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Implementation of Vijeo Citect in SCADA-Based Industrial Plant Level and Pressure Control

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Abstract. *Implementing an efficient control system in modern industry requires proper integration between SCADA (Supervisory Control and Data Acquisition) software, PLC (Programmable Logic Controller) control, and measurement parameters such as level and pressure. This thesis aims to investigate the implementation of Vijeo Citect software in SCADA-based level and pressure control using Twido PLC control to control field devices related to level and pressure. Vijeo Citect software is configured to monitor and control the system in real-time, as well as integrate data from the Twido PLC to analyze and respond to desired level and pressure parameters. The results of this research illustrate that the implementation of Vijeo Citect in level and pressure control using the Twido PLC as a controller provides an effective and responsive solution. When the surface level is 0% (0 cm), the level transmitter emits a current of 3.85 mAmp and the pressure transmitter emits a current of 3.9 mAmp and when the surface level is 90% (60cm) the level transmitter produces a current of 5.65 mAmp while the pressure transmitter produces a current of 7.81 mAmp with a pressure of 2.5 bar after closing the solenoid valve.*

Keywords: *vijeo citect, plc twido, level and pressure control*

1. Introduction

Level and pressure control is critical in a variety of fields, including industry, technology, and the environment. Level and pressure control is an integral part of processes involving liquids and gases, and contributes to the efficiency, safety and sustainability of operations (Aftab et al., 2016; Aghenta & Iqbal, 2019). Level and pressure control can be done by various methods, including the use of valves, sensors, automatic control systems, and advanced technology such as SCADA (Supervisory Control and Data Acquisition) systems. The main goal is to ensure consistency, safety and efficiency in various processes involving liquids and gases (Mahendra et al., 2021).

SCADA is a computer-based system that can supervise, control and acquire data on a process in real-time. Examples exist in various industries such as the manufacturing industry, waste management industry, gas and oil industry, electrical energy distribution, water distribution and so on (Schneider, 2010). Supervisory control is the most important part of a SCADA system, but apart from these 2 (two) things, there is data acquisition which is the main factor in close loop control as a comparative feedback signal. Data acquisition is a system that functions to measure data on a physical quantity object obtained from a transmitter which will then be converted into electrical signals, collect data and process the data to then be presented according to the desired needs (Listiana & Febrianto, 2022).

Vijeo Citect software is SCADA software which functions to control and monitor industrial processes. This software can be implemented in various industrial applications such as control of level, pressure, temperature, humidity, and so on. In the industrial world, the level of control and pressure is very important to maintain the stability of the production process (Akbar et al., 2020). In general, level and pressure control is carried

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out using a PLC (Programmable Logic Controller) which functions as the brain of the control system. The PLC takes data from sensors or level and pressure gauges and provides control signals to actuators such as pumps or valves to maintain the level and pressure at the desired values.

In implementing the Vijeo Citect software on level and pressure, the Twido PLC is used as a controller between the Vijeo Citect software and hardware installed in the plant such as sensors and actuators (Mahadian, 2017). Vijeo Citect software is used to monitor production process conditions in real time and control the operation of actuators such as pumps or valves. Overall, the implementation of Vijeo Citect software at the control and pressure level using the Twido PLC is the right solution to optimize the control process and increase control efficiency.

2. Method

Design of system block diagrams

The system hardware design in the form of a block diagram is as shown in Figure 1. The parts of the block diagram consist of a SCADA user interface using Vijeo Citect software which functions as system monitoring and control, a Twido PLC is used as a hardware controller, a pump motor is used for filling water in reservoirs, the Pressure Transmitter is used to measure the pressure of water or liquid in pipes, the Level Transmitter functions to measure the water level, the Selenoid Valve functions as an opening and closing valve when the water level is at the minimum or maximum position, the Pneumatic Valve functions to opens and closes the valve when using it for consumers, the Start Button functions to turn on the plant, and the Stop Button functions to turn the plant off to its original position.

