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Prototype Project SCADA on Hemodialysis Mixing Tank Operation

Dede Furqon Nurjaman, S.T., M.T.
Department of Electrical Engineering, Universitas Jenderal Achmad Yani
dede.furqon@lecture.unjani.ac.id

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***Abstract*—Pharmaceutical companies are an example of an industrial sector that uses technology-based systems in its production process. In this research the author will develop a SCADA (Supervisory Control Acquisition Data) system as a platform to solve several problems that are present in pharmaceutical production, namely in the drug production process using hemodilysis mixing tanks. The method that the author uses for this research is experimental research and data collection methods, which use the independent variables of the study, water level control and temperature control, while the independent variables related to the system reading results are displayed on the SCADA screen. Based on the results of mathematical calculations, it can be concluded that the production process using the SCADA system produces a more efficient time with a total time difference of 38 minutes/batch. Operations using SCADA technology within 24 hours were able to produce 4 batches of Infusion Bags, while using the conventional system only 3 batches. Operational needs using SCADA technology will generate more benefits in terms of cost and time, creating more effective and efficient work system for the company.**

***Index Terms*—Control, Mixing tank, SCADA, Temperature, Water Level**

I. Introduction

Technological progress is running faster as time goes by, the industrial revolution 4.0 is proof that humans have succeeded in developing technology to help in all areas of life. Technology has made people's lives easier. In addition to daily life, the impact of technological developments has also affected the economic pattern of society, including production patterns in various industrial fields.

A pharmaceutical company is an example of an industrial sector that uses a technology-based system in its production process, one system that is quite good in its use is the SCADA system. By using this system, the machine operator only has to supervise the production process, this proves that the use of technology has penetrated various aspects of life.

Several studies have been developed related to the SCADA system and monitoring. Among them are research conducted by (Nugroho S.A, 2018) studying and designing a monitoring and control system on 150 KV to 20 KV distribution panels using the Adobe Flash CS3 simulation method. This research has succeeded in designing a SCADA system in a 150 KV to 20 KV substation at PT PLN. With a monitoring and control system on the distribution panel that the system can work in real time, another research was carried out by (Nugroho S.A, 2018).

Another study conducted by (Handy Wicaksono, 2012) discusses a software called Wonderware InTouch as a SCADA software application that can be used as a monitoring and control medium, this can be seen from the types of SCADA network topology that are used whenever reviewing a SCADA design. .

In addition, research conducted by (Teguh PM, 2013) examines a SCADA water level control system, in this case the SCADA system can function as Monitoring and Control of a water level in a container / place using animation so that it can be seen in real time, the Valve is controlled in the form of a water opening position so that the water level can be adjusted to meet a predetermined set-point. The results of the SCADA system display test are included in the good category and are real time because it uses a level transmitter sensor as a supporting instrument device.

In this paper, the author will develop a SCADA (Supervisory Control Acquisition Data) system as a platform to solve several problems that exist in pharmaceutical production, namely in the drug production process. In the drug production process, companies generally use a lot of human labor as the main power in terms of mobility and operation, this is

This causes a lot of time and money needed, because the conventional method requires a longer process in the work.

Based on this, we developed the SCADA system to reduce operator mobility at work so that no time is wasted and increase the amount of production due to time efficiency, so the company will get more income because it maximizes the time and costs available.

A. SCADA Definition

Definition of SCADA System (Supervisory Control and Data Acquisition SCADA or Supervisory Control and Data Acquisition in general is a system that collects data and analyzes it in real time. SCADA is not strictly a controller but focuses on the level of supervision and monitoring. The SCADA system is a combination of telemetering, telesignalling, and telecontrolling. SCADA (Supervisory Control and Data Acquisition) has long been known as a control system. The SCADA system was the first to acquire data using panel meters, lights, and graphs with tape recorders. Operators manually operate several buttons for supervision and control This device is still used for monitoring, control and data acquisition in factories and power generation facilities [1].

SCADA system provides flexibility in setting up and configuring the system. The more things that can be monitored, the more detailed operations are seen, and everything works in realtime. No matter how complex the process handled by the PLC, the operator can see the operation of the process at large or small scale and operators can trace if something goes wrong to increase efficiency [1].

