DESIGN OF AUTOMATION SYSTEM FOR WATER TREATMENT AND DISTRIBUTION PROCESS AT TELKOM UNIVERSITY AREA III

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Abstract

Water is a basic need of people for their life. However, the need of water is increasing along with the growing demand from manufacturing, thermal electricity generator, and domestic use. Artesian water as commonly used water usually has poor water quality. Artesian water in Telkom University has a high compound of iron (Fe). The high level of iron (Fe) compound indicate weak water quality and could cause dark spotting on the white stuff, iron smell, and colloid which cause a health damage. Furthermore, it requires much time to discover a problem in water treatment and distribution because the controlling and monitoring process which is done by an operator is done manually. To maintain water quality appropriate to standard and to discover a problem regarding distribution process efficiently, it needs a system to do centralized monitoring and controlling process using SCADA which contains the design of PLC program and HMI. This research results a proposed automated system which is simulated in a water treatment and distribution model. The proposed water treatment process consists of coagulation, flocculation, sedimentation, aeration, filtration, and disinfection. The overall system of water treatment and distribution process is connected to PLC Siemens and HMI.

Keywords: Automated water treatment, SCADA, PLC, HMI, centralized controlling, centralized monitoring

1. Introduction

Water is a basic need of people for their life [1]. Clean water is utilized by the people for their activities such as industrial needs, city sanitation, agriculture, washing, cooking, etc. Get along with economic growth and number of the citizen, the clean water needs are increasing. Based on the demand for water needs, it is predicted that there will be 55% increase in water demand, between 2000 and 2050 due to 400% growing demands from manufacturing, 140% increasing demand from thermal electricity generation, and 130% from domestic use [2]. There are 3 water sources commonly used by people. Those are surface water, artesian water, and rain water. Artesian water is the most common used water source [3]. But, artesian water usually has poor water quality. Its quality is not appropriate to the standard of consumable clean water. Artesian water usually contains minerals such as manganese, iron, magnesium, calcium, and metals. High mineral dose which is above the standard, may cause brown water, dark spotting in clothes, and health damage. It is toxic to people health through physiological disorder such as liver, kidney, and nerve damages [4].

Table 1 The Result of Water Quality Test

No	Analysis Parameter	Unit	Standard	Method	Test Result
1	TDS	mg/L	1500	SMEWW-2540-C	285
2	Turbidity	NTU	25	SMEWW-2130-B	2.02
3	Iron (Fe)	mg/L	1,0	SMEWW-3500-Fe	1.25
4	Fluoride (F)	mg/L	1,5	SMEWW-4500-F	0.162
5	Chloride (Cl)	mg/L	600	SMEWW-4500-Cr	8.09
6	Manganese (Mn)	mg/L	0,5	SMEWW-3500-Mn	0.132
7	pH	-	6,5-9,0	SMEWW-4500-H+	7.58

Telkom University is an institution that uses water for many activities around it. However, based on the observation that has been done, it has poor water quality. It is characterized by the smell of iron in the water, yellow stain on the toilet's wall as well as on the floor, accumulated debris on the bucket, and yellow appearance of the water. A questioner survey is conducted to do further identification toward water quality in Telkom University. The results of questioner show that 61% of 344 respondents agree that the water in Telkom University contains accumulated debris on the bucket, 54% of respondents agree that the water has brown color, 55% of respondents agree that there is a smell of iron in the water, and 73% of respondents indicate that the water could cause yellow stain on the toilet's wall as well as on the floor. Based on the test result, artesian water in Telkom University contains a high composition of iron (Fe) which is 1.25 mg/L. it is 0.25% higher than the maximum standard of iron (Fe) compound for clean water, which is 1.0 mg/L. The high level of iron (Fe) compound indicate weak water quality and could cause dark spotting on white stuff, cause an iron smell, and colloid which cause nausea and abnormal pain [1]. Table 1 shows the result of water quality test of artesian water at Telkom University.

