Design Of A Water Level Control System Using Sensor Level Switch And Relay On A Storage Tank Simulator Plant

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Abstract— Storage tanks or more commonly known as storage tanks are one of the units or equipment found in the field of process engineering, whether on a small, medium or large industrial scale. This tool is often found in chemical industries such as the oil and gas industry, petrochemicals, polymers, and others. The uses of this storage tank are very broad. Apart from storage, it is also a medium for flowing fluid to tanks or other units. On an industrial scale, there needs to be control over the use of storage tanks, both in the filling and emptying processes. The control process that occurs is the automatic filling process when the storage tank level touches the lower limit and the filling process will stop when the storage tank level touches the lower limit. designing water level control in a storage tank simulator using Omron relays, where the relay is the main component to help the control process and there is a level switch sensor as a level sensor in the storage tank. The controlled output is turning on and off the storage tank filling pump.

Keywords: Storage Tanks. Relay. Level Switch Sensor, Level Control.

1. INTRODUCTION

Storage tanks or more commonly known as storage tanks are one of the units or equipment found in the field of process engineering, whether on a small, medium or large industrial scale. This tool is often found in chemical industries such as the oil and gas industry, petrochemicals, polymers, and others. The uses of this storage tank are very broad. Apart from storage, it is also a medium for flowing fluid to tanks or other units.

Storage tanks are often cylindrical, perpendicular to the ground with a flat bottom, and a loose or floating roof. There are many environmental regulations that apply to the design and operation of storage tanks, often depending on the nature of the fluids contained within them. Aboveground storage tanks differ from underground storage tanks in the types of regulations that apply. Above-ground storage tanks can be used to contain materials such as petroleum, waste materials, water, chemicals, and other hazardous materials, while meeting strict industry standards and regulations.

In this practical work, the operational system design is carried out on the storage plant simulator in the PPSDM MIGAS instrumentation laboratory. In this storage tank plant simulator, water filling is still done manually. The pump is turned on by the operator when the storage tank water is empty, and the pump is turned off by the operator when the water is full or overflows the storage tank.

Using this manual system can have the effect that when the water is full it will overflow and when the water runs out there is no person or operator to run the pump so the water will not be filled. Therefore, a solution is offered to automate the system using level sensors on the storage tank plan. This system functions to regulate the height of the water level so that the water in the storage tank will not overflow and run out.

2. SYSTEM DESIGN

This system will work with a pump mechanism that will fill the tank when the low or lower-level switch level sensor detects that the water level in the tank is below the sensor. The pump will fill the tank until the high-level switch sensor detects that the water level in the tank has passed the sensor, then the pump will turn off. When the water in the tank is used or consumed until the water level in the tank touches the low-level switch level sensor again, the pump will turn on again and start filling water into the tank. The buzzer in the system is used as an alarm or indicator that the water level in the tank has reached a low level or high level. The

