed, the contact will return to its closed position (PNP transistor will operate in saturation mode)

The relay coil is energised if power is available to the output coil (at pin □). Otherwise, this coil will be de-energized and turned off. O:0/0 is usually used in conjunction with an output module. B:1/0 (Binary: 1st word (0 to 255)/ 0 bit (0 to 15)) can be assigned to a memory. In this way, open and closed contact assignments are created. it may be assigned to the I:0/0 input module B:0/0 (Binary: 0th word (0 to 255)/ 0th bit (0 to 15)) can be assigned to a memory, meaning that 0 is the binary digit and 0s mean something, outputs of previous or next rung can even be assigned to open or closed contacts

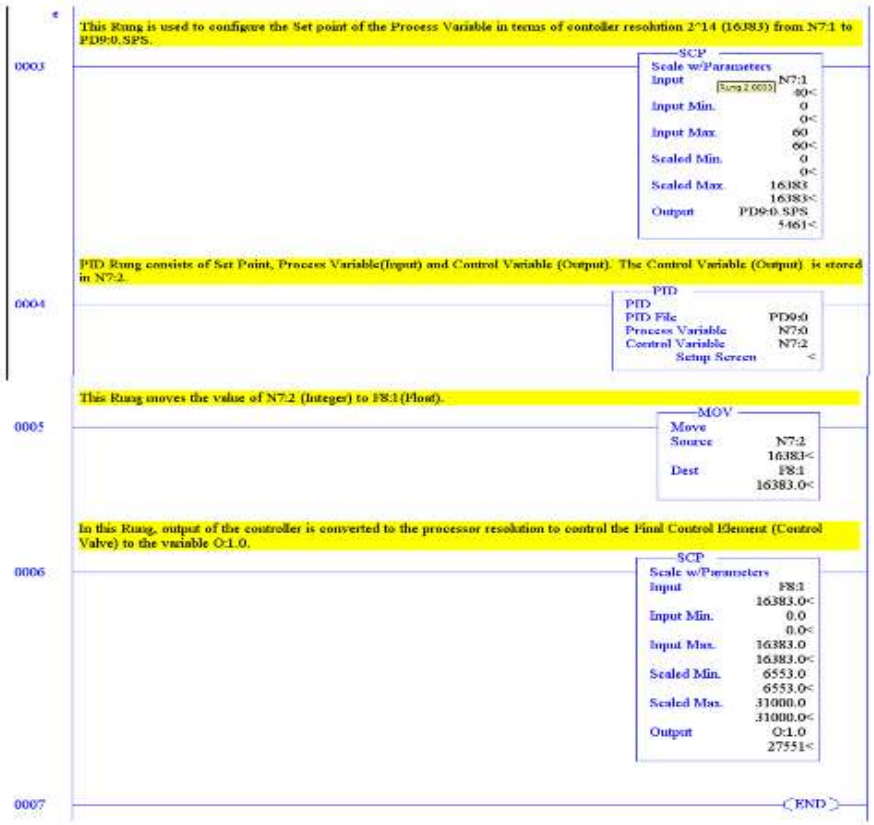

Fig.6. Ladder Logic Program for controlling flow in water distribution system

The timer's T4:0 (0 to 255) DN (done) was at 0 and Accum (Accumulator) value was at 0 at the beginning. To select the time base, we must set the Pre-set value and choose 1.0 second, 0.01 second, or 0.001 second. When you want to make an output active or inactive after a timer has run for a pre-determined amount of time, use the TON instruction. When the "true" signal is activated, this output instruction starts timing (starting either at one second intervals or at one hundredth of a second intervals).

The EXACT amount of time (as set in the PRESET) is waited for; during that time, the accumulated intervals are tracked (ACCUM); and once the accumulated time equals the

PRESET time, the DN (done) bit is set. The timer's accumulated value (ACC) adjusts each time the rung conditions are met until it reaches the pre-set value (PRE). When the rung conditions go false, regardless of whether the timer has timed out, the accumulated value is reset. Even if a tonne has not reached its pre-set value, if power is lost while the TON is timing, the EN and TT bits remain set, and the accumulated value (ACCUM) does not change

SOFTWAREIMPLEMENTATION

3.1 RSLOGIX 500

An especially useful software application for ladder logic programming is RS Logix 500, which is especially useful for MicroLogixTM and Allen-Bradley SLC 500TM processors like PLCs. It is only compatible with Windows, and was developed by Rockwell software. By using our personal computer, we can programme the PLC using RXLogix 500. The screenshot of Figure 5.1 shows an RXLogix 500.The software is developed in a way that focuses on logic instead of syntax. It is possible to have n number of options, such as being able to edit the video in a manner of dragging and dropping as well as a programmer having access to a project verifier. Programming is made easier if you can have search and replace functions to help you find patterns in your code. This model RSLogix programme is shown in Figure 5.2.By using an Ethernet Port or RS-232 Port, we can dump the PLC programmes into PLCs. Rx-LinxTM provides the connection between PCs and PLCs. Two types of licences are available for this software. The Licences are for the commercial version and the educational version. Model 3245-D is for commercial use, while Model 3245-C is for educational use.