Generally, there are 4 water treatment and distribution process in Telkom University. These processes consist of pumping process which suck water from the water source, place the sucked water in the ground tank, filtration, and distribution. Controlling and monitoring process of water treatment and distribution is done manually and there is no special treatment to reduce iron (Fe) concentration of the water. Therefore, it could not be denied that the water contains high iron (Fe) compound. Moreover, it requires much time to discover a problem in water treatment and distribution process because all the controlling and monitoring process are done manually.

Based on a previous research that has been done by Aziz and his team (2013), chlorine could be added to water to increase its quality. The additional of chlorine could increase clarity of the water, kill or inhibit bacteria, and reduce iron compound in the water [5].But, the application of chlorine in high dosage could cause health problems such as eye irritation or skin irritation [6]. Hence, the use of chlorine should be in an optimum dosage. In the other side, to increase the efficiency of controlling and monitoring process, an automation system using PLC and SCADA is designed [7].

Therefore, a controller is required to maintain water compound appropriate to standard and problems related to distribution could be avoided. A system that could increase an efficiency of monitoring toward water distribution is required as well. One of the solutions is by using automation system to do controlling and monitoring the process for water treatment and distribution which maintain water quality appropriate to the standard and help the operator to monitor the whole process easily. Based on those problems, a research on automation system design of water treatment and distribution at Telkom University will be conducted.

2. Literature Review

2.1 Water Treatment Process

Generally, water treatment consists of 3 types. There are physical, chemical, and biological processing. In physical processing, water treatment is done mechanically, without additional of other substances. In chemical treatment, there is he addition of chemical such as alum, which is used to eliminate heavy metals contained in the water. Whereas, in biological processing, the treatment generally use microorganisms as a processor media [8]. Artesian water treatment scheme generally consist of six processes. Coagulation is an operating system that has a major impact in water treatment process. In the coagulation process, a destabilization colloid compounds and suspended particles are done to form a particle lump. To destabilize the particle, a coagulant is required. Coagulant will be mixed with raw water. The most common used coagulant is a metal salts coagulant, such as sulfur, ferric chloride, and ferric sulfate [9]. Flocculation is a slow stirring process that is done after a quick steering process. The objective is to accelerate the particle lump forming rate which has appropriate size to be precipitated and filtered [9]. Sedimentation is a process of separating solids with water by utilizing the gravity force. By using sedimentation, the water that flows to the next process is water that has been separated from the particle lump [9]. Aeration is a technology that could be effectively used to treat water with high levels of Fe metal. The process carried out in aeration is the process of adding the oxygen to the water in order to oxidize the Fe [10]. Filtration is a process used to separate the colloids and solid particle out of the water [11]. Disinfection process on water treatment aims to kill microorganisms in water [12]. Moreover, the addition of disinfectants such as chlorine in certain level could reduce the amount of iron compound in the water.

2.2 Automation System

Automation is a process or procedure that is done without operated by a human. The job is achieved by using a program instruction which is combined with a control system to execute the instructions in the processes. To automate the process, the energy is required to run the process and the programs as well as the control system that have been designed [13].

The components which is used in the application of automation systems consist of input, controller, and output. The component that is used as input can be a buttons or sensors. For the controller, the components that can be used in form of PLC or microcontroller. As an output, motors or solenoids could be used [14]. Input is usually known as a sensor, which is used to detect physical variables such as a temperature, force, or a pressure. Generally, these tools, which is used to measure data in a process, is composed of two components, called as sensors and transducers.

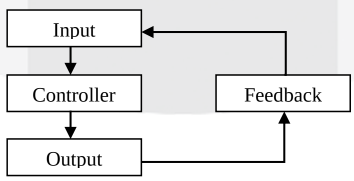

Figure 1Automation System Components

A sensor is a tool used to detect physical measurement variables such as temperature, force, and pressure. The sensor is generally categorized according to the measured variable. Sensor plays an important part in the modern manufacturing process. While the transducer changes the physical variables detected by the sensor into an alternative form which is usually a voltage of electricity [13]. Water flow sensor is a simple sensor that detects that the flow of liquid through the pipe. Water flow is detected by using turbine rotation inside the sensor components [7]. While water level sensor is a type of sensor used to determine the state of water in the water storage tank [15]. However, as the output of the process, there is an actuator. The actuator is a hardware component that converts the signal from the controller into a change in physical form. The change is usually a change of position or motion. Commonly used electrical actuators include AC motor, DC motor, stepper motor, and solenoid valve [14]. The pump is a type of fluid engine that serves to suck water from one place to another place through a pipe. The working principle of a pump is to convert the mechanical energy into kinetic energy and press the fluid. While the solenoid valve is a valve that has 2 ports. It is used to open and close the water flow automatically.