sensor system installed on the tank uses a level switch high sensor with a NO (Normally Open) configuration and a low switch level sensor with an NC (Normally Close) configuration.
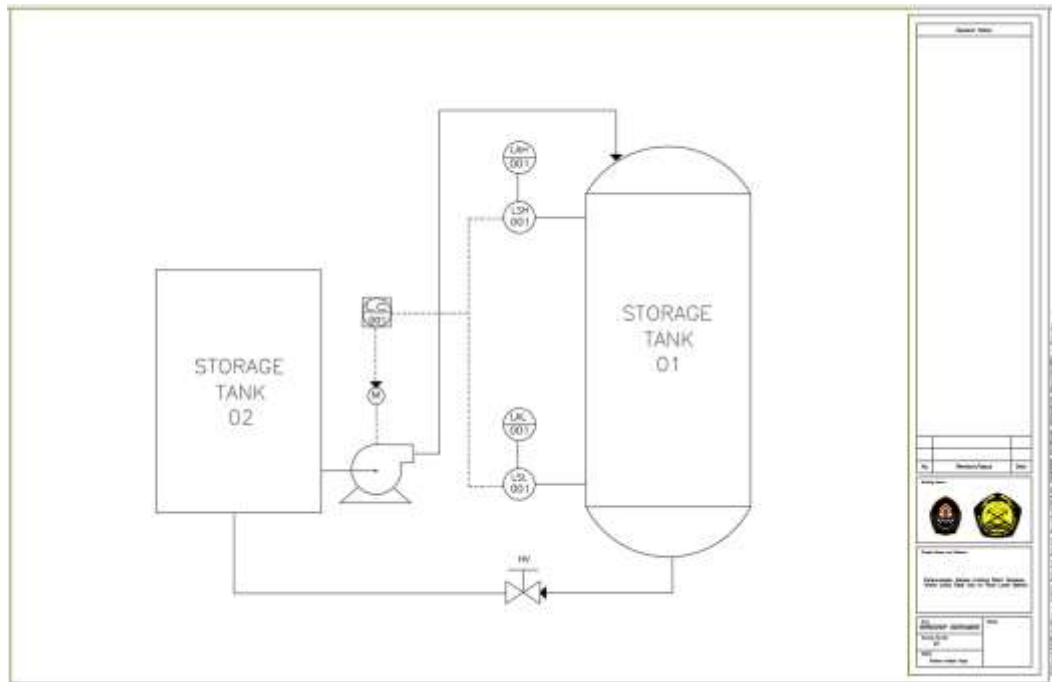

Figure 2. 1 Flow Diagram Storage Tanks Simulator Plant

2.1 Automation System Design

Based on the existing process mechanism, the process inputs and outputs obtained for wiring and system logic purposes can be determined, which can be seen in the table below:

Table 2. 1 System I/O

No.	Input	Output
1.	Sensor Level Switch High	Pump OFF, Pump OFF Indicator Light, High Working Level Switch Indicator Light, and Buzzer
2.	Sensor Level Switch Low	Pump ON, Pump ON Indicator Light, LOW Working Level Switch Indicator Light, and Buzzer
3.	ON button	System ON, System Indicator Light ON
4.	OFF button	System OFF

Table 2. 2 System Table

Input				Output		Description
ON	OFF	LSH	LSL	Pump	Buzzer	
0	0	0	0	0	0	Standby
1	0	0	0	0	0	System ON
1	0	0	1	1	1	Level Low, Pump ON
1	0	0	0	1	0	Fill Pump
1	0	1	0	0	1	Level High, Pump OFF
1	0	0	0	0	0	The water in the tank decreases
1	0	0	1	1	1	Level Low, Pump ON
0	1	0	0	0	0	System OFF

