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ANALYSIS OF ELECTRICAL FAULTS IN THE CRANE HOISTING CONTROL PANEL AT THE SEI DAUN PTPN 3 PALM FACTORY

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ABSTRACT

The frequent issues encountered in the palm oil processing process at PTPN 3 Sei Daun primarily involve electrical disruptions in the hoisting crane control panel. These damages have adverse repercussions for the company, resulting in production halts. The objective of this research is to analyze the root cause of the issue and subsequently determine maintenance and efforts to anticipate these disruptions. One of the problems that often occurs is a damaged contactor, which results in it stopping the operation of the hoisting crane itsel. The expected outcome of this research is to minimize the occurring damage, optimize maintenance, and prevent breakdowns, allowing the company to optimize its palm oil processing.

Keywords: *Hoisting Crane, Control Panel,Kontaktor*

INTRODUCTION

Oil palm is one of the most essential plantation commodities in Indonesia and serves as a source of foreign exchange. Palm oil is essential to Indonesia because it provides new jobs for the community. The flesh part of the oil palm fruit can be converted into crude palm oil and reprocessed into oil raw materials. However, several machines are involved in palm oil processing before being processed and used in everyday life.

One of the tools used in the Sei Daun PKS is a Hoisting Crane with a capacity of 5 tons. The tool is a lifting aircraft used to move oil palm during production. The Control Panel is the main component that plays a vital role in Hoisting Crane. The control panel on the crane is a central control system that regulates the power distribution and indicators of the electrical system on the Hoisting Crane in case of damage. The Hoisting Crane Control Panel functions as a control center, consisting of the main switch, direction control, speed control, and other switches used to turn on or off the crane hoist. As production progresses, there is often a disturbance in the Hoisting Crane component, which causes downtime on the Hoisting crane. Therefore, a better maintenance approach is needed to reduce the downtime ratio on the Hoisting Crane machine so that production activities are not disrupted.

Problem Statement

Based on the background of the problem above, the problem formulations in this study are:

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1. What causes interference in the form of contactor damage to the Hoisting Crane control panel
2. How to determine the cause of interference in the form of contactor damage to the Hoisting Crane Control Panel.

Problem Limitations

1. This research only analyzes disturbances in the form of contact damage.
2. Does not discuss disturbances that are mechanical Hoisting cranes.

Research Objectives

The objectives to be achieved in this research are:

1. To determine the cause of electrical faults in the Hoisting Crane Control Panel.
2. To determine the optimal maintenance action so the machine can operate adequately.

Research Benefits

1. Provide knowledge about what damage can occur to the Hoisting Crane Control Panel.
2. Become a reference for PTPN 3 in designing effective and efficient maintenance methods to optimize production results.

THEORETICAL BACKGROUND

Hoisting Crane

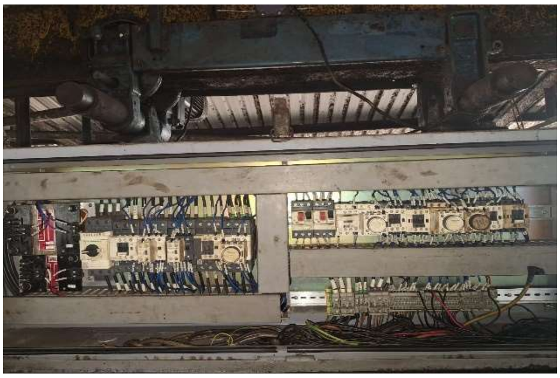
The Hoist Crane electric motor is the type of motor that is most widely used in industry, one of which is the Hoist motor as a Hoist drive motor in the production building, packing building, and warehouse, which aims to move an item (load) where the load is in the form of a lorry containing ripe FFB. According to how it works, the Hoisting Crane at Sei Daun PKS has 3 Electromotors, which have their respective movements: the Hoist, Traveling, and Tilting.

