Electrical Motor Interference Monitoring Based On Current Characteristics

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Abstract. The use of electric motors of the industrial world is as a motor for production equipment. One example of using an electric motor is a conveyor. The conveyor has a long operating time. Conveyors can move objects from one place to another. Therefore, the condition of the conveyor machine must be good so that there are no operational errors. Errors in conveyor operation can result in delays in the production process. From these problems, research is made on a controller and monitoring of electric motors on the conveyor based on current parameters. This electric motor monitoring is based on Programmable Logic Control. This system is designed by utilizing a Current Transformer to measure the current in each electric motor. This current condition detects the condition of the electric motor in real time. If there is a change in a current that is not in accordance with the normal current, the system will detect a disturbance. This system can also control the direction of motor rotation. This system can inform all forms of disturbances to electric motors in the form of indicators and graphs of current movements in real time.

1. Introduction

The electric motor is one of the equipment that is widely used by the industrial world as a driving machine. One of the uses of electric motors in production equipment is conveyors [1], [2]. The conveyor machine has more than one motor as a driving force. The conveyor machine also has a long operating time. Conveyor machines are used to move goods from one place to another. Therefore, the condition of the conveyor machine must have good and stable operational quality. During the production process, you must always pay attention to the condition of the conveyor machine so that if there is an error in the operation of the machine it can result in obstruction of the production process. Examples of conveyor failures such as those that occur in an induction plant can cause the engine to burn.

With these problems, we need a system that can detect any disturbances or abnormal conditions installed on the conveyor machine [3], [4]. The current disturbance detection system still relies on the operator by checking it manually. This condition can cause human error indirectly due to the inaccuracy of the recorded data. Usually technicians are lazy to do periodic checks because they require a large amount of energy to check industrial machines. So it is necessary to make a real-time and accurate machine condition detection system. This system can also make a screen display to make it easier for the operator to check the machine. This does not require a lot of time and effort. One of the methods used is to use Current Transformer (CT) to retrieve current data from each electric motor on the conveyor. With the use of this CT, it can be seen the current value issued by the motor when it
starts working normally or abnormally. Motor current condition data can be displayed on the HMI display in the form of a real time flow chart use Programmable Logic Control (PLC) [5]–[7]. The condition of the motor current when starting with normal, shows the current movement on the screen. The current characteristics of the HMI can determine which electric motor is having problems. So that the warning indicator can be informed to the operator to check and maintain.

2. Control System

2.1. Programmable Logic Control (PLC)

PLC is a digital electronic device with programmable memory. This programming is to store instructions that carry out specific functions such as: logic, sequences, timing, counting, and arithmetic. This programming is to control an industrial machine or industrial process as desired. In executing the program, the PLC requires a scan time for one execution cycle. This scan time consists of several processes, namely internal processing, input reading, program processing and output. Program processing is the PLC process in processing input data according to the program being made. The output process is the PLC process in issuing data to be issued which is added to the PLC. All of these processes are carried out sequentially and will always be repeated. In this study using a PLC Modicon M221 type.

2.2. HMI

HMI (Human Machine Interface) is a computer-based interface software in the form of an interface between humans and controlled machines or equipment. HMI can make visualization of technology or real system. This visualization is complemented by real data and in accordance with the conditions in the field. The vision is displayed on the monitor in the control room in real time. This visualization can be accessed online via electronic equipment. For small-scale processes such as in subsystems, the HMI used can be a simpler touchscreen display. In HMI there is also a visualization of the engine control can be used to control or control the machine properly. In addition, the HMI also displays an alarm if a fault condition occurs.

2.3. Software SoMachine Basic

SoMachine Basic is a software or software to create a program on the PLC Modicon M221 type. The software is released for free and can be downloaded on website. This software is very light with a size of no more than 500MB, and is compatible with the Windows 10 Operating System (OS). This software has advantages, namely:

a. Easy in programming.

b. Easy commissioning (programming via USB / Ethernet, upload function, save custom data restore).

c. Flexibility and Scalability.

2.4. Current Transformer (CT)

Current transformers (CT) generally function as a tool for measuring large currents. CT functions so that measuring instruments (ampere meter, cos phi meter, watt meter, etc.) can be used to measure currents that are much larger than their original capacity. By using a CT, a measuring instrument with a nominal current of 1A or 5A can be used to measure currents of hundreds to thousands of amperes. CT works by "reducing" the current value measured by a certain ratio to the value that can be measured by the measuring instrument. For example, an Ampere Meter with a nominal current of 5A, meaning that the Ampere Meter can only pass a maximum current of 5A. The ampere meter will be used to measure the current on the MDP (Main Distribution Panel) panel, where the maximum current reaches 100A. Because the nominal current to the Ampere Meter is only 5A, if it is installed directly into the MDP to measure a current of 100A, the Ampere Meter will burn. To avoid this, we need a current transformer capable of measuring 100A of current on the primary side and outputting a current of 5A on the secondary side. We can choose a CT with a ratio of 100 / 5A.
2.5. Selector Switch

Basically, the Selector Switch is a contact / switch that is moving with a button or rotary lever to select one of two or more positions. There are things that act like a toggle switch where the selector can stop at one position, and there are those that act like a push button, where after making a selection the selector will return to its original position or neutral position.