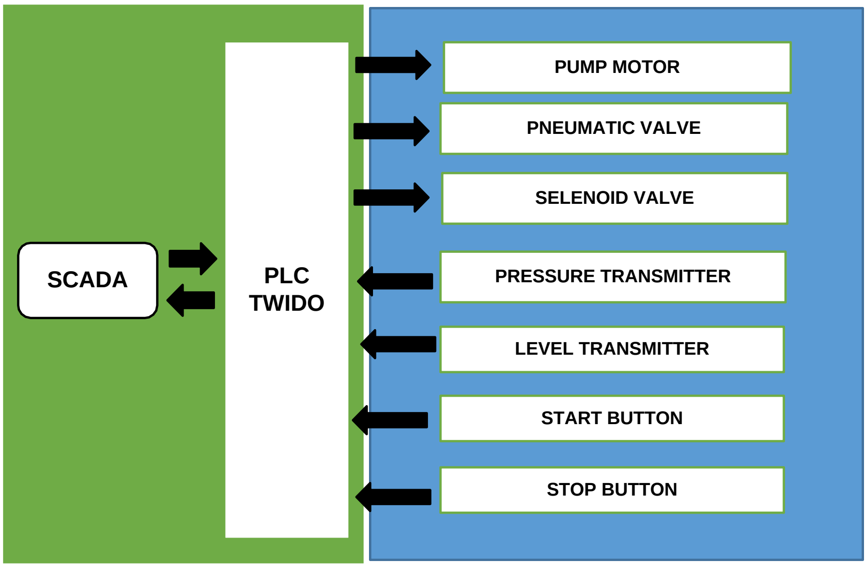

Figure 1. Design of system block diagrams

Level and Pressure Control SCADA Architecture

This level and pressure control SCADA system is built with several main elements, namely a computer, a TWIDO PLC and several input/output elements. Figure 2 is part of the Level and Pressure control SCADA architecture.

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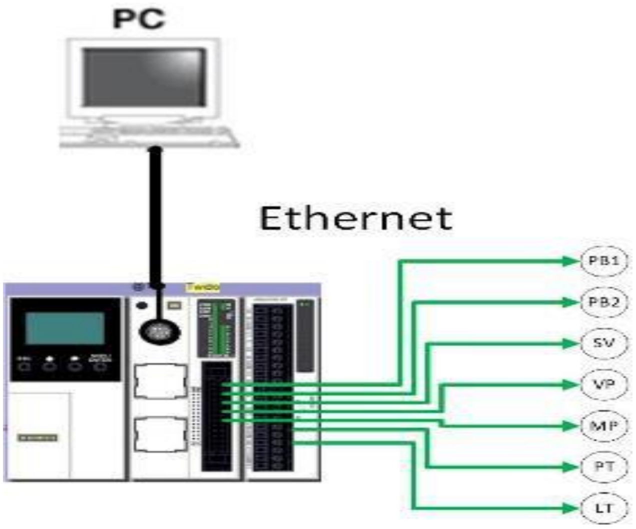

Figure 2. SCADA architecture design level and pressure control

Plant Level and Pressure Control Diagram

Figure 3 is a picture of the plant as hardware that can control level and pressure by means of a pump motor (MP) which will fill from the water source tank to the filling tank up to the maximum surface level of the Level Transmitter (LT), and the solenoid valve (S) will be ON. when charging occurs. The Pressure Transmitter (PT) will sense the water pressure in the pipe, if the pressure read has reached the maximum limit of the water level in the filling tank, the solenoid valve and pump motor will turn OFF again, then the pneumatic valve will turn ON for consumer use.

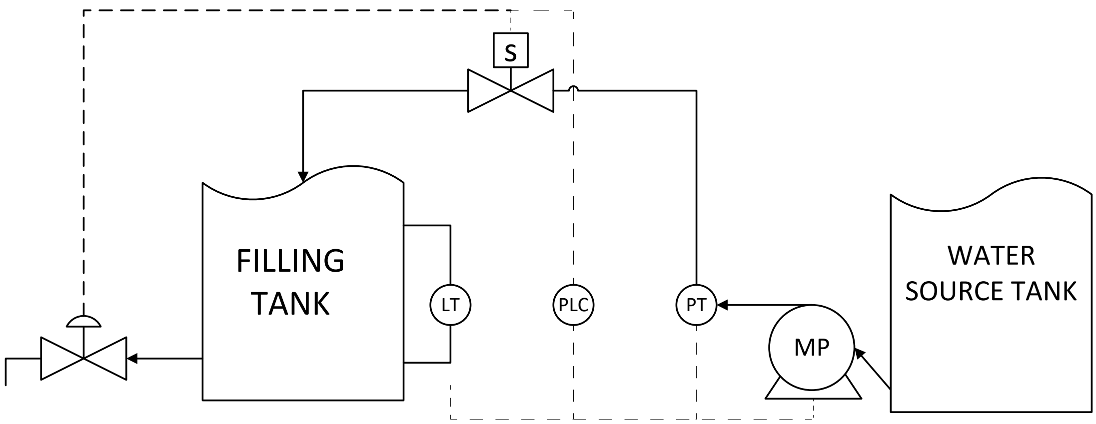

Figure 3. Design of piping instrumentation diagrams for level and pressure control SCADA Device I/O Configuration