B. *Supervisory Control Mechanism*

Control or Master Terminal Unit (MTU) is control carried out on top of local control or Remote Terminal Unit (RTU). Supervisory Control and Data Acquisition (SCADA) is a system that collects information or data from the field and then sends it to a central computer that will manage and control the data. In its application, the subsystems that make up SCADA consist of: 1. HMI (Human Machine Interface) 2. MTU (Master Terminal Unit) 3. RTU (Remote Terminal Unit) 4. SPAJ and SPAU 5. Communication System (Between MTU and RTU) Basic architecture of a scada system can be seen in figure 1.

Fig 1. SCADA Basic Architecture [2]

II. Research Variable

The preparation of this paper is based on an applicable problem that is realized in the manufacture of a prototype, namely the planning and realization of the tool so that it can display the performance as planned with reference to the problem formulation. Data and component specifications used in planning are data taken from the component data sheet. Selection of components based on planning and adapted to components on the market.

The steps taken to realize the tool to be made include system design, manufacture of hardware (hardware) and software (software), tool testing and analysis, as well as drawing conclusions and suggestions.

The analysis used in this study uses two research variables:

a) Independent variable (independent variable): a variable that influences or causes a change in the value of the dependent variable and is the most important influence variable in research. The independent variables of this research are variations of water level control and temperature control.

b) Dependent variable (dependent variable): The dependent variable in this study is the result of reading the SCADA water level control and Temperature Control system which is displayed on the SCADA screen.

A. *System Design and Manufacturing*

System design is carried out as an initial step before the formation of a system and its supporting electronic circuits that are ready to be realized. This is done so that the system created can run as it should. The system design carried out includes:

1) Hardware Design such as tool specifications, components, wiring, and designing valve placement.
   - Using CX Supervisory software as HMI (Human Machine Interface).
   - Using a Simatic Field PG laptop as the Master Terminal Unit (MTU).
   - PLC OMRON CP1H XA as Remote Terminal Unit (RTU).
   - USB serial cable as a communication link between MTU and RTU.
   - Loop Calibrator as Simulation of water level sensor and temperature sensor for analog PLC input.
   - Aquarium pump 60 watts, 2500 L/hour for simulation of entering water into the tank.
   - Silicon hose as jacketing for tank heat exchange
   - Valve Actuator has a voltage of 220 VAC.

The hardware manufacturing stage begins with making a miniature tank mechanism and making a holder for the valve placement according to the design that has been made. After the mechanical manufacture of the miniature tank is completed, the next process is the process of installing the jacketing hose on the tank body and installing the valve and hose according to the design. Then do the merging of the valve cable with the I/O PLC according to the plan. As the final stage of hardware manufacturing is the incorporation of PLC panel wiring, valves, and hose installation.

2) After the hardware is designed, the next step is software design. This software functions to regulate the overall performance of the system which consists of several hardware so that this

system can work properly. This design begins with making a PLC ladder diagram using software cx programmer version 9.6 which is a software programmer issued by OMRON, then making a SCADA HMI (Human Machine Interface) display design using CX Supervisory software which is a paid software issued by OMRON.Software design, making PLC ladder diagrams using the cx-programmer, making HMI (Human Machine Interface) designs using CX-Supervisory

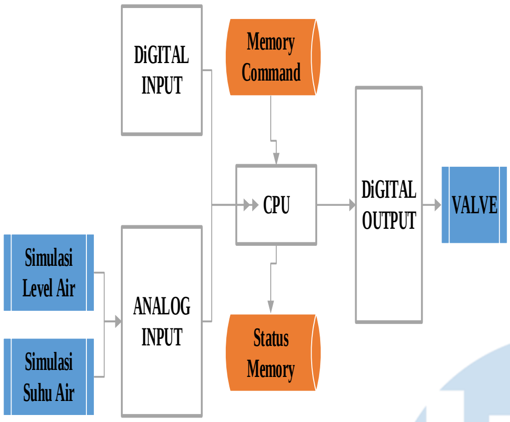


Fig 2. Block Diagram

Making PLC software is done by implementing a flow diagram of the program that has been planned, and then converting it in the form of a ladder diagram using software cx-programmer version 9.6 to then be transferred to the PLC. After the PLC programming is done, the next step is to design the HMI (Human Machine Interface) display. In making the HMI display design, operational ease must be prioritized, so that the operator does not have difficulty in operating it. The making of the SCADA HMI in this paper uses the CX Supervisory software as the SCADA platform that I use.