Programmable Logic Control (PLC) is a specialized form of the microprocessor-based control system by utilizing the programmable memory for storing instructions and implementing the function such as logic, sequencing, timing, counting and arithmetic to control machine and designed process. So, it would be able to be operated by engineers who have not really much knowledge of computing and programming language. PLCs are used in industry to control the machines, displacements, and equipment which used as material handling [13]. Totally Integrated Automation (TIA) Portal is a software used to program Siemens PLC. It contains of ladder diagram as its programming language and to command the machine/equipment to do any kind of process. TIA Portal is the development of SIMATIC STEP 7 and have the same basic programming [16].

Supervisory Control and Data Acquisition (SCADA) is a system that can conduct supervision, observation, and control of a process. Simple SCADA is done by relying on simple indicators such as lamps, analog meters, or alarms. Along with the development of computer technology, the computer becomes an important component used in designing SCADA. The SCADA system currently has a central system in which central monitoring and controlling can be performed at both close and long distances [17]. In SCADA system, HMI is used as a display of connecting SCADA system between man and machine. HMI displays data to the operator and provides the input medium used to control the process by the operator. Human Machine Interface is used as an intermediary between man and machine. Without using HMI, the process of supervision and control will be more difficult and require more time. Wonderware InTouch is one of Human Machine Interface software which is completed with SCADA software system.

In order to record the processing data, database is required. The database is data collected systematically on the computer and can be processed using software with the aim to be able to produce an information. The database is a storehouse of information that will be further processed. Therefore, the database is an important aspect of the information system. The process of entering data into the database and retrieving data from the database requires the Database Management System software. Microsoft SQL Server can be used as a database server that manages all data storage and transaction processing of the application [17].

2.3 Previous Researches

A research that has been done by Saputri (2011) regarding the evaluation of PDAM Tirta Kerta Raharja water treatment plant in Tangerang city. The research resulted in the evaluation of the raw water treatment installation to produce drinking water that meets the standard quality [9]. A research that has been done by Azzahrah and Susilawaty (2013) on the effectiveness of chlorine to lower the iron content in artesian water. The study resulted in an effective dose of chlorine to reduce iron levels in water, using a dose of 1.5mg / L to 2.5 mg / L [18]. A research that has been done by Hastutiningrum et al (2015) on reducing iron (Fe) and manganese (Mn) concentration in artesian water by using conventional cascade aeration method and vertical buffle channel cascade aeration. They said that technology can be used to treat a water with high concentration of iron and manganese is aeration process. Aeration is a process to add an oxygen to water. Therefore, iron and manganese would be oxidized [10].

A research that has been done by Gowtham et al (2014) related to automation systems on drinking water filtration, water treatment control, water leak identification using PLC and SCADA and Self Power Generation on inventory control system. In the study, an automation system was designed to control water treatment and distribution systems to detect water leaks or water theft and reduce time. By using PLC and SCADA, the controlling and monitoring process is done centrally [7]. A research that has been done by Baranidharan et al (2015) related to an automation system on water distribution using PLC and SCADA. In the research, an automation system that detects the flow of water by using a flowmeter sensor is designed. The system can reduce a large number of workers who work to control and monitor the distribution system. The system can be used to avoid water leakage and reduce time [15]. A research that has been done by Fathoni (2015) regarding the design of SCADA for the automation process. In the SCADA, Wonderware Intouch is used as an HMI software and uses Microsoft SQL Server as a database [17]. A research that has been done by Permana (2016) on the design of consul control of water treatment and distribution. The control consul is created to control the level of water tanks, acid and base solutions, PAC solutions, and pressure control at pressure tanks. The system simulated using Schneider TM 221CE24R PLC, while the HMI device used is Wonderware Intouch [19].