In order for the PLC to communicate with the Vijeo Citect software, communication configuration must be carried out. The communication settings in the design of this research can be seen in Figure 4. The communication settings used in SCADA are serial type with a baud rate used of 19200 and Global Time Out speed of 3000 ms and using RTU data mode (8 bits), without using flow control (none) and stop bit (1 bit) and parity (none).

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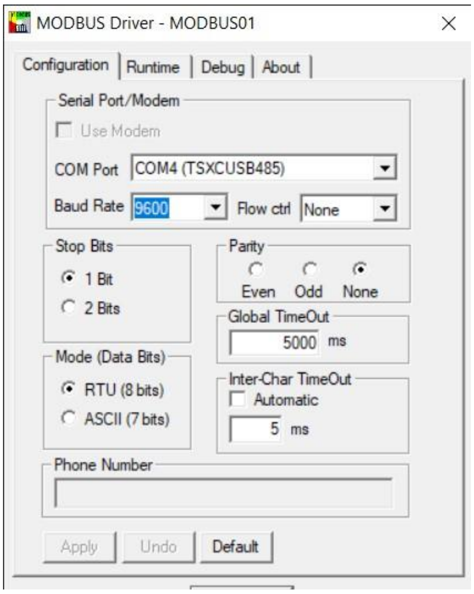

Figure 4. SCADA Serial Modbus Communication settings

3. Results and Discussions

Design Results of Prototype Plant Control and User Interface

This research uses a simple plant design which aims to be used as a practicum module for students to understand the working principles of the system for setting level and pressure parameters using a TWIDO PLC with digital and analog control. The prototype of this simple level and pressure control plant is shown in Figure 5.

Meanwhile, the test results of the user interface display using Vijeo Citect for plant level and pressure control are as shown in Figure 6. Parts of the user interface display in the figure include: Level Indicator as a level display (cm) to determine the surface level of the filling tank, Pressure Indicator to display the given pressure value, Start button to run the plant with red (OFF) and green (ON) indicator lights, Stop button to turn off plant performance with blue (OFF) and green (ON) indicator lights, as well as Pump Motors, Pneumatic Valves and Selenoid Valves with red (OFF) and green (ON) light indicators.

Figure 5. SCADA-based level and pressure control plant prototype

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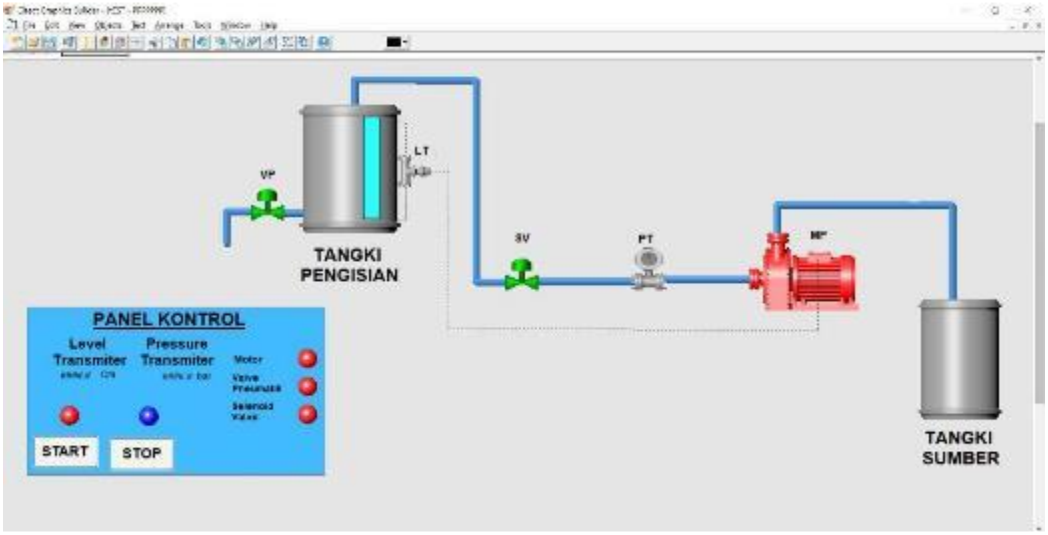

