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COUNTER MOTOR COMPRESSOR INNOVATION to INCREASE RELIABILITY of COMPRESSOR in MUARA TAWAR POWER PLANT

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ABSTRACT

Air service compressor plays an important role in combined cycle power plant. Air services compressor used to supply air to control valve and solenoid on gas turbine and steam turbine equipment. In Muara Tawar power plant, compressor performance can not be monitored in real time because there is no counter in the motor compressor. Counter on the motor compressor is necessary to help simplify the process of monitoring and improve reliability. Comoter Line (Counter Motor Compressor made by Muara Tawar engineer) is a tool to help preventive maintenance and monitor the motor compressor so it doesn't exceed the maximum working hours. Comoter Line can monitor the work of the motor and its bearings so that preventive maintenance becomes more efficient. By using this tool, it can reduce the risk of equipment damage from high to medium. This program had proven the capability to improve reliability, availability, increase efficiency and reduce hazardous & toxic waste (B3) in Muara Tawar power plant.

KEYWORDS: Compressor, Counter, Reliability, Hazardous & Toxic Waste (B3).

1. INTRODUCTION

Air service compressor plays an important role in combined cycle power plant [1]. Air services compressor used to supply air to control valve and selenoid on gas turbine and steam turbine equipment. There are 3 air service compressor owned by Muara Tawar power plant, 2 compressor unit is damaged and 1 can be operated. Air compressor that operates is air compressor no.2 for 24 hours and there is no backup in case of interference. Two other units of compressor at Muara Tawar power plant is damaged because of damaged HP filament and bearing condition which has been decreased.

In Muara Tawar power plant, compressor performance can not be monitored in real time because there is no counter in the motor compressor. Counter on the motor compressor is necessary to help simplify the process of monitoring and improve reliability. Problems that occur from the destruction of 2 units of the compressor caused by grease and bearing damage. It is known that the bearing motor has life time, where according to SKF (Svenska Kullagerfabriken), the average of standard bearing operation is 20000 hours operation, while for addition of lubrication (grease) is every 3090 hours operation [2]. Compressor in Muara Tawar power plant damaged because there is no precise and accurate monitoring of operating hours.

It is necessary to make a devices to monitor the working hours of the motor compressor. Comoter Line (Counter Motor Compressor made by Muara Tawar researcher) is a tool to help preventive maintenance and monitor the motor compressor so it doesn't exceed the maximum working hours. This Comoter Line can reduced motor compressor damage caused by the bearing life of the motor. This happens because maintenance can make grease addition and can perform bearing replacement before the bearing's operating time is up. Another impact by using comoter line is increase of compressor unit reliability. The reliability of a power plant to provide electricity to the electricity network

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is the most important task to ensure energy availability [3]. With good compressor reliability it can support the target of PJB to get to world class power plant.

2. REVIEW

Air Service Compressor

Air services compressor used to supply air to control valve and selenoid on gas turbine and steam turbine equipment [4]. Figure 1 shows 3 pieces of compressor, 2 are damaged and only 1 is in operation. Compressor no 2 is operating 24 hours supplied air with pressure above 500 kPa.

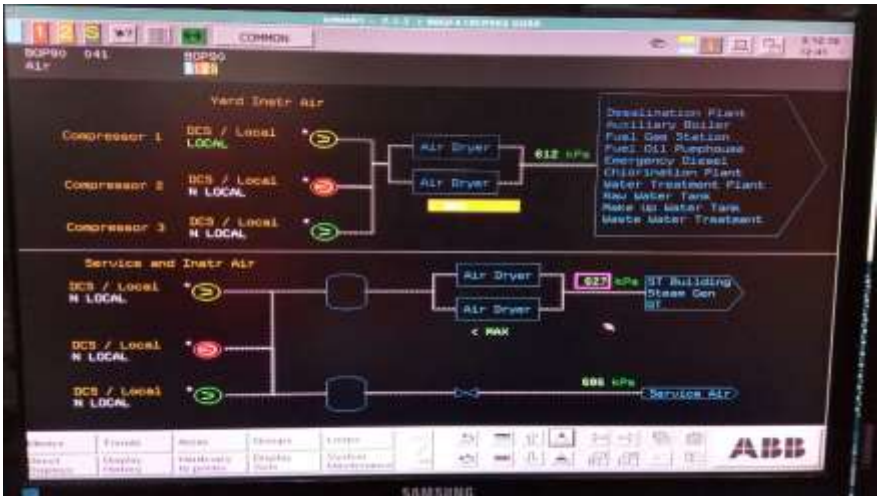

Figure 1. Air Service Compressor function

For instrument and control equipment, output air compressor passes 2 pieces of air dryer so that no water entering the control valve or solenoid that can cause corrosion on the component. Air service compressor also supply air to service water used by steam turbine and turbine generator. Motor air service compressor has technical data shown in Table 1.