Figure 1. Hoisting Crane

Crane Panel Kontrol Hoisting Crane

The control panel on a crane is the central control system that regulates the power distribution and the electrical system's indicators on the crane in case of damage. The control panel consists of various electronic and mechanical components designed to ensure the safe and efficient operation of the crane hoist. The function of the crane hoist control panel is to control the operation of the crane hoist, including lifting and lowering heavy objects, moving objects from one place to another, and regulating the Hoisting Crane's speed and direction of movement. The voltage in this control panel is divided into 2, namely 380 volts for the electromotor power source on the Hoisting Crane and 42 volts for the control voltage supply, which is lowered using a step-down transformer. The hoisting Crane control panel serves as a control center, consisting of the main switch, direction control, speed control, and other switches used to turn on or turn off the crane hoist. Some of the components contained in the crane hoist control panel are :

1. Circuit Braker
2. Contactor
3. Trafo step down
4. Limit Switch
5. Timer On Delay
6. Joystick.



Figur 2 Panel Control.

ContaCtor

Contactors are electrical equipment that works based on the principle of electromagnetic induction, a connecting device, or an electric switch that works based on a magnet that can connect the electricity supply with the load, in this case, in the form of an Electromotor. In the contactor, there is a coil, which, when electrified, will cause a magnetic field in the iron core of the stationary part to make contacts that can move and will be attracted by the magnetic force of the stationary contact with the electrified coil. The iron core in a Kontaktot has a primary coil attached to the iron core. The short circuit ring is a vibration damper when the two iron cores are attached. This will cause the primary and auxiliary contact to move from a normal position where the NO contact will be closed while the NC will be open. The contact will remain in position if the magnetic contactor's primary coil is still powered by voltage.

Figure 3 Contactor

The following formula is used to determine the rating value of the Contactor that will be used to run an Electromotor.

$I_{nominal} = \frac{P}{\sqrt{3}\ x\ V\ x\ Cos\ \emptyset}$ (1)

$I_{Rating\ kontaktor\ min} = I_{nominal}$ x 100 % (2)

Crane Hoisting Control Panel Disruption

1. **Overloadtrip**

Overloadtrip happens because the load in the form of an electromotor experiences an increase in overcurrent (overload); the cause of this overload is there are several kinds, namely the motor burned, the source cable to the electromotor is cut off 1 phase, the bearing on the electromotor is stuck / dry.

2. **Short circuit**

This disorder is caused by scratches or cuts on the cable from the Control Panel to the Electromotor, which is usually caused by shocks so that the cable rubs on the uneven surface of the panel/cable barrel; this can cause heat due to sparks, which can result in Trip on Breaker or Thermal Overload.

3. **Contactor Malfunction**

This interference occurs because there are several kinds of things, such as the current passing through the contactor is greater than the carrying capacity of the rated current on the contactor due to the increase in current in the Electromotor so that it generates heat, which causes the contactor to stick or also because the control voltage supply from the step-down transformer is problematic so that the contactor does not function properly, the contactor that sticks when turned off will not be isolated from the power source, this can cause the Electromotor to be turned off through an emergency stop. Also, this disturbance is due to the cable connection using a Schoen cable with a contactor that is not strong/tight; this will cause excessive heat on the contactor terminal because there is a distance on this connection.

4. **Control system failure**

This interference occurs due to the disconnection of the limit switch connection that connects the 42v current from the joystick to the contactor to run the Electromotor of the Hoisting Crane. Usually, it occurs because the condition of the limit switch is not good and also because the limit switch holder is broken due to the impact of the object; the result of this disturbance is that one of the movements of the Hoisting Crane cannot be operated.