B. *Testing Tool*

To ensure that this system runs according to plan, it is necessary to do a test. The test method used is to test the system for each mode in SCADA and to test the system as a whole, then analyze the results of each test. These tests include:

1) *Hardware Testing*

Hardware testing is carried out with the aim of adjusting the condition of whether the Valve is working in accordance with SCADA orders and testing the toughness of the tool being tested from the Mechanism side. The test uses water to find out whether the water fills all parts of the tank or hose and is checked again so that there are no leaks.

2) *Software Testing*

Software testing is done by observing the HMI display on the computer screen in runtime mode. Testing this software includes testing the function of the HMI display button and the work of the program that has been transferred to the PLC.

3) *Overall System Test*

After the hardware and software are integrated into system, then the overall system is tested with runtime mode on the CX Supervisory software. It aims to determine the performance of the tool.

III. Test Result and Analysis

The results analysis of the SCADA Mixing Tank prototype in this paper are to calculate the length of time produced in an effort to produce a drug and compare the length of the process when using a conventional system with the SCADA system. This can use the Sequential Time calculation method, which is to calculate the length of time 1 process that can be calculated into output and profit. The test is carried out by comparing the results of the manual output of one day (3 shifts) 4 times mixing the tank with the results of the automation output of one day (3 shifts) 5 times of mixing the tank, in this test we have to test in detail and also many times so that the results are accurate.

The final results of the tools made in this paper include software (software) and hardware (hardware). The combination of these two devices forms a SCADA Mixing Tank system.

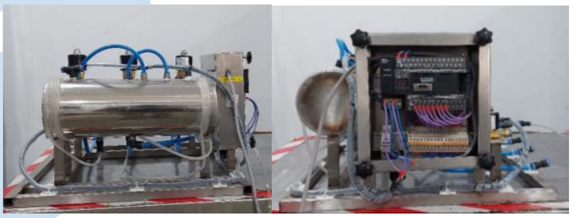


Fig 3. Prototype Mixing Tank

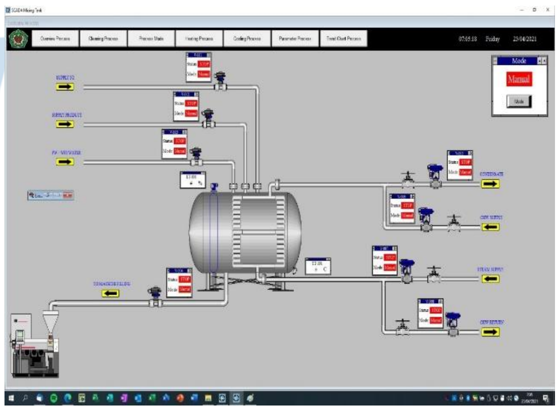


Fig 4. SCADA Display

The parameters used in the SCADA system are several processes, including:

1. Cleaning
2. Mixing (water & product filling)
3. Heating
4. Cooling
5. Transfer Mode

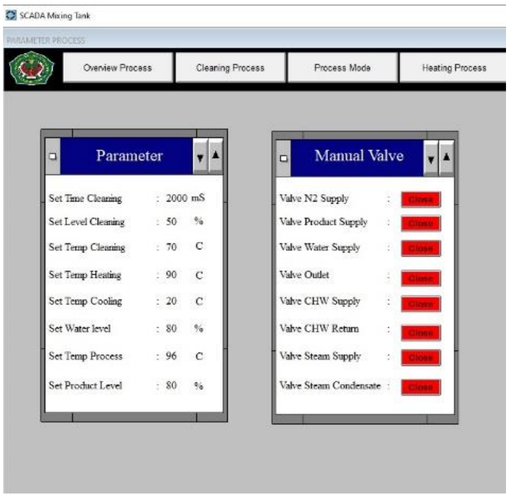
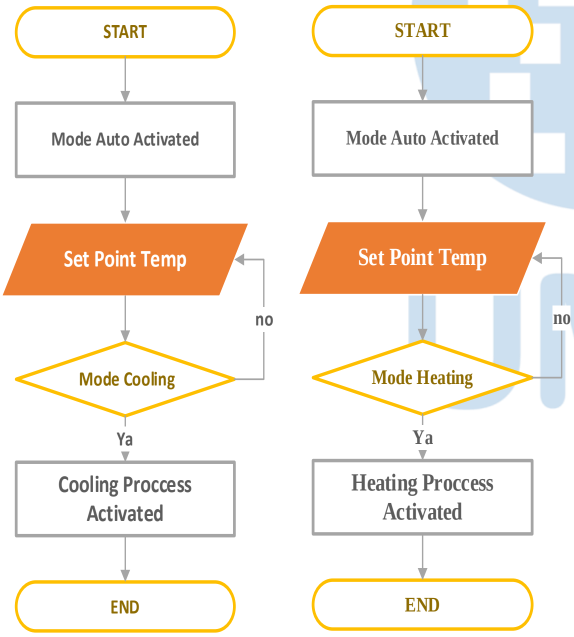