Table 1. Technical Data Motor Air Service Compressor

Description	Data
Type	Siemens Motor ILA6 283-2AC
Voltage	400 V
Current	150 A
Output Motor	90 kW
Efficiency	0,91
Torque	289 Nm
Weight	610 kg

Bearing and Grease

Bearing is an engine element that used to limit the relative motion between two or more machine components. Bearing requires good care so that long working life is obtained [5]. One of the main forms of bearing treatment is lubrication or grease.

Grease is a two phase (semi-solid) lubricant substance [6]. Grease made from mineral oil mixed with a thickener. Grease is used in bearing mechanisms that require little lubrication, which does not necessarily use oil as a lubricant. The negative side of using grease is friction. This is due to the high viscosity value. Therefore, it is necessary to

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conduct periodic monitoring for the addition of grease in accordance with its user standard.

Life Time Bearing dan Grease

Bearing and grease equipment has a certain lifetime. The lifetime data of bearing and grease is taken from the bearing manufacturing SKF. Table 2 shows the recommendation of a 6200 series bearing lubrication.

Table. 2 Bearing 6200 Series Lubrication Recommendation

Bearing	Quantity (oz.)	Interval		
		900 rpm	1800 rpm	3600 rpm
6200	0,04	25.900 hr	23.400 hr	19.100 hr
6201	0,07	25.600	22.900	18.400
6202	0,07	25.200	22.200	17.300
6203	0,07	24.800	21.500	16.100
6204	0,10	24.200	20.400	14.500
6205	0,12	23.600	19.400	13.100
6206	0,15	22.700	18.000	11.300
6207	0,19	21.900	16.700	9.700
6208	0,23	21.100	15.600	8.510
6209	0,25	20.600	14.800	7.690
6210	0,28	20.100	14.100	6.950
6211	0,33	19.400	13.100	5.970
6212	0,38	18.600	12.100	5.130
6213	0,43	17.900	11.200	4.410
6214	0,47	17.500	10.700	3.980
6215	0,50	17.100	10.200	3.600
6216	**0,55**	**16.400**	**9.400**	**3.090**
6217	0,65	15.800	8.730	2.660
6218	0,74	15.200	8.090	2.280
6219	0,84	14.700	7.500	1.980
6220	0,95	14.100	6.950	

Motor Air service compressor has a 6216 bearing series with motor speed is 3,000 rpm. In accordance with Table 1 obtained from SKF, for series 6216 with motor rotation reaching 3,000 rpm using the closing round parameter of 3600 rpm, so the grease lubrication is performed approximately every 3090 hours or 125 days. Quantity of lubricant used is 0.55 oz which is equivalent to 15.59 grams. While for bearing itself has a lifetime for 20,000 hours or 2.5 years. Where the lifetime values are based on the lifetime bearing formula that is:

$L_{10} = 〖(□(C/P))〗^{p}$ ……(1)

Where : L10 = Basic rating life (at 90% reliability), millions of revolutions
C = Basic dynamic load rating, kN
P = Equivalent dynamic bearing load, kN
P = Exponent for the life equation, 3 for ball bearings, 10/3 for roller bearings

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3. METHOD

Root Cause Failure Analysis

The analysis used is RCFA in motor compressor number 3. Figure 2 describes some factors that cause damage to the motor number 3. Factors that exist in RCFA obtained from data processing and observation in field.