RESEARCH METHODS

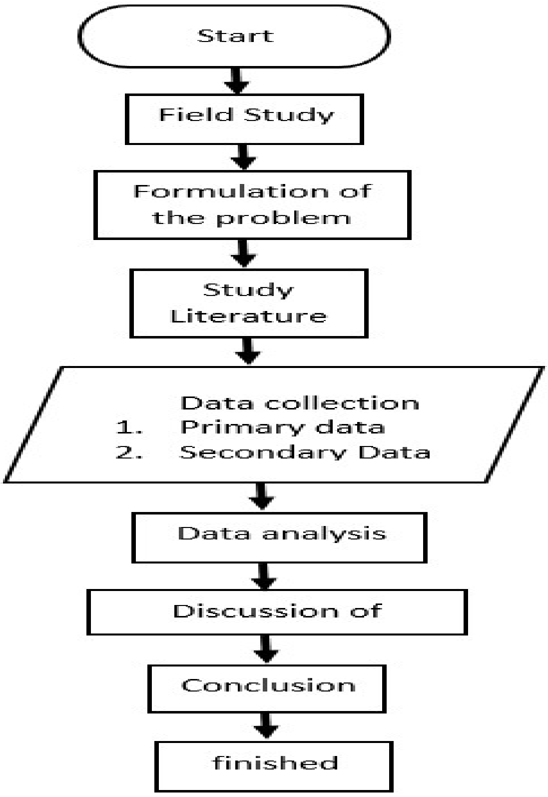
Time and Place of Research

This research uses a qualitative approach based on hoisting crane disturbance data from the beginning of 2023. This research was conducted starting on September 1, 2023, and the place of implementation at the Sei Daun Palm Oil Mill PT Perkebunan Nusantara 3, at the address Sei Meranti Village, District, Torgamba, South Labuhan Batu Regency, North Sumatra.

Tools and Materials

In this study, the tools and materials used for data analysis and processing are as follows. Data processing as follows:

1. Crane Hoist Motor
2. Ampere pliers
3. Connecting Cable
4. Voltage Source



Flow Diagram

Research Data

Control Panel Components

The following is a list of components that are on the dick panel to run the Hoisting Crane.

Table 1. Panel Components

Component Type	Control Panel Components	Amount
Main Contactor	Contactor LC1D65A 42V	1
Supply Voltage Control	Trafo step-down 42V	1
Motorized Lift (*Hoist*)	Motor Circuit Breaker GV3P 65	1
	Contactor LC1D65A 42 V	4
	Contactor CAD32 42 V	1
	Timer on Delay LAD10	1
	Limit Switch Omron WLca2	1
	Joystick 2 ways	1
Motor Way (*traveling)*	Motor Circuit Breaker GV2ME08	1
	Contactor LC1D09 42 V	4
	Timer On Delay LAD10	1
	Timer Of Delay LAD10	1
	Cross limit switch	1
	Joystick 4 ways	1
Pouring motor *(tilting)*	Motor Circuit Breaker GV2ME14	1
	Contactor LC1D09 42 V	2

Hoisting Crane Specifications

The existing Hoisting Crane at Sei Daun PKS has three units of Electromotor drive, which has a capacity of 14.2/2.1 KW each for the lift motor, 3 KW for the Pour motor, and 2.3 KW for the road motor, which works 24 hours as long as the factory runs production as a lorry carrying palm fruit with a weight of 2.5 tons per lorry. The following are the specifications of each Electromotor for each movement.

Table 2. Lift Motor Specifications

Merk/Type	Demag / KBH 180 B 2/12
Electromotor Type	AC 3-fasa cage rotor induction motor
Power	14,2 KW dan 2,1 KW
Nominal current	35 A / 19 A
Voltage	400 V
Rotation	2900 / 475 rpm
Frequency	50 Hz
Cos Q	0,82 /0,24
Kutub	2/12
Connection	Delta

Table 3. Tuang Motor Specifications

Merk/Type	Demag / KBA 100 B 4
Type of Electro-Motor	Motor induksi rotor sangkar 3 fasa AC
Power	3 KW
Nominal current	8,7 A
Voltage	400 V
Rotation	1420 rpm
Frequency	50 Hz
Cos Q	0,68
Kutub	4
Connection	Delta