2.2 Working Principles of the Water Level Control System

This system works when the on button is pressed then the system will be active. When the low level sensor detects that the water level is at the bottom of the tank, the pump and buzzer will turn on. The pump will start filling the tank with water. When the water level in the tank has passed the lower limit or is in the middle of the tank, the buzzer will turn off and the pump will remain on to continue filling the tank until the water level in the tank reaches the upper limit of the tank. When the high level sensor detects that the water level in the tank is at the upper limit of the tank, the pump will turn off and the buzzer will turn on. When the water in the tank is used and the water level is below the upper limit of the tank or in the middle of the tank, the buzzer will turn off and the pump will remain off until the water in the tank reaches the lower limit so that the pump and buzzer will turn on again to fill the tank. This system will run continuously. When the off button is pressed, the system will turn off and all processes will stop, the system is in standby state.
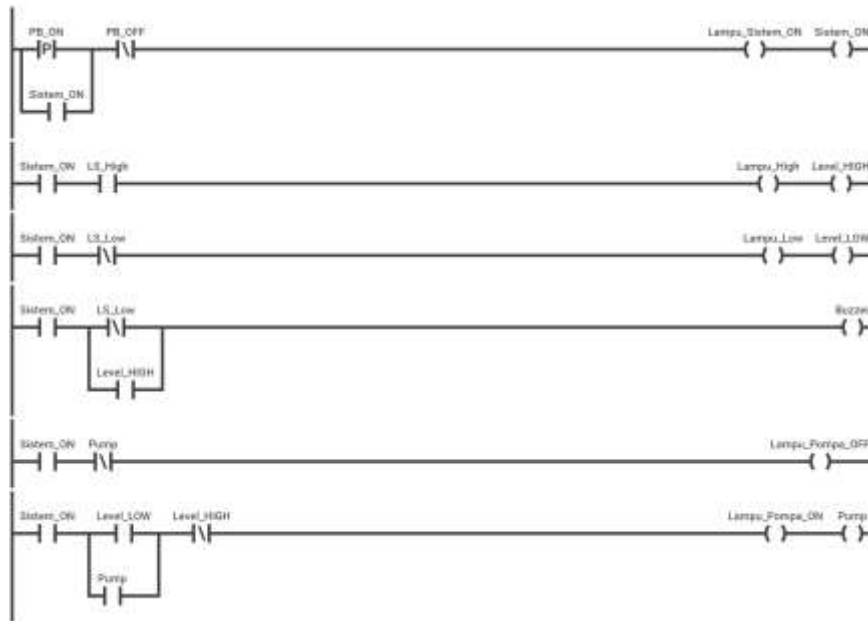

Figure 2. 2 Ladder Diagram Logic

2.3 System Wiring

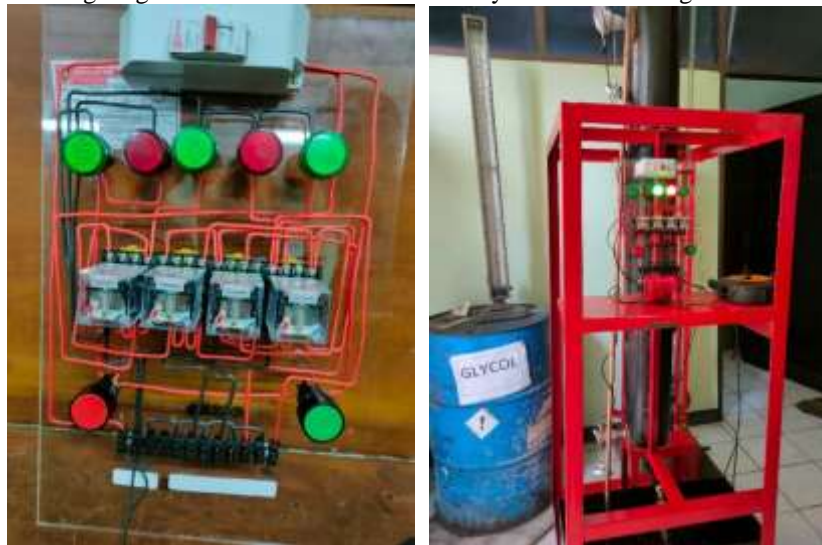The following is a wiring diagram for the water level control system in the storage tank.