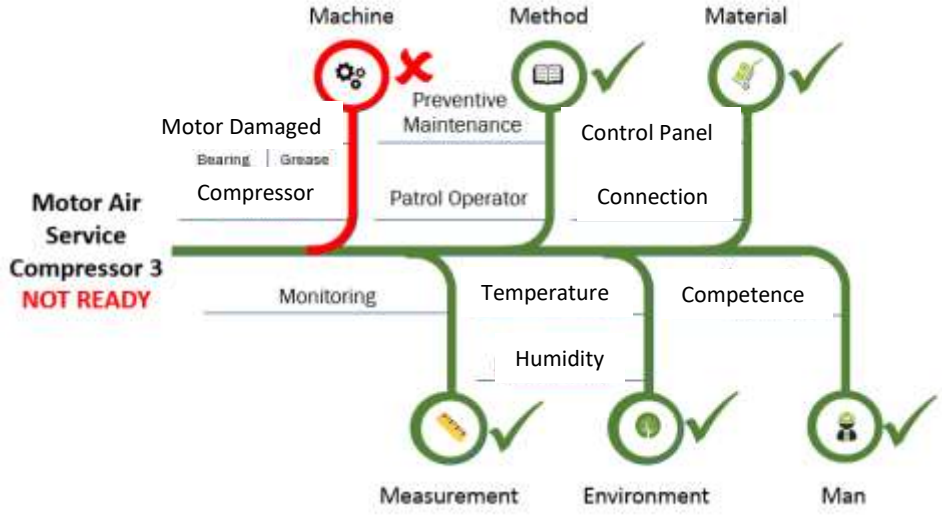

Figure 2. RCFA

The first observation was made on the motor grease. From the observation found the grease in bearing motor has changed color to black, this causes the grease lubrication does not work well.

Second observation, the observation of the bearing of the motor itself, from the observation found the existence of damage on the bearings caused by not optimal lubrication in the bearing so that friction occurs in the bearing that causes trip on the motor. Grease bearing motors that change color can be seen in figure 3.

Figure 3. Grease Motor that looks Black

From the operational data it was found that 2 air service compressor initially amounted, but over time added 1 unit as a back up if the pressure is not reached. The fact is only 1 compressor operated every day with a duration of 24 hours because one compressor able to produce pressure above 500 kPA (pressure condition for turbine steam operation and turbine generator). This pattern of operation makes the operating hour of the compressor can not be monitored in real time.

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Designing Comoter Line

Comoter Line is a tool used to monitor data bearing and grease in real time based on operating hours. Comoter Line works when the motor starts to operate. Monitoring data is displayed locally, via sms, and via apps.

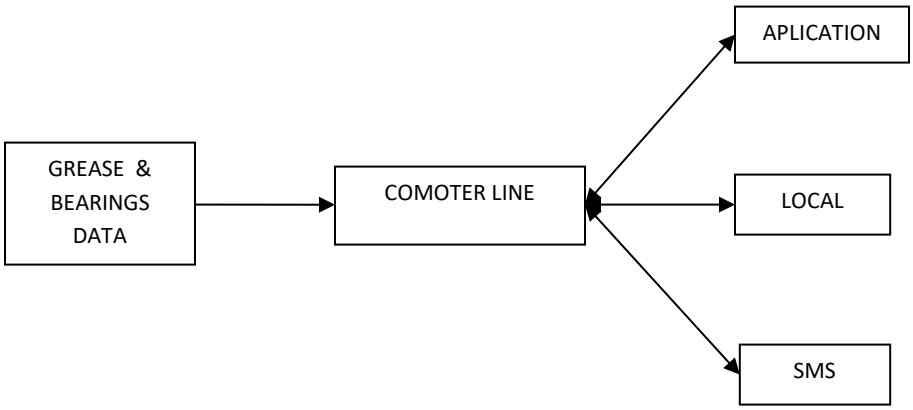

Figure 4. Comoter Line Block Diagram

a. Design of Microprocessor Systems

Microprocessor used to processing and monitoring data in comoter line. The components of the minimum micro-processor system consist of resistors, capacitors, Atmega16, push-button, LCD, and Xtal 16 MHz. Figure 5 shows the microprocessor system design.