Fig 5. Parameter Display on SCADA

The result of reading the SCADA Mixing Tank system in this study is to calculate the length of time produced in an effort to produce a drug comparing the length of the process when using conventional systems and SCADA systems. This can use the Sequential Time calculation method, which is to calculate how long it takes one production process and conclusions can be made and calculated into outputs and profits.



(a) (b)

Fig 6. Flowchart of Cooling(a) and Heating(b) Process.

The test was carried out by comparing the results of the manual output one day (3 shifts) is 4 times mixing the liquid and the results of the automation output in one day (3 shifts) 5 times mixing the liquid.

A. Cleaning Process Analysis

Mathematical calculation results from an analysis of the cleaning process, which can be concluded that conventional systems take ± 25 minutes, when compared to using the SCADA system, the time required is ± 11 minutes, it can be concluded that using SCADA can save time for ± 14 minutes.

B. Cooling Process Analysis

The results of mathematical calculations from an analysis of the Cooling Process, which can be concluded that the conventional system takes ± 24.30 minutes, this can be compared between the conventional system and the SCADA system which only takes ± 21.00 minutes, it can be concluded that this system can save time for ± 3.30 minutes this writer can describe in a Time Chart.

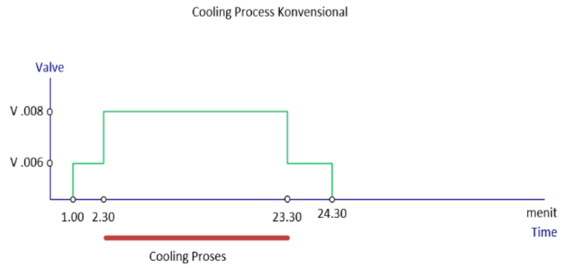


Fig 7. Conventional Process Cooling Time Chart

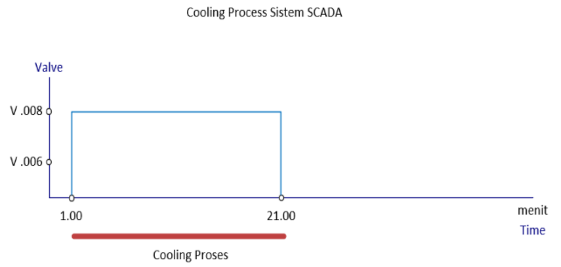


Fig 8. Time Chart Cooling SCADA Process

C. Heating Process Analysis

The results of mathematical calculations from an analysis of the Heating Process, which can be concluded that the conventional system takes ± 64.30 minutes, this can be compared with the SCADA system which only takes ± 61.00 minutes, it can be concluded that this system can save time for ± 3.30 minutes I can describe this in a Time Chart.