Table 4. Street Motor Specifications

Merk/Type	Merk/Type	Demag / 90 B 4
Type of Electro-Motor	Jenis Elektromotor	Motor induksi rotor sangkar 3 fasa AC
Power	Daya	2 KW
Nominal current	Arus nominal	5,9 A
Voltage	Tegangan	400 V
Rotation	Putaran	1390 rpm
Frequency	Frekuensi	50 Hz
Cos Q	Cos Q	0,7
Kutub	Kutub	4
Connection	Hubungan	Delta

Wiring Diagram Power and Control

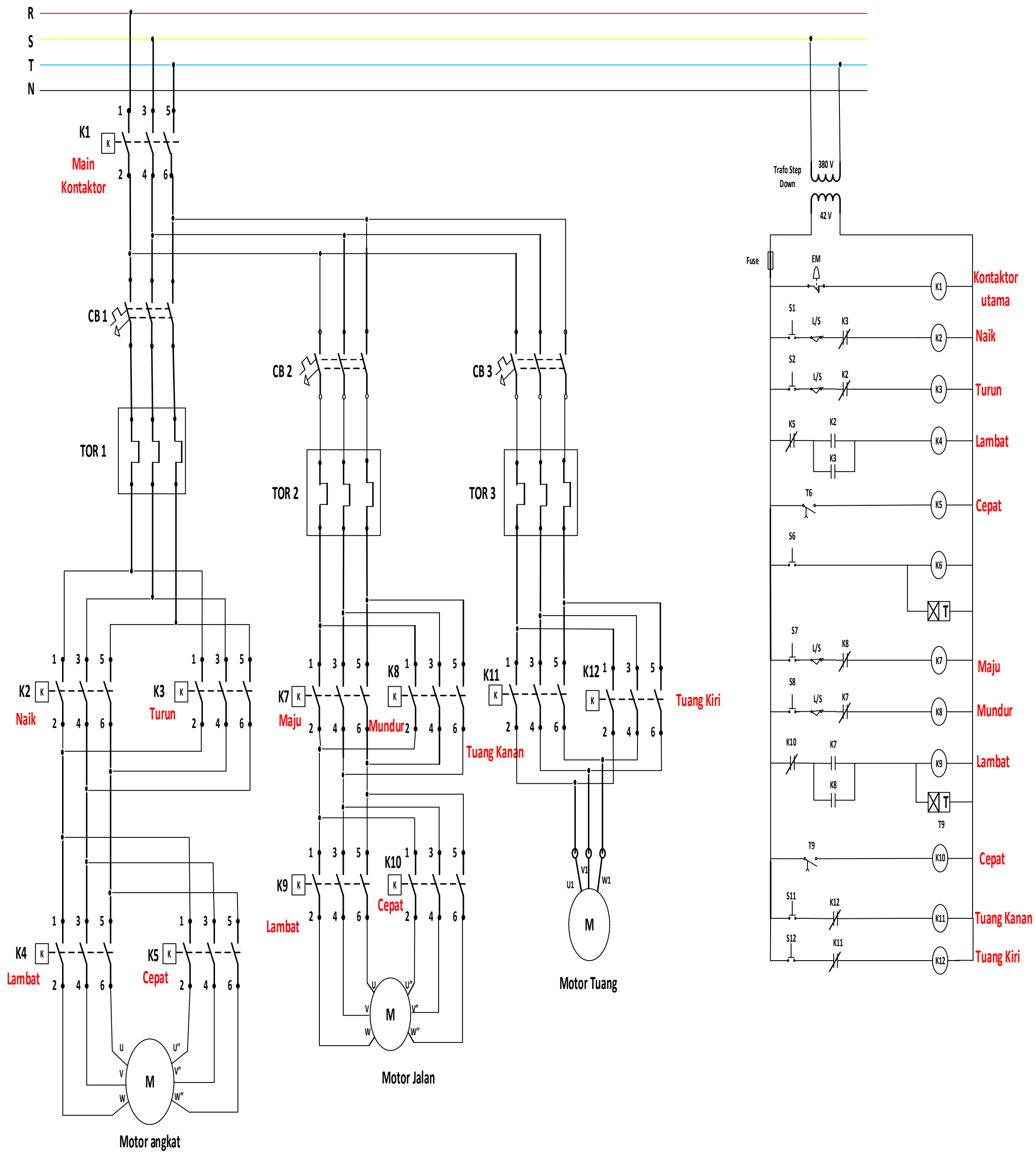


Figure 4. Wiring diagram of power and control

Damage Interference Data

Data on disturbances to the Hoisting Crane control panel at PKS Sei Daun was taken for the last nine months, starting January 2023. So the following is a table showing disturbances to the control panel in 2023.