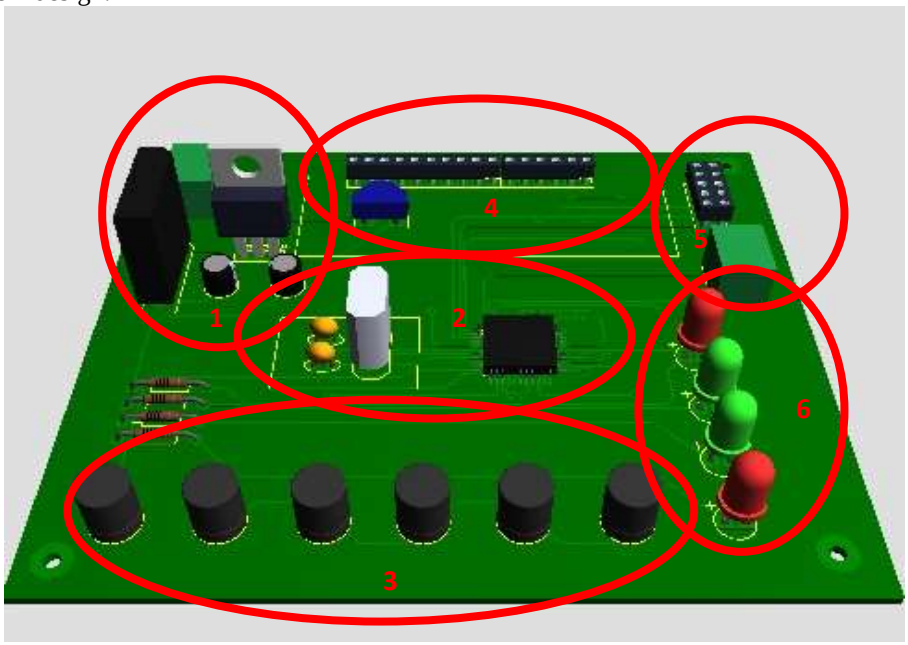

Figure 5. Microprocessor System Design

The description of Figure 5 is as follows.

1. Power Supply 220 VAC to 5 VDC
2. Microprocessor with 16 MHz Clock

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3. Push Button
4. LCD Displays
5. USB Programmer and Input from Motor
6. LED Displays

b. Counter Program Design

The design of this program used to display an operating hour counter as well as motor stop, it can communicate with PC and Android. The application of this program is called CVAVR based C language.

Notes | serialcomo.c

```
31  // Standard Input/Output functions
32  #include <stdio.h>
33  #include <stdlib.h>
34
35
36  unsigned char temp[6];
37  int detik=0,menit=0,jam=4165,indeks=6;
38
39  // Timer1 overflow interrupt service routine
40  interrupt [TIM1_OVF] void timer1_ovf_isr(void)
41  {
42  // Reinitialize Timer1 value
43  TCNT1H=0xC2F7 >> 8;
44  TCNT1L=0xC2F7 & 0xff;
45  detik++;
46  // Place your code here
47  }
48
49
50  #define ADC_VREF_TYPE 0x00
51
52  // Read the AD conversion result
53  unsigned int read_adc(unsigned char adc_input)
54  {
55  ADMUX=adc_input | (ADC_VREF_TYPE & 0xff);
56  // Delay needed for the stabilization of the ADC input voltage
57  delay_us(10);
58  // Start the AD conversion
59  ADCSRA|=0x40;
60  // Wait for the AD conversion to complete
61  while ((ADCSRA & 0x10)==0);
```

Figure 6. Comoter Line Programming Application

c. Design of Android Application Program

This program used to read the monitoring data from the Comoter Line tool. There are 3 main menu i.e. real time reading through internet, real time reading via sms, and real time reading through bluetooth. This android application can provide warning via sms if operating hours of grease or bearing has been reached.

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Figure 7. Android Comoter Line Application

d. Automation Design with Comoter Line

By using this automation, real time monitoring data can be directly processed in ellipse (work order system in Muara Tawar power plant). When bearings and grease has reached the maximum life time, it will directly create a work order (WO).