3. Proposed System

3.1 Design of Water Treatment Plant

The water treatment contains of coagulation and flocculation, sedimentation, filtration, disinfection, and also final shelter. Whole basin size for each process need to be calculated accordance to water need in order to fulfill the water demand.

1. Intake

Intake is a water resource that is used to fulfill the water demand in Telkom University area III. In this design, water source that will be used is an artesian water which is sucked from well with deep of 100m. The water sucked from the source have to accordance to the water need, which is 9.4 L/s. In area III, there are 3 pumps and each pump is used to suck water from 1 source. Those pumps will work alternately every 15 minutes. The pump that need to be used in this sucking process is a 2 inch ½ HP submersible pump from Isnano type 2QGD1-50-0.37. The pump can suck 10L/s of water.

2. Coagulation Plant

Coagulation is used to mix the water with coagulant and make flocks in the water. It is designed as follows:

Q = 10 L/s
Number = 1 unit
Detention time (td) = 20 second
Diameter of pipe = 100mm
Speed of Gradient = min 1,000/second
Upright pipe height = 4 m
Headloss of pipe = 0.1 m
The length of the injection pipe = 8m

The calculation of coagulation basin is represented as follows:

Volume of coagulation basin:

V = Q x td
= 0.01 m^3/s x 20 s
= 0.2 m^3

Volume of injection pipe = 0.25 x 3.14 x D^2 x L
= 0.25 x 3.14 x 0.1^2 x 8
= 0.063 m^3

Td of injection pipe = Q/A
= 0.01 / 0.063
= 6.3 second

G of coagulation pipe $= \sqrt{\frac{g \times h}{v \times td}}$

$= \sqrt{\frac{9.81 \times 4.1}{0.8038 x\, 10^{-6} \times 6.3}}$

=2818.267 / second

G.Td = G x td
= 2818.267 x 6.3
= 17,755.08

The value of speed gradient (G) conforms the G criteria as well as G td minimum. But, Td does not conform the design criteria. However, it need an additional of shelter to fulfill the Td with hexagon basin which aims to add to the aesthetics of the planned water treatment plant (Priambodo, 2016). The coagulation unit is designed with 0.5m of high. The further calculation is shown as follows:

Side length (s) $= \sqrt{\frac{2}{3}\frac{v}{\sqrt{3}\, 0.5}} = \sqrt{\frac{2}{3}\frac{0.181}{\sqrt{3}\, 0.5}}$ = 0.38 m

3. Coagulant Basin

In this proposed design, 2 coagulant basins are designed with dimension of 2.5x2.5x2.5 meters, which consist of 1 tub of watering and 1 tub of brewing as shown in the Figure IV.5. The storage basin is equipped with mixer to facilitate the process of making coagulant solution. Coagulant injection system uses 1 dosing pump and 1 spare pump. The water demand discharge is 9.4 L /s. By using a 20 ml PAC to 1 L water ratio, the required PAC discharge is 9.4L /s x 20ml / L = 188 ml /s ≈ 16 m3 / day. Within 1 day, it is assumed that water at Telkom University area III is used in 24 hours.

So, the tub capacity can be used for water treatment is calculated as follows:

Capacity for each basin = V basin / Vol. PAC
= 16 m^3/ (16 m^3/day)
= 1 day

The PAC will be added to the water in the water pipe to be supplied to the flocculation bath. It is designed as follows:

Diameter of pipe = 12.5 mm
Length of pipe = 10 m
Type of pipe = PVC

4. Flocculation Plant

Flocculation works to enlarge the flock that has been formed in the coagulation unit. The shape of the flocculation unit is planned to be a circle of 2 units. The inlet channel is designed using galvanized iron pipe with specification as follows:

Length = 0.85 m
Coefficient of roughness = 120
Water discharge for each tub = 0.05 m^3/second
Flow speed = 1.25 m/second

Check if of the hoadloss on the inlet pipe is calculated as follows:

A pipe = 0.005/1.25
= 0.004 m^2

D pipe $= \sqrt{\frac{4 \times 0.004}{3.14}}$
= 0.07 m

The used pipe is a standard pipe with diameter of 76mm (2 ½”). To accommodate 0.01 m^3/second, 2 units of pipe are required. While for the design criteria of flocculation plant is described as follows:

Detention time =10 minutes
Gradient speed = 20 -70 L/dtk
G x td = 10000-100000

The flocculation unit will be designed 2 cylindrical tubs with flocculation using a stirring system that utilizes the motor in flocculation. The calculations for each tube are as follows:

G = 60/s td 10 menit
Volume of tub = 0.01 x 600 = 6 m^3

If the tub is designed to have a high of 1 m, so the diameter of tub is calculated using the following calculation.

D $= \sqrt{\frac{4 \times V}{3.14 \times h}}$

$= \sqrt{\frac{4 \times 6}{3.14 \times 1}}$

= 2.8m

Total high of tub = h + freeboard = 1 +0.4 = 1.4m

The outlet channel uses the same size as the inlet which has been calculated to flow the appropriate amount of water to fulfill the water need.

5. Sedimentation Plant

Sedimentation serves to precipitate flock that has been formed in the process of coagulation and flocculation. Sedimentation is designed with the use of settler plate which use to expand the settling zone and shorten the settling distance so that the effective deposition process occurs on the plate. In this design, 2 sedimentation basins were created.

The settler plate has the following specifications:

Distance of settler plate (w) = 7.5 cm

High of settler plate (h) = 1.73 m

Thick of settler plate = 1 mm

The angle of settler plate (θ) = 60°

The calculation of sedimentation plant size is represented as follows:

Area (A) $= \frac{Q}{Vs} \times \frac{w}{h \cos \alpha + w \cos^2 \alpha}$

$= \frac{0.05}{0.0017} \times \frac{0.075}{1.73 \cos 60 + 0.075 \cos^2 60}$

$= 2.5 \text{ m}^2$

m

Width of Flocculation = Length of flocculation

Length $= \sqrt{2.5}$

= 1.6 m

Width of plate space = w / sin α

= 0.075 / sin 60

= 0.087 m

Number of plates width of plate. = Tube length/total

= 1.6 / 0.087

= 18 units

Length due to angle = 1.73/tan 60

= 1

Design of the mud space based on the research that has been done by Priambodo (2016) and will be applied to this design is as follows:

The base length of the slurry zone = 0.5 m

The base width of the slurry zone = 0.5 m

Depth = 0.4 m

6. Filtration Plant

The filter uses a rapid sand filter type with the consideration of rapid sand filter does not require extensive land but require backwash in operation. This filter is planned to use silica sand as filtration media and gravel as buffer media. In this design there will be 2 filtration areas in order to keep the water flow when one of the filters is being cleaned. The water discharge is 0.005 m3/second and filter speed is 5 m3/jam.m2.

The specifications for each filter are described in Table IV.3, as follows:

Tabel 1 The Detail Layer Size Of Silica Sand for Filtration

Diameter (cm)	Flaksi Berat (x)
0.069	30% of 70 cm
0.098	50% of 70 cm
0.130	20% of 70 cm

The buffer medium has a media thickness of 20 cm, where the gravel has a diameter of 0.4 cm. While the underdrain of nozzle is required so that grains of sand and buffer do not enter the drains. The nozzle specifications are as follows:

Slot nozzle : 1 mm

Number of slot : 40 slot

High of slot : 15 mm

Design of filter unit dimensions :

Number of filter basin

$= 12\ Q^{0.5}$

$= 12 \times 0.005^{0.5}$

=0.8 unit ≈ 1 unit for each 0.005L/s.