Table 5. Data on Damage to Hoisting Crane Control Panels January – September 2023

Month	Control Panel Malfunction			
	Contactor Component Damage	Short circuit	Overload Trip	Control system failure
January 2023	1	-	-	-
February 2023	-	-	1	-
March 2023	-	-	-	-
April 2023	-	1	-	2
May 2023	1	-	1	-
June 2023	-	-	-	-
July 2023	1	-	-	-
August 2023	-	1	1	1
September 2023	1	-	-	-
Amount	**4**	**2**	**3**	**3**

The table above shows that there were 4 disturbances to the control panel that occurred in the last 9 months, where the most frequent disturbances were damage to the contactor which occurred in January, May, and July, September.

RESULTS AND DISCUSSION

One of the disturbances that often occurs in Hoisting Crane control panels and is the focus of researchers is contactor damage. The damaged contactor was used to operate the hoist motor, resulting in the Hoisting Crane being unable to lift the lorry, so it could not work usually. According to data from PKS Sei Daun technicians, one of the problems that occurs due to contactor damage is described in the following table:

Table 6 Hoisting Crane Panel Disturbance Data

Date	Friday, September 15th, 2023
Time	09.00 wib
Priority	Urgent
Disorder Description	Hoist motor buzzing, no power
Cause	Contactor K2 loss contact 1 fasa
Effect	Hoisting Crane cannot operate
Handling	Replace damaged contactors
Normal condition	Voltage fasa = 380 - 400 V Current = R;25A S;25A T;25A Control voltage = 42 V
Disorder Conditions	Not operating *(Shutdown)*

The contactor damage to the Hoisting Crane control panel is urgent, so it needs to be dealt with quickly so that the production process is not hampered. From the results of the data from the technician, there is a possibility that the factor causing the disturbance is a current surge, which causes the current passing through the contactor to exceed its current rating value so that Excessive heat arises, which causes the contactor to glow/melt as seen in the picture below.

Figure 5. Damaged contactor

However, a possible factor still causes this problem, namely, loose contactor bolts installed due to lack of maintenance on the control panel.

Based on data on damage to the Hoisting Crane control panel on contactor damage, current measurements were carried out for each phase when lifting loads at slow and average speeds and when empty (0%), 25%, 50%, 75%, and complete (100%). The following is a table of measurement data and graphs.

Table 7. Measurement of Slow Speed Lift Motor Current

Load Weight	Load Current (A)		
	R	S	T
0%	14.3	14.6	14.5
25%	14.7	14.6	14.6
50%	15.1	14.9	14.8
75%	15.2	15.4	15.3
100%	16.8	16.3	16.1

Table 8. Normal Lift Motor Current Measurements

Load Weight	Load Current (A)		
	R	S	T
0%	17	16.9	16.8
25%	22.9	23.6	23.5
50%	24	23.3	23.1
75%	25.6	25.4	25.3
100%	26.3	26.1	26