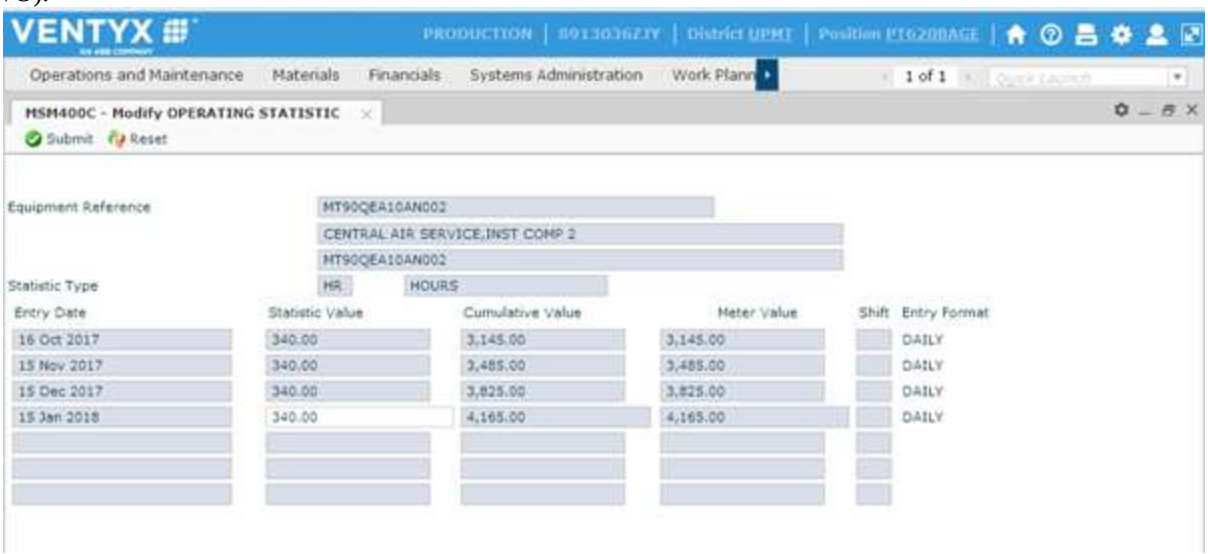

Figure 8. Comoter Line to Ellipse

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4. RESULTS AND DISCUSSION

Risk Analysis

The risk analysis before and after the innovation can be seen in figure 9. It can be seen that the risk decreased from the high level into low level after innovation.

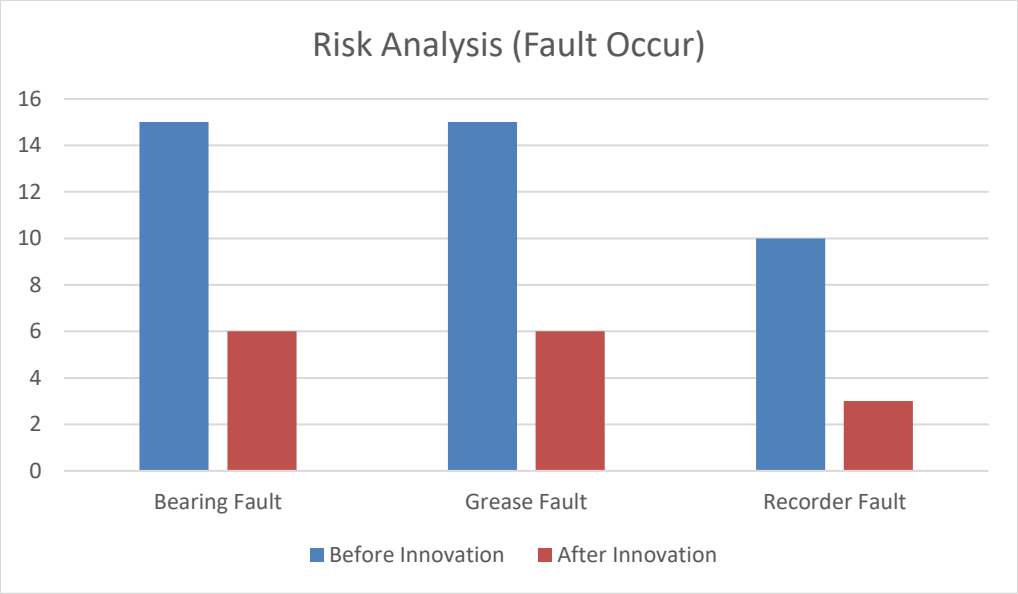

Figure 9. Risk Matrix

Figure 9 shows the risk reduction was achieved in some part of the system as follow:

A. The bearing fault decrease from high to moderate.
B. Grease fault decreases from high to moderate.
C. Incorrect recorder decreases from major to low.

5. CONCLUSION

Comoter Line can monitor the work of the motor and its bearings. Hence, the preventive maintenance more efficient. Comoter Line has capability to reduce the risk of equipment damage from high to medium.

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