Size of basin = Q/V filtrasi

= 0.005/5

$= 3.6 \text{ m}^2$

Wwidth = width of sedimentation

= 2 m

Length $= 3.6 \text{ m}^2/2\text{m} = 1.8$ m

The backwash pump is planned to use a centrifugal pump of two units that work in turn. Water used for backwash process is clean water. The backwash design is calculated as follows:

Discharge of backwash $= 0.00323 \text{ m}^3/\text{detik}$

Length of backwash pipe = 17 m

A pipe = 0.00323/1.25

$=0.0026 \text{ m}^2$

D pipe $= \sqrt{\frac{4 \times 0.0026}{3.14}}$

= 0.057 m

The pipe used is a standard pipe with a diameter of 62.5 mm (2.5 ") and uses a backwash pump with the following specifications:

Length = 25.6 cm
Width =20.0 cm
Height = 65.2 cm
Head pump = 5.8 m
Discharge of pump = 3.23 L/s
Pump efficiency = 70 %
Transmission efficiency = 85%

7. Disinfection Plant

The disinfection process is performed by injection of chlorine solution at the inlet from the reservoir. The dose of chlorine solution injection was determined using a ratio of 1.5mg / L. The number of disinfectant used in this system is determined as follows:

Density = 2.35 kg/L
The requirement of chlorine = Q x affixing dose
= 10 L/s x 1.5 mg/L = 15mg/s =1.3 kg/ day
Volume of chlorine = kebutuhan kaporit/ ρ kaporit
= 1.3 kg/ day / 2.35 kg/L = 0.6 L/ day
Volume of water $= \frac{95\%}{5\%}$x 1.3 kg/ day =24.7 L/ day
Volume Solution = V chlorine + Vwater
= 0.6 L/ day + 24.7 L/ day = 25.3 L/day
Count discharge = 25.3 L/day/24 hours/day
= 1.1 L/hours =0.3 ml/s

Disinfectant tub that will be designed measuring 1m x 1m x 1m. The design is similar to coagulant tub. However, the capacity of the disinfectant basin is calculated as follows:

Tub Capacity = V tube/V solution = 1 m^3/25.3 L/day =39.5 days

3.2 The need of PAC Dosage

Jar test is performed to determine the correct dose of PAC in the coagulation process in order to form particle collection. Jar test is the process of testing the dose of coagulant to get the optimum dose in laboratory scale (Permatasari & Apriliani, 2013). The steps in doing the jar test are as follows:

1. Take samples of raw water. The raw water used in the test jar for water treatment is well water. Samples of raw water taken amounted to 6000mL.
2. Check for water turbidity and pH . Before doing jar test, it is necessary to check the turbidity and ph. Based on the results of the water test it is known that the turbidity is 3.65 NTU and pH 7.4. Then the dose of PAC for the test jar is determined as 5mL, 8mL, 11mL, 14mL, 17mL, and 20mL.
3. Filling 6 glasses of chemical with 1000mL of raw water. In doing the jar test, used 6 glasses of chemistry each 1000mL. The size is a laboratory scale that can be scaled in accordance with the water treatment needs of the design.
4. Stirring at 120 rpm for 1 minute.
5. Adding 1% PAC solution simultaneously to all glasses. The PACs are fed into each glass according to several doses specified at point 2, i.e. 5mL, 8mL, 11mL, 14mL, 17mL, and 20mL.
6. Waiting for 20 seconds
7. Determine the rotation speed to 50 rpm and stir the water mixture and PAC for 5 minutes. This stirring process is called fast stirring with the aim that PAC and water can be mixed.
8. Decrease the rotation speed to 20 rpm and stir the water mixture and PAC for 5 minutes. This stirring process is called slow stirring with the aim that particle collection can occur more quickly.
9. Waited 15 minutes. Observe the flock
10. Take a clear solution to check for turbidity and pH. The clear solution will be checked to determine which dosage is optimal and would be used.

Based on the jar test, the chosen dosage is 20 ml because it is the optimum dosage. It has the lowest turbidity and appropriate pH level. This jar test result will influence the treatment of the water. Besides the PAC dosage, the rotation and time of mixing process also influence the water treatment. The rotation speed is 20 rpm and conducted for 15 minutes.