Figure 2. 3 Control System Wiring

The following is a wiring diagram image of the water level control system using level switch and relay sensors in the storage tank plant simulator.
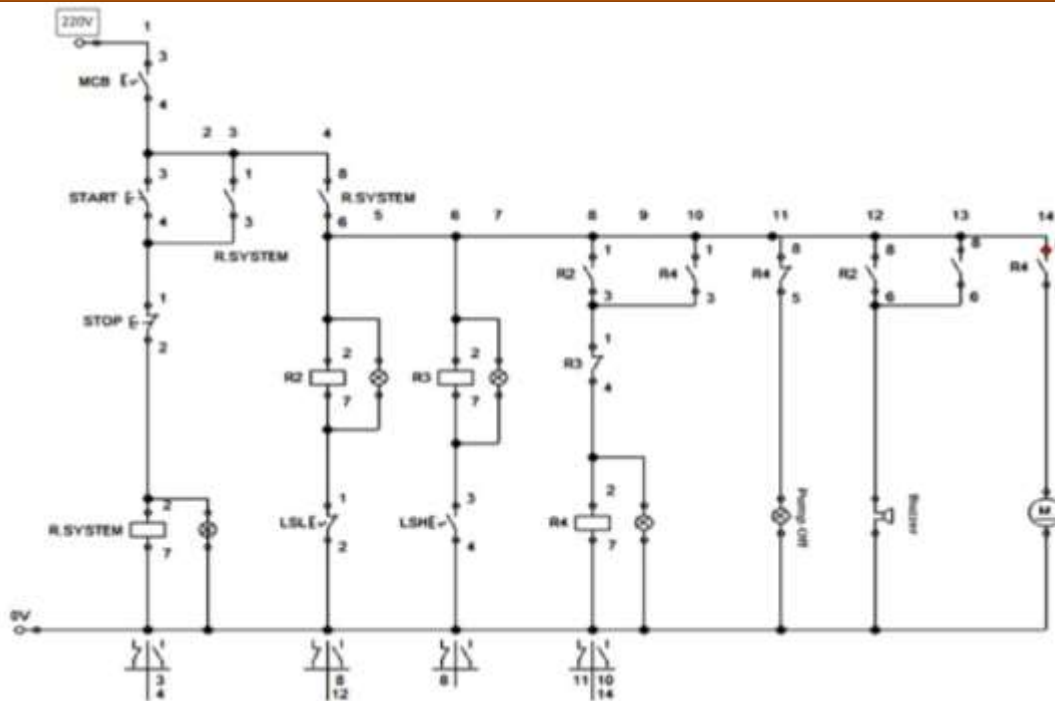
Figure 2. 4 Wiring Single Line Diagram Control System

The working process of the above system is
1. The system will error if the operator presses the start button, and will turn off when the operator presses the Stop button
2. The sensor system works in normal conditions, when the system is not yet running, Level Switch Low (LSL) is in NC condition, the buzzer and pump will turn on to fill the storage tank, when the water is above the Level Switch Low (LSL) sensor, the sensor will change to Normally Open (NO) and the buzzer will turn off.
3. The working system of the Level Switch High sensor in Normal conditions is Normally Open (NO), if the water is above the Level High sensor, then the condition will change to Normally Close (NC) the buzzer goes off and the relay automatically turns off the pump.

3. Discussion
3.1 Simulation and System Test
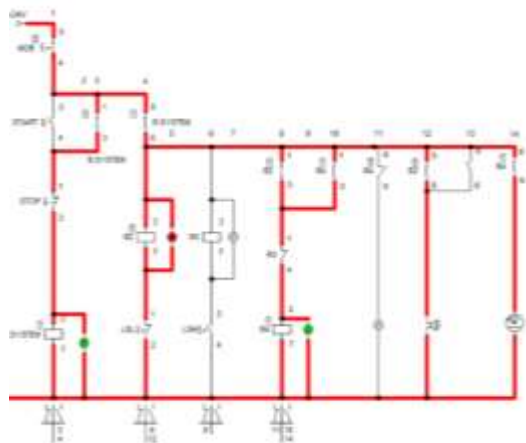A work simulation is carried out on the system as follows:

Figure 3. 1 Filling Tank Simulation

Figure 3. 2 System Test Filling Tank

The following is the working process of the water level control system in a storage tank with Level Switch Low Normally Close (NC) conditions:

1. Operate the water level control system by pressing the start button and deactivating the system by pressing the stop button.
2. The image above shows that the Level Switch Low (LSL) sensor in this system is in Normal Close (NC) condition.
3. When the Level Switch Low (LSL) sensor is in the NC condition, the indicator light will turn green, then the buzzer alarm will sound as an indicator, the pump is wrong, getting a command from the relay and if the pump is running, the light will turn green on relay 4.
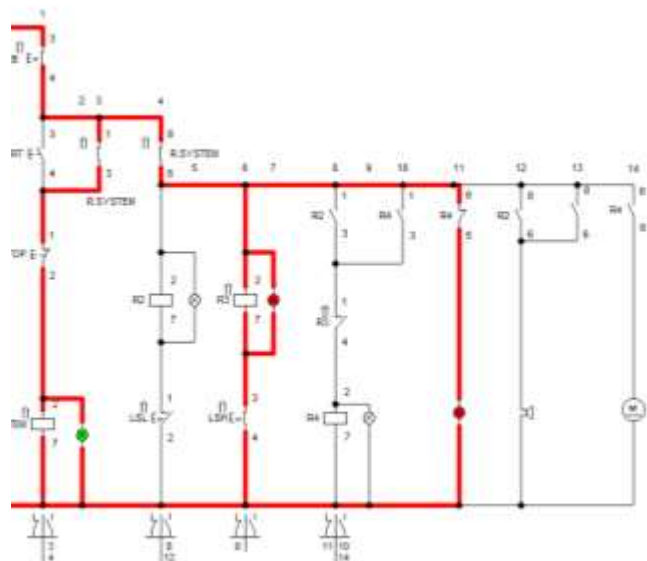

Figure 3. 3 Simulation Pump OFF when Level Switch High (LSH) in Close Condition
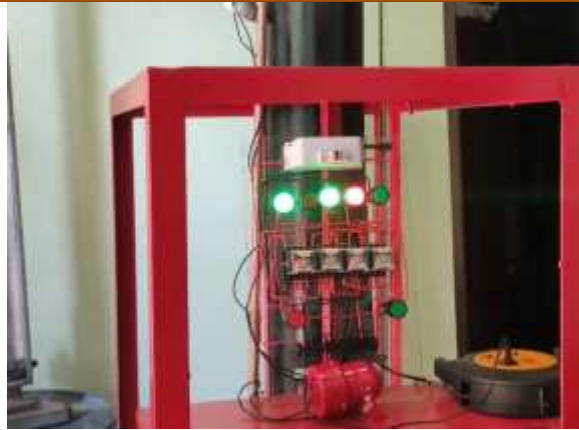
Figure 3. 4 Pump OFF When LSH in Close Condition Test

The following is the working process of the water level control system in a storage tank with Level Switch High Normally Close (NC) conditions:

1. Operate the water level control system by pressing the start button and deactivating the system by pressing the stop button.
2. The image above shows that the Level Switch High (LSH) sensor in this system is in Normal Close (NC) condition.
3. When the Level Switch High (LSH) sensor is in the NC condition, the indicator light turns red on relay 3 then the buzzer alarm will sound as an indicator, the pump will stop receiving a command from relay 4

4. Conclusion

From the practical work that has been carried out for approximately 4 weeks, the author can conclude the results of the Water Level Control System Design Using Sensor Level Switches and Relays in the Plant Simulator Storage Tank:

1. Storage tanks are used as storage or as a medium for flowing fluids to tanks or other units and are one of the units or equipment found in the field of process engineering, whether on a small, medium or large industrial scale.
2. The level switch is an instrumentation component that is used as a sensor to detect the fluid level in the tank.
3. Relays are electromechanical components that work with electromagnetic principles to move switch contacts so that with a small electric current (low power) they can conduct higher voltage electricity, apart from that relays can also be used for control and protection systems.
4. Based on the design, it can be concluded that the automation system in the storage tank plant simulator is very helpful for users so as not to manually turn a pump On-Off. If the water pump in this system is turned on continuously, it can also cause the pump to heat up and waste power supply, so this automation can increase the efficient performance of the pump and the pump will not overheat easily.

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