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Design of A Portable Trainer Simulation of Coal Distribution and Boiler Water Control Process in PLTU Based on PLC

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ABSTRACT

The purpose of this research is to simulate the coal distribution process using a conveyor and water regulation in the boiler whose program is made using PLC-based CX-Programmer software. The first method used in the conveyor work process is to install several lights and 2 motors on each conveyor as many as 5 conveyors are connected with a timing belt as an indicator that the conveyor is working. The second method used in the simulation of water regulation in the boiler is almost the same as the conveyor system, namely by installing several motors and lights as indicators of the boiler working, as well as adding a high/medium/low sensor to adjust the water level. The conveyor and boiler systems work automatically using PLC devices that have been programmed through the CX-Programmer. In the 3-phase (reverse-forward) motor load test, the following data were obtained: PLC input voltage is 224 Volts, V line voltage is 396 Volts, motor input voltage is 398 Volts, and motor current is 1,6 Ampere. The result of this research are used as additional measurable equipment in the energy conversion laboratory which previously amounted to 2 test equipment into 3 test equipment.

Keywords: PLC, Conveyor, Coal, Boiler.

Introduction

Coal-based Steam Power Plant is still the foundation of the State of Indonesia to meet domestic energy needs; according to the exposure of PLN Mega Project Director Muhammad Ikshan Asaad, the role of PLTU still dominates by 50.4% or 31.827 Mega Watt of the total energy generation produced[1][2]. It can be imagined the energy crisis that will occur if PLTU in Indonesia has difficulty supplying coal or water in the process. Over time, the control system was created in the form of a programmed control that uses PLC[3]. (Programmable Logic Controller). PLC is a system specially designed to perform control functions in various types of processes with low to high levels of complexity[4]. In other words, the more complex the processes to be dealt with, then the use of PLC will be more important to facilitate those processes[5].

There are several factors driving the development of PLC systems in recent decades. First, the high level of flexibility of the PLC system [6]. In the previous system, for each electronically controlled production machine its respective control system was required. That is, if there are 20 engines, there may be 20 different controllers available[7]. Using a PLC system, fewer controllers are needed to operate 20 of these engines [8].

Almost all applications that require electrical control require PLC. One example of the application of PLC can be found on the coal distribution system (conveyor) and the process of setting water boilers on PLTU [9][10].

Research Methods

The first method used in the conveyor work process is by installing several lights and 2 motors on each conveyor of 5 conveyors that are connected to the timing belt as the indicator of the Conveyor works [11]–[18].

The second method used in the simulation of water settings on boilers is almost the same as the conveyor system by installing several motors and lights as the indicator of the boiler works, as well as adding a high/medium/low sensor to regulate the water level. The conveyor and boiler systems work automatically using PLC devices that are already programmed through the CX-Programmer[19]–[26].

Results and Discussion

Testing of coal simulation

From the simulation testing of coal distribution using the conveyor that has been carried out, the results were obtained that the application of the ladder diagram on the CX-Programmer went well [27]–[34].

Here are the details of the results of the PLC trainer's work on the simulation testing of the conveyor:

1. When the push button 2 is pressed, then the X1 light turns on and the M1 engine rotates indicating that the conveyor A is working. Conveyor A serves as a carrier of coal from coal ship unloader to coal yard.
2. When the push button 4 is pressed, then the X2 light turns on and the M2 engine rotates indicating that the B conveyor is working. Conveyor B serves as a coal transmitter to conveyor C.
3. Ten seconds after the B conveyor is working, the X3 light turns on and the M3 engine rotates, indicating that the C conveyer is working. Conveyor C serves as a coal transmitter to the crusher house.
4. Ten seconds after the C conveyor works, the M4 engine rotates indicating that the crusher house is working. In the crusher house, coal is smoothed before moving forward to the D conveyor.
5. Ten seconds after the crusher house conveyor works, the X4 light turns on and the M5 engine rotates indicating that the D conveyer is working. Conveyor D serves as a coal transmitter to conveyor E.
6. Ten seconds after the D conveyor works, the M6 engine rotates which indicates that the E Conveyor is working. The conveyor serves as a carrier to the coal bunker.
7. When the push button 6 is pressed, then the X6 light turns on indicating that the coal bunker is working. Coal bunkers serve as coal shelters before moving on to coal pulverizers.
8. Ten seconds after the coal bunker works, the X6 and X7 lights light up, which indicates that coal pulverizers work before coal proceeds toward the boiler to be burned.

