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Investigating the Influence of Time Variation on Electric Motor Vibration Characteristics

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ABSTRACT

This research aims to analyze vibrations in a 1750 HP Westinghouse electric motor. The electric motors have an important role in the company's operations. Hence, the vibration analysis may crucial to carried out for optimal performance and prevent potential damage. In this research is to find out the vibrations that occur according to the permitted vibration standards and to find out the parts of the machine that have an influence in order to minimize the vibrations that occur. Vibration test was carried out using the vibration analyzer as a measuring instrument and temperature testing. The results of the vibration analysis was obtained the vibration values on the Drive-End and Non-Drive End sides were still moderate and suitable for operation. The highest vibration value occurred in the first 10-minute test in the Non-Drive End (NDE) vertical direction with an rms value of 0.083 inch/s.

KEYWORDS: *Vibration, Electric motor, Direct electric, Non direct electric.*

1.0 INTRODUCTION

Companies engaged in oil exploration often use rotating equipment in running their operations, and one of the important equipment used is an electric motor. One of the electric motors used is a motor with a power of 1750 HP. This motor is used to rotate the shipping pump located at the oil well location, where the pump functions to suck oil from the earth and channel it to the storage tank [1]. In the operation of this electric motor 1750 HP, unexpected damage often occurs, causing operations to stop and requiring a long time to repair [2]. These incidents often halt operations entirely, causing significant downtime. Consequently, repairs become a lengthy and involved process. Therefore, this certainly has a significant impact on the production process.

Several types of damage that often occur include damage to bearings, windings, and rotors [3],[4]. Bearing damage is the most common and bearings function as a place to support the rotation of the rotor shaft [5],[6]. The tolerance between the bearing and the rotor shaft must be maintained very tightly; mismatched clearance can cause damage to the bearing. Damaged bearings will cause high vibrations.

Vibration values that exceed the threshold can cause further, more severe damage to the machine [7],[8]. Therefore, smooth operations are highly dependent on the prime condition of the equipment. Identification of the cause of damage and monitoring the condition of the electric motor is very important [9],[10]. The aim of this research is to find out the vibrations that occur according to the permitted vibration standards and to find out the parts of the machine that have an influence in order to minimize the vibrations that occur.

2.0 METHOD

2.1 Electric Motor Specifications

The location of the survey, vibration data collection and vibration analysis of the machine is located in an oil well. The specifications of the Westinghouse of 1750 Hp electric motor with a 3-phase AC motor are electrical devices that convert electrical energy into kinetic energy through the use of an electric field clutch as shown in Figure 1. This motor operates on a 3-phase power supply and is generally used in companies with high production capacity [11],[12]. The specifications are a 1750 HP electric motor; 4000 V; 214 A; 3 Phase, 3570 rpm; 50 HZ; DE – NDE (Drive-End and Non-Drive End) with sleeve bearing.

2.2 Electric Motor Testing

Vibration testing was conducted using the Adash A4300 vibration analyzer, a specialized measuring instrument designed to assess the mechanical condition of rotating machinery. During data collection, a transducer was carefully placed on the body of the electric motor, in close proximity to the bearing, to capture accurate vibration signals. This positioning ensures that the readings reflect the operational state of the bearing and surrounding components, which are critical areas for monitoring potential mechanical faults or imbalances.

Figure 1: Electric motor 1750 HP

In addition to vibration analysis, other diagnostic tools were employed to obtain a comprehensive understanding of the motor's condition. A tachometer was used to measure the rotational speed of the electric motor, providing data essential for correlating vibration frequencies with mechanical components. Simultaneously, a thermometer was utilized to monitor the temperature of the motor, enabling the detection of thermal anomalies that may indicate overheating or inefficient operation. These combined measurements contribute to a holistic evaluation of the motor’s health and performance.

3.0 RESULTS AND DISCUSSION

3.1 Sleeve Bearing Temperature Check

Bearing temperature data collection was carried out using a thermometer measuring instrument. Data collection was carried out by opening the plug at the top of the bearing housing, where in the hole is the upper surface of the sleeve bearing.