3. RESULT AND DISCUSSION

For end users, the reports and database can be rendered using graphical or tabular representations, as mentioned in these projects.The fig.7. shows the response of flow control operation in the water distribution system with servo problem, servo problem means, when the set point change according to the requirement of water by the consumer how the flow rate is changing with respect to the variation in the reference value. And in other hand due to the sudden leakages, theft happens in a particular house or in the street, it will be indicated in the response of the flow, after detection of variation immediately send the message to the concern in charge and also automatically regulate the flow according to the set point.

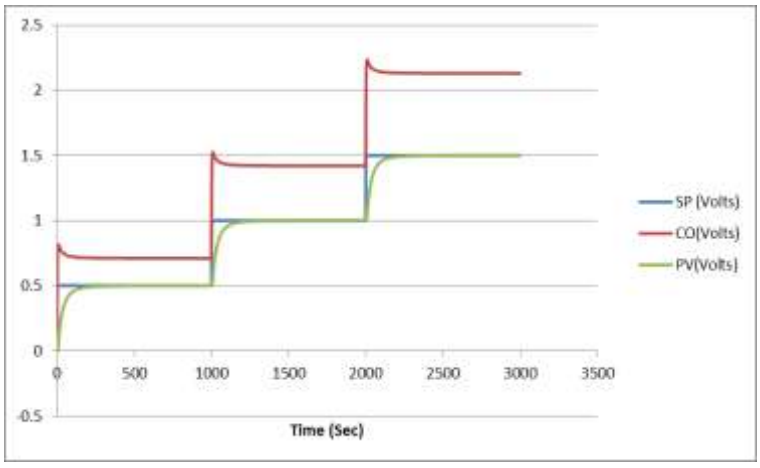

Fig.7. Flow control for water distribution system with servo regulation

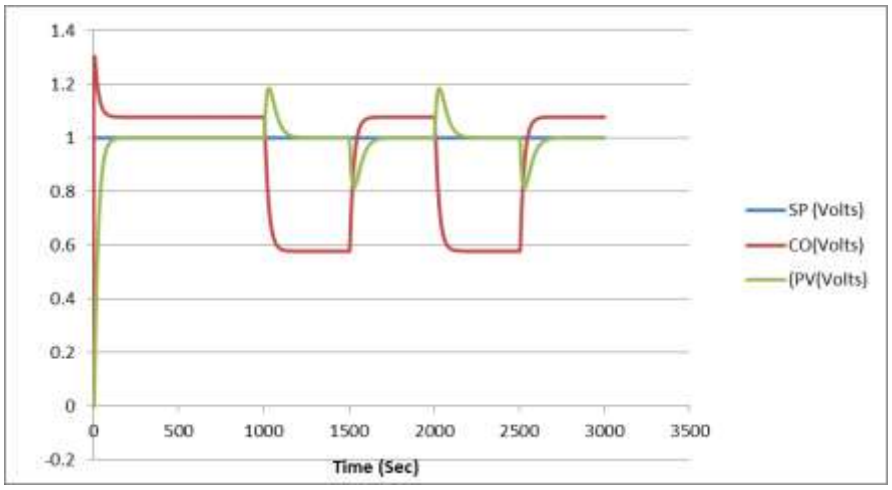

Fig.8. Flow control for water distribution system with load regulation

4. CONCLUSION

SCADA has been developed to monitor the level of water and other parameters. Managing the water flow while allowing the various project set points to vary are the two functions of this tool. The experimental results showed that the use of PLC-based controls boosts the mobile performance of SCADA systems. It has come to the point where it can be confidently stated that by utilising SCADA and PLC, processes and operations will be completed more quickly than if a human does the work manually. The transient response in an automation control system with minimal error will be equivalent to that of an analogue control system with 0.92% of total error. Overall system performance will finally improve with increased automation activity.

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