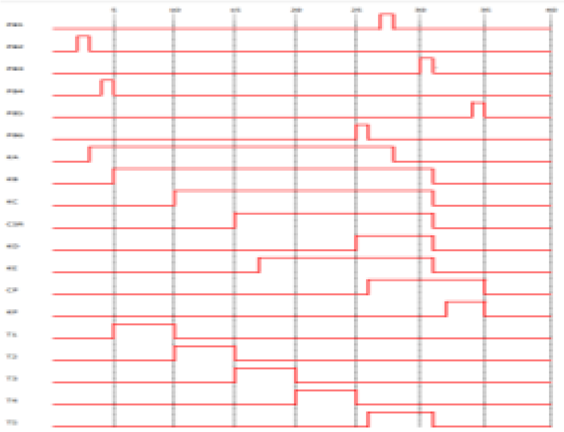
Testing Simulation of Water Boiler Setup on PLTU. From the simulation testing of the water setting on the boiler that has been carried out, it was obtained the result that the application of the ladder diagram on the CX-Programmer is in accordance with the control diagram which has been created.

Here are the details of the results of the work of the PLC trainer on the simulation testing of the water setting on the boiler:

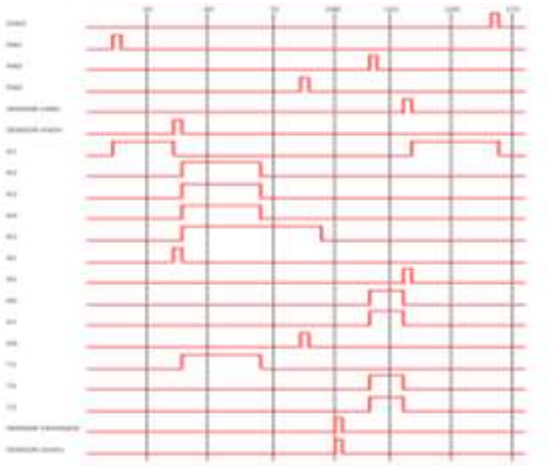
1. When the push button 1 is pressed, then the X1 light turns on and the M1 engine rotates indicating that the feed water pump is working. The feed water pump serves as a water supply to the steam drum.
2. When the water level has already reached a high position and the high sensor is pressed, at the same time, the X2 light, X4 lamp, X6 light, and the X9 light are lit, and M2 motor, M3 engine, M4 motor is rotated. The X2 light turns on and the M4 engine rotates which indicates that the Primary Air Fan (PA Fan) is working. The PA Fan serves as a primary air supplier. The X9 light turns on and the M2 engine rotates indicating that the blower is working. The blower serves as an air transmitter for the burning of boilers. The X6 light is on indicating that the burner is working. The burner serves as a burner in the boiler's combustion chamber. The X4 light is lit and the M3 engine is rotating which indicates that the fuel pump is working. Fuel pump serves as a water supply to the boiler. After 15 seconds, the X4, the X6, the X9 lights will stop lighting, and the M2 engine, the M3 engine will stop rotating.
3. If the combustion is not complete, press the push button 3. When the push button 3 is pressed, then the X3 light turns on and the M5 engine rotates indicating that the FD Fan is working. PD Fan serves as a secondary air supply.
4. When the push button 2 is pressed, the X5 light turns on indicating that the ash conveyor is working. Ash conveyor serves to channel ash from the ashes disposal part of the boiler. The X7 light is also lit and the M6 engine rotates which indicates that the Fan ID is working. (for 10 second). Fan ID serves as an exhaust gas sucker before it is driven to the stack.

Conclusion

Results of timing diagram testing.



Picture of 1. Timing Diagram Simulation of Coal Channeling using Conveyor



Picture of 2. Timing Diagram Simulation of Water Boiler Setup

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