Working Principle of Selector Ammeter

The ammeter switch selector here functions as an option for checking the amount of electric current for each phase at the load of a 3-phase induction motor. The way it works is by turning the switch to the right or left in accordance with the amount of flow which we want to check. The meaning of the code attached to the switch selector is as follows:

0: neutral position selector (no Current)
R: phase current measurement (R)
S: phase current measurement (S)
T: phase current measurement (T)

3. Results and Discussion

3.1. System Scheme

[Fig. 1. System Scheme]

In the schematic created, it explains the main source for the load using 3 phase 380 with a 3 Phase induction motor load, control of the load using a PLC that has been programmed and all controls and information will appear on the HMI screen, where the CT is a current sensor whose data will be entered into PLC to be processed and displayed in the form of real time graphics on the HMI display, besides HMI, there are also pushbutton and indicator lights that can be operated manually by the user without going through the HMI display. System scheme as shown in Figure 1.

3.2. Testing of Starting Load System at HMI

[Fig. 2. Starting load system testing at HMI]
When the system is activated and the FWD / REV command is pressed, the FWD / REV indicator will light up, then after 10 seconds of motor load indicators 1 and 2 will light up followed by the starting indicator blinking which indicates that motor load 1 and 2 have started. The 10 second delay is made when the user wants to change the direction of rotation from FWD to REV, there is no need to turn off the entire system, but only with the REV command, FWD will automatically turn off replaced with REV that turns on then after 10 seconds M1 and M2 followed by starting back on. The starting indicator is used so that when the current surges high it is not considered a disturbance, then if when starting one of the motors it does not turn on then the inactive motor indicator will be seen. Starting load system testing at HMI as shown in Figure 2.

3.3. Conveyor Design

![Conveyor Design](image)

Fig. 3. Conveyor Design

From the conveyor design in Figure 3, there are two drives using a three-phase induction motor and two load testers on each motor. This load tester serves as a load test on each motor which will later be used for case studies of disturbances in the conveyor machine. Case studies through a load tester starting from full load by increasing the pull of the load tester until the current reads the same as the nominal current of the motor. Overload by exceeding the pull of the load tester until the current exceeds the nominal current of the motor. Even if there is wear on the belt, the test is carried out by increasing and decreasing the load continuously. Continuous testing as if there is a slip on one of the roller belts used, then from this test it can be seen that the current reads as a detection of disturbances.

4. Results and Discussion

4.1. When Starting Without Load until stable

![Start current display at HMI](image)

Fig. 4. Start current display at HMI
This test is to display the motor starting current without load until the current value is stable. This stable current condition takes two seconds from the starting current condition. This test is displayed on the HMI numeric display. The condition when the starting current can be seen in Figure 4. The current condition has reached stable, can be seen in Figure 5.

4.2. Interference Detection Testing

In this Overload test, the current is 0.5 A below the maximum current that has been entered into the system, so the load indicator that is overloaded will flash an exclamation point and the OL indicator will also flash, simultaneously the Fault time continues to calculate the length of time the Over Load occurs and calculate the total Fault the number of times overloaded once the load is activated. When
one of the loads reaches its maximum current limit, the fault indicator lights up and the load turns off. Then followed by the load indicator that the fault is also off. When all loads reach their maximum current limit, the fault indicator lights up and all loads experiencing the fault are off. then followed by the load indicator that the fault is also off. The condition when one of the loads is overloaded can be seen in Figure 6. The condition when all loads are overloaded can be seen in Figure 7.

4.3. Testing System Fault on Load

The HMI display condition when two motors experience a fault can be seen in Figure 8. The current condition when the fault is as shown in Figure 9. The load current has reached and exceeds the maximum current limit entered into the system, the Fault indicator lights up and all loads that experience the disturbance die followed by the load indicator that experiences Fault also dies. In this Fault detection test, the operator can find out through the HMI display and which load hardware is experiencing the Fault. On loads that have experienced faults can resume operation after the whole system is OFF and restart again.

5. Conclusion
a. Based on the results of testing and analysis carried out on these tools, conclusions can be drawn:
   b. PLC program can communicate well with HMI, this can be seen from the HMI display.
   c. HMI operations are only for authorized operators with registered user names and passwords.
   d. The operation of the motor rotation direction control can automatically be reversed directly without shutting down the entire system.
   e. Indicators as system condition information are complete enough to display warnings and a numerical display of load currents.
The displayed flow graph has a real-time update time of one second and can be flipped back to the previous chart record. For future research, can add temperature detection device, vibration, and which is a tool to detect motor load conditions when working. Can also add IoT-based monitoring so that it can also be monitored when not at the job site.

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