Figure 6. Results of the plant user interface design for level and pressure control

Water Level Test Results in Filling Tank

In this test the water level is measured with a level transmitter (LT), with an input voltage of 24 VDC and an output current of 4-20 mA. Figure 7 shows graphical data on the change value of the water lever in the filling tank against the value of the level transmitter output reading in the form of current. From the graphic image, it can be seen that at a surface level of 0 cm, a transmitter current of 3.85 mA is obtained, while the highest level reading data in this plant is 60 cm with a current output of 5.65 mA. With the number of test samples measured at 5 levels, the average change in transmitter output current obtained for every 15 cm level increase was 0.45 mA. The data trend for changes in the increase in transmitter current with respect to the increase in water level every 15 cm is close to linear.

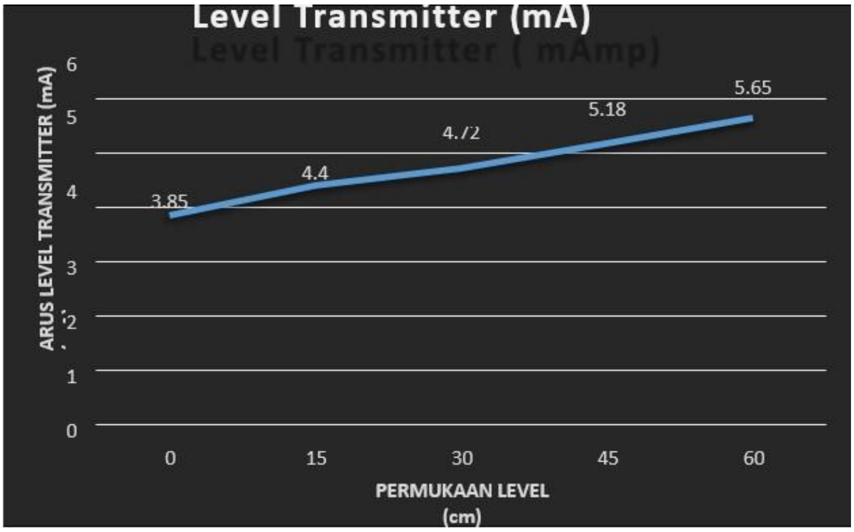

Figure 7. Graphical display of transmitter level output current

Pressure Transmitter Test Results

In testing the Pressure Transmitter (PT) with an input voltage of 24 volts DC and an output current in the range of 4-20 mA, using PLC analog response control. Table 1 shows data on the value of pressure changes that are read against changes in output current on

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the Pressure Transmitter by testing using compressor air pressure. Based on the measurement results, the greater the pressure applied and read by PT, the greater the increase in current obtained. The average increase in current for every change in 1 bar of pressure is 1.50 mA with an average reading error of 5.42% and an increasing trend that tends to be linear.

Table 1. Changes in compressor pressure relative to the pressure transmitter current

Pressure (bar)	Measurement current value (mA)	Actual current value (mA)
0	3.90	4.00
1	5.41	5.66
2	6.96	7.32
3	8.51	8.98
4	10.00	10.64
5	11.90	12.30
6	12.91	13.96

Measurement Results on PLC

Reading the transmitter output value on the PLC uses the value in the compare block. Configuration of the compare block needs to be done to obtain comparable data between the measurement results at the plant and those displayed on the SCADA GUI. Table 2 shows the values in the PLC of the Level Transmitter and Pressure Transmitter. In this table, when the initial condition of the water level is still 0 cm and the pump has not been activated, the Level Transmitter output current already has a value of 3.85 mA and the Pressure Transmitter current is 3.9 mA. When the pump starts to activate and the level in the filling tank starts to rise, the current reading value on the Pressure Transmitter tends to stabilize when the level reaches 15 cm to 45 cm, namely 6.31 mA. When the water level is at its maximum position at a height of 60 cm, the level transmitter output current reaches 5.65 mA and the pressure transmitter output current increases to 7.81 mA, with the value at LT being 25 and the value at PT being 58. The trend of changes in level readings towards the current output from LT can be seen in Figure 8, and the trend of changes in level readings towards the current output from PT is shown in Figure 9.