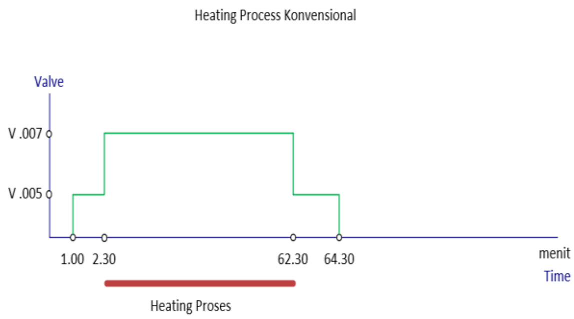


Fig 9. Conventional Process Heating Time Chart

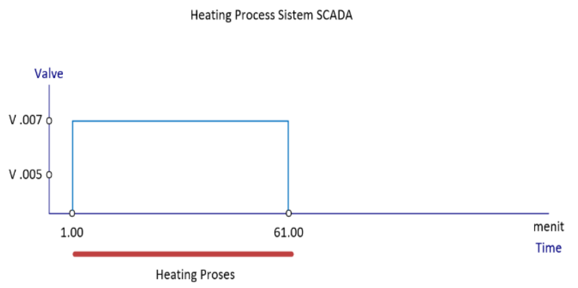


Fig 10. Time Chart of SCADA Process Heating

D. Process Mode Analysis

The results of mathematical calculations from the Process Mode analysis can be concluded that the conventional system takes ± 201.00 minutes, this can be compared with the SCADA system which only takes ± 190.00 minutes, it can be concluded that this system can make time efficient for ± 11 minutes.

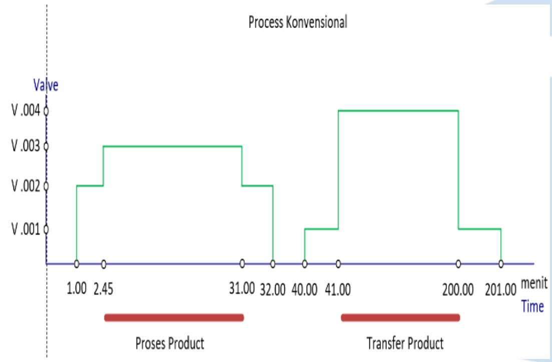


Fig **11**. Time Chart of Conventional Process Mode

Fig 12. Time Chart of SCADA Process Mode

IV. Data Analysis

The results of the mathematical calculation of a system that can be concluded for the conventional system takes a longer time when compared to the SCADA system, this can be seen in the operational mathematical analysis within one full day this can be calculated by combining all processes into one Sequential time optimal and comprehensive.

TABLE 1. PROCESS TIME COMPARISON

No	Process	Conventional	SCADA system	Efficiency
1	Cleaning	25 Minutes	10 minutes	20 minutes
2	Process	201 Minutes	190 Minutes	11 Minutes
3	Cooling	24.30 Minutes	21 Minutes	3.30 minutes
4	heating	64.30 Minutes	61 Minutes	3.30 minutes
5	ready	60 Minutes	60 Minutes	0 minutes
Total		375 minutes	342 Minutes	38 Minutes

1) *Conventional System*

1 time Production = 375 Minutes = 6.25 Hours / Batch
1 Shift = 8 Hours
3 Shifts = 24 Hours
3 Shifts = 3 Batches
(19.10 Hours + 1 hour Rest in each Shift)

2) *SCADA system*

1 time Production = 342 Minutes = 5.7 Hours / Batch
1 Shift = 8 Hours
3 Shifts = 24 Hours
3 Shifts = 4 Batches
(22.8 Hours + 1 hour Rest in each Shift)

3) *Company Profit Assumption*

The price of the infusion product produced from this machine production 500 cc double port type with the latest 2021 price, which is Rp. 20,000, we hereby calculate the company's profits using the SCADA system are:

1 bag of infusion = 500 cc or $\frac{1}{2}$ $\boldsymbol{Liter}$
1 Tank = $\boldsymbol{2000\ Liter}$
1 Tank = 4000 Bags of Infusion

With this results of the calculation one time production / Batch is 4000 Bag Infusion:

1 bag of infusion = IDR 20,000

4000 Bags of Infusion = IDR 80,000,000 / Batch

From this calculation, it is obtained that if the SCADA system is used, which is Rp. 320,000,000 in 3 shifts, and if use the Conventional system which can only generate Rp. 240,000,000 in 3 shifts, this is a profit difference of Rp. 80,000,000 from 3 shifts a day.

V. Conclusion

- ✓ A SCADA-based system has been created for a prototype hemodialysis mixing tank using a cx-programmer and a cx-supervisory.

- ✓ The production process using the SCADA system results in a more efficient time with a total time difference of 38 minutes/batch.
- ✓ Operations using SCADA technology within 24 hours are able to produce 4 batches of Infusion Bags, while using the conventional system only 3 batches.
- ✓ The SCADA system assumed to be able generate a profit increase of 32% from Rp. 240,000,000/day to Rp. 320,000,000/day.

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