Table 9. Graph of Hoist Motor Current Measurement Results

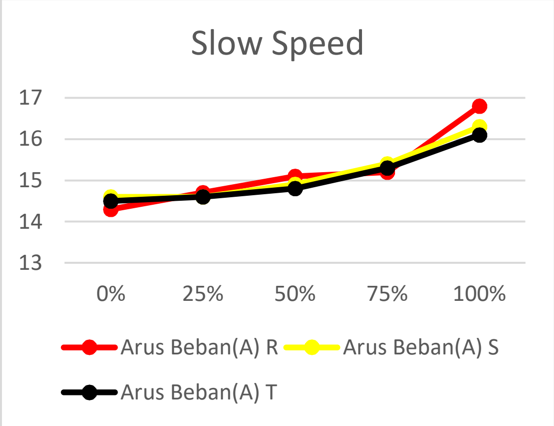
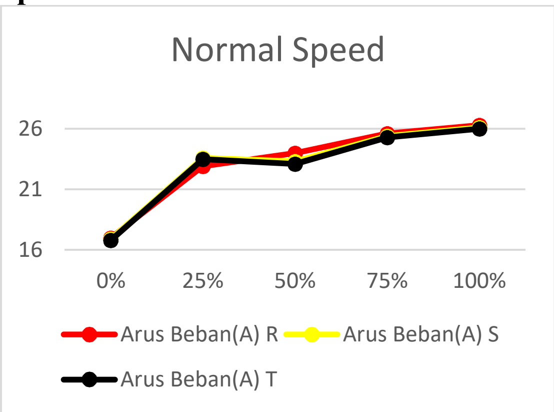


Table 10. Graph of lift motor current measurement results (Hoist)



Discussion

Based on the lifting motor (hoist) specification data in table (3). To determine the nominal current flowing in the Hoist Motor, use equation (1) as follows:

$$I_n\ Motor\ Hoist = \frac{P}{\sqrt{3}\ x\ V\ x\ Cos\ \emptyset}$$

$$I_n\ Motor\ Hoist = \frac{14200}{\sqrt{3}\ x\ 360\ x\ 0.82}$$

$$I_n\ Motor\ Hoist = 27{,}8\ \text{A}$$

$$I_{Rating\ kontaktor\ min} = I_{nominal}\ \text{x}\ 100\ \%$$

$$I_{Rating\ kontaktor\ min} = 27{,}8\ \text{x}\ 100\ \%$$

$$I_{Rating\ kontaktor\ min} = 27{,}8\ \text{A}$$

According to the calculation results of the current flowing in the electromotor from the equation above, the current flowing when the electromotor is loaded based on table (9) is considered normal because it is still below 27.8A, and based on the calculation results for the contactor rating in equation (2), the installed contractor for lift motors, as shown in the table below, corresponds to or even exceeds the contactor rating value based on calculations.

Lift Motor (*Hoist*)	Motor Circuit Breaker GV3P 65	1
	Contactor LC1D65A 42 V	4
	Contactor CAD32 42 V	1
	Timer On Delay LAD10	1
	Limit Switch Omron WLca2	1

Motor protection system analysis

The protection device used on the Electromotor is a motor circuit breaker, which also functions as an overload limiter, as listed in table (2) "control panel components." When the current passing through the protection device to the motor when running exceeds the current rating on the safety, adjusted to the motor's nominal current, the protection device disconnects (trips). To determine the overload rating value for the hoist motor, use the equation below.

$$Setting\ overload = I\ nominal\ x\ 110 - 120\ \%\ (3)$$

$$Setting\ overload = 27{,}8\ x\ 110\ \%$$

$$Setting\ overload = 30{,}58\ \text{A}$$

Figure 6. Setting overload

Table 11. Comparison of Protection Relay Settings Between Motor Circuit Breakers and Calculation Results.

Description	Motor Circuit Breaker	The calculation results
Setting rele proteksi	48 A	30,58 A

Based on the table above, the protection settings for the Motor Circuit Breaker are not the same as the calculation results for the overload protection settings (overload).

CONCLUSION

From research into the analysis of electrical disturbances on the control panel of the Sei Daun Palm Oil Factory Hoisting Crane PTPN 3, it can be concluded that the disturbances on the control panel were contactor damage, short circuit, overload, and control system failure.

The leading cause of damage to the contactor on the control panel is that the excessive current passing through the contactor to the electromotor is too large, causing excessive heat, which causes the contact pins to melt/glow.

After analyzing the overload setting of the Lift Electromotor, it was found that the overload rating value had exceeded the nominal current value on the Electromotor, so it was unsuitable for use.

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