Table 2. Value in the compare block PLC configuration from LT and PT

Level (cm)	Value at PLC (LT)	Pressure Transmitter (mA)	Value at PLC (PT)	Level Transmitter (mA)
0	0	3.9	0	3.85
15	17	6.31	13	4.40
30	17	6.31	27	4.72
45	17	6.31	44	5.18
60	25	7.81	58	5.65

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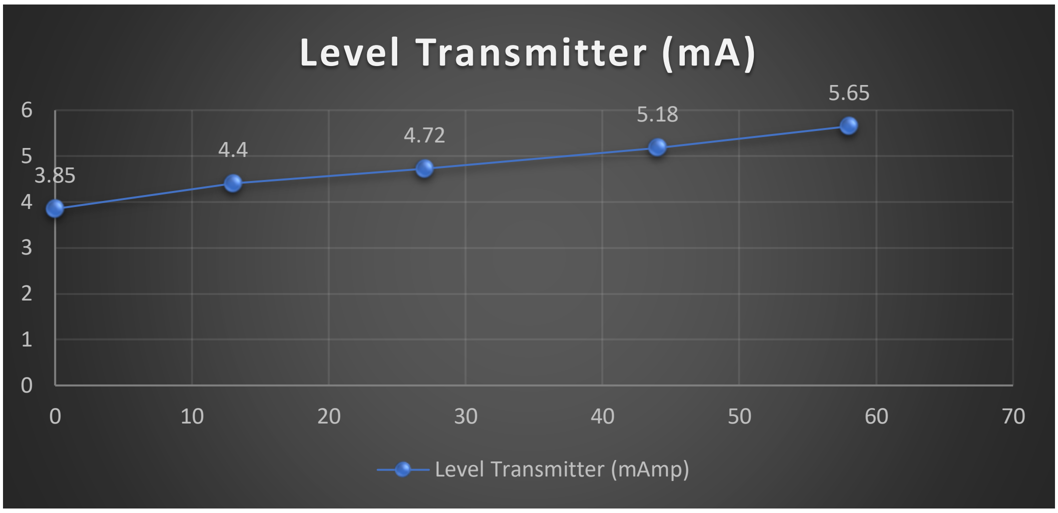

Figure 8. Trend of changes in level readings towards current output from LT

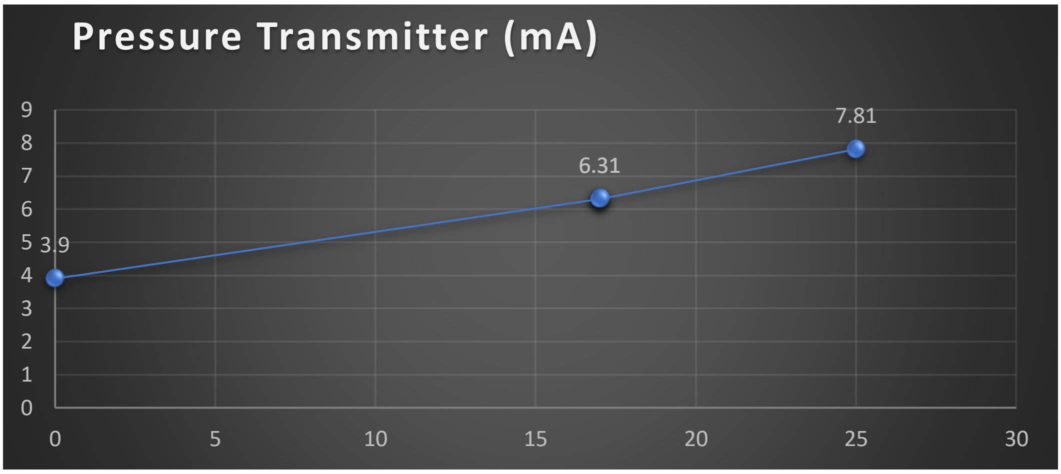

Figure 9. Trend of changes in level readings towards the current output from PT

4. Conclusions

Configuring the Vijeo Citect with the Twido PLC uses the PLC's internal memory address with a variable address for the Vijeo Citect. The Pump Motor (MP) will work when the surface level is 0 cm to 60 cm. If the surface level is already 60 cm, the solenoid valve will close the flow so that the pressure on the Pressure Transmitter increases to 2.5 bar so that the Pump Motor returns to its original position (OFF). When the surface level is 0% (0 cm) the level transmitter emits a current of 3.85 mA and the pressure transmitter emits a current of 3.9 mAmp and when the surface level is 90% (60cm) the Level Transmitter emits a current of 5.65 mA while the Pressure Transmitter emits a current of 7.81 mAmp with a pressure of 2.5 bar after closing the solenoid valve

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