The Diagram of Water Treatment Plant can be seen in the Figure 4, as follows:

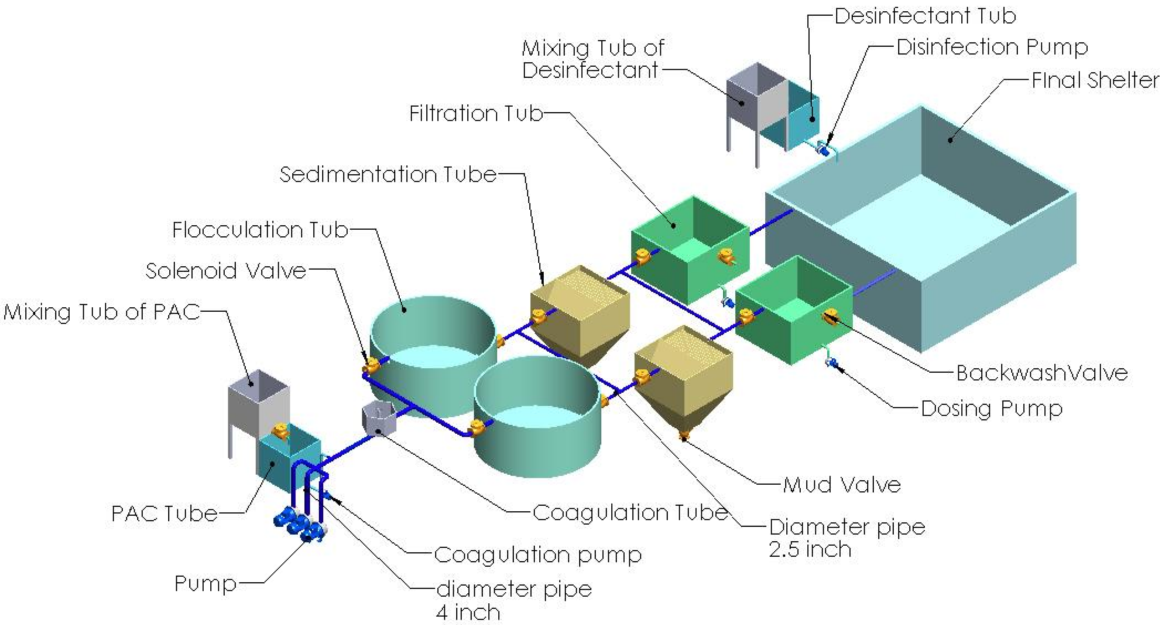

Figure 2 Water Treatment Plant

3.3 The need of chlorine dosage

Azzahra and Susilawati has been done their research and it is resulted to the optimum dosage for chlorine in water treatment for artesian water. It is 1.5 mg/L to 2.5 mg/L [18]. The chlorine dosage will be used in the disinfection process which add the chlorine to the water in order to kill the microorganism.

3.4 Distribution Scenario

Distribution process contains water distribution from ending shelter to groundtank and buildings. When a rooftank or groundtank is empty, which is detected by water level sensor, the solenoid valve would be opened. When the shelter is full, then the solenoid valve would be closed. It can be seen in Figure 5a.

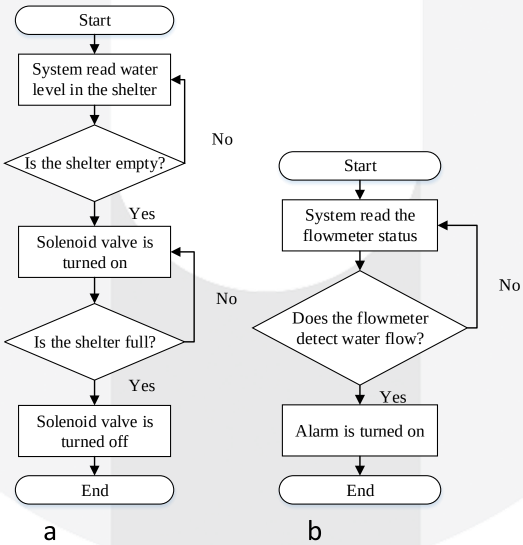

Figure 3 (a) Proposed Distribution System, (b) Alarm Scenario

Beside those processes, which work on each building, there is also an alarm function to indicate the system error. The alarm would be turned on when the solenoid valve is opened but the flowmeter do not detect the water flow in the pipe. Which mean that the pump do not run well. This scenario is used while filling the shelter (solenoid valve is opened).

3.5 Design of PLC Program

The process scenario that has been designed will be translated into PLC programming language. The program used for Siemens PLC 1200 is made in ladder diagram using TIA Portal V12 software. Scenarios are translated into ladder diagrams according to the input and output addresses used. In PLC programming, the input and output addresses are commonly called tag names. The scenario that translated into ladder diagram is appropriate to the system scenarios.

3.6 Design of HMI

Human Machine Interface (HMI) is used to monitor and control all water treatment and distribution processes in Telkom University area 3. HMI is designed for water treatment and distribution process using Wonderware inTouch software. In HMI which is designed to control and monitor the water treatment and distribution process, there are several windows to display information to the operator.

The login window is the initial view when the application is opened. This login system is also used as a security system to avoid system errors due to being operated by an inappropriate operator. To be able to log into the SCADA system, the user must enter a username and password that has been registered before to be able to access the system. Water treatment window is used to facilitate the user in controlling and monitoring the water treatment process at Telkom University Dormitory. The window of distribution 1 and 2 are used to facilitate the user in controlling and monitoring the distribution process of water supply at the dormitory area 1 and 2. The user could monitor the distribution and control it in the same window. The controlling activities are turn the system on/off or turn the solenoid open/close, to turn on/off the pump, etc. The database window contains information about the processing, production, and distribution displayed from the database so that the user can view the information in the database without opening the database application. The database system is designed as a state-of-the-art document on clean water processing and distribution system. The design of the database used on the proposed system of water treatment and distribution system of clean water using software Microsoft SQL server 2012. This window is used to set the system, which consists of change password and configures user. Change password is a function used to change the password of the user. Configure password is a function used to add, delete or change the username of the user. Logout is a function used when the user wants to exit the system. By doing a logout then the display will return to the login window.

4. Process Simulation

A model simulator of water treatment process use LED, solenoid valve, DC motor, pump, and detent button. LED is used as an indicator that the process is running. The solenoid valve is used to open and close the water automatically. However, in some parts, the used of a solenoid valve is simulated by using LED. In this case, LED is used to indicate that solenoid valve is opened. DC motor is used as an indicator of mixer system for flocculation process. A small pump in the model is used to replace submersible pump which is used to suck water from the intake. The detent button is used as a water level sensor which used to detect the level of water and trigger others process. Besides that, the button is used as a metal sensor which used to detect the metal concentration of the water automatically.

A model simulator of distribution process use LED and detent button. LED is used as an indicator of the solenoid valve which used to open/close the water flow to shelter. Moreover, LED is used as an indicator that the pump is active which is used to suck water to the shelter. The detent button is used as a simulator of water level sensor which is used to indicate the level of water and to trigger other further processes. Besides that, detent button is also used as a simulator of flowmeter sensor to indicate the water flow which flows through the pipe.

5. Conclusion

Based on the research that has been done which is a design of automation system for water treatment and distribution process at Telkom University, it concluded that the increasing water quality is important to be cone in Telkom University. However, to increase water quality, standard water treatment process which consist of coagulation, flocculation, sedimentation, aeration, filtration, and disinfection should be executed. Coagulating is a process to mix 20ml PAC per 1 L water. Flocculation is used to produce flock from the water. Sedimentation used to separate water and solid particle. Aeration is used to reduce iron compound. Filtration is used to filtrate water and smaller solid particle. Disinfection is a mixing process of water and 1.5 mg/L chlorine. The SCADA system could control and monitor those processes in a desktop window. So, over all process could be controlled and monitored easily.

Moreover, The SCADA system for distribution process could be used to control and monitor those processes in a desktop window as well as the water treatment process. The SCADA System could decrease the time required to do monitoring and controlling instead manual process. It could be used to know which building has empty water, in which building the filling process of rooftank is done, and detect which pipe that do not flow the water appropriately. It also could detect error easily and discover it faster. The proposed automation system could monitor and control the whole water treatment and distribution process from a desktop.

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