Tabel 1: Temperature sleeve bearing

Sleeve Bearing	Temperature
Posisi Drive End (DE)	155 °F / 68.3 °C
Posisi Non-Drive End (NDE)	153 °F / 67.2 °C

When compared to the results obtained from speed measurements with normal motor speed, it is slightly different, the possibility of deviation in rpm values occurs because the input voltage from the electric motor testing facility is no longer 100% in condition show in the Table1.

3.2 Electric Motor Vibration Check

The vibration data collection was carried out within a period of 30 minutes and was carried out every 10 minutes using Adash A4300. Data collection was carried out by placing the Transducer on the bearing housing or the closest to the bearing position. Data collection was carried out at the DE (drive end) and NDE (non drive end) measuring points of the electric motor. Data collection was carried out in radial and axial directions. The results of the data collection obtained the following values.

3.2.1 The First Stage Testing

Testing in the first 10 minutes can be concluded that the Electric Motor is in a condition that is worthy of operation. The vibration value in the Horizontal DE - NDE direction shows a very good value of 0.041 RMS with the highest value of 0.058^0-Peak as in the Table 2. The vibration value in the axial DE - NDE direction is lower than in other directions, which indicates that the axial movement in the electric motor is quite small and still below the threshold. The vertical vibration value of DE-NDE is in the moderate category of 0.083 RMS with the highest value of 0.117^0 - Peak, this indicates that the Electric Motor foot level is not level show in Figure 2.

Table 2: Vibrations in 10 minutes

Measurement Point	Vibration Monitoring Result (inc/s) Vibration Result RMS*	0-Peak	Status	Remarks
DE Horizontal	0.041	0.058	good	
DE Vertical	0.048	0.068	moderate	
DE Axial	0.024	0.034	good	
NDE Horizontal	0.045	0.064	good	
NDE Vertical	0.083	0.117	moderate	Highest
NDE Axial	0.036	0.051	good	

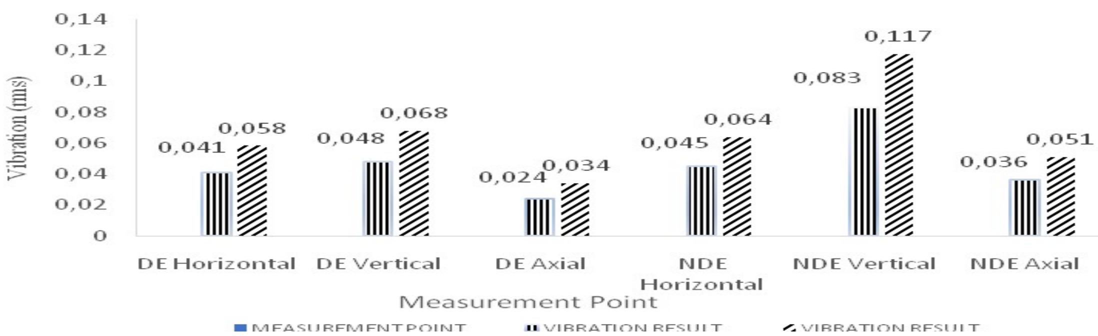

Figure 2: Vibration graph on 10 minutes machine work

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3.2.2 The Second Stage Testing

Testing at the second 20 minutes can be concluded that the electric motor is in a condition that is worthy of operation as in the Table 3. The overall vibration value of the electric motor did not change significantly when compared to the vibration value at 10 minutes. The vibration value in the horizontal DE - NDE direction shows a very good value of 0.46 RMS with the highest value of 0.065^0-Peak. The vibration value in the axial DE - NDE direction is lower than in other directions, which indicates that the axial movement in the electric motor is quite small and still below the threshold. The vibration value in the vertical direction DE- NDE is in the moderate category of 0.082 rms with the highest value of 0.116^0 - Peak, this indicates that the Electric Motor foot level is uneven show in Figure 3.

Table 3: Vibrations in 20 minutes

Vibration Monitoring Result (Inc/S)				
Measurement Point	Vibration Result		Status	Remarks
	RMS*	0-PEAK		
DE Horizontal	0.040	0.057	Good	
DE Vertical	0.050	0.071	Moderate	
DE Axial	0.024	0.034	Good	
NDE Horizontal	0.046	0.065	Good	
NDE Vertical	0.082	0.116	Moderate	Highest
NDE Axial	0.036	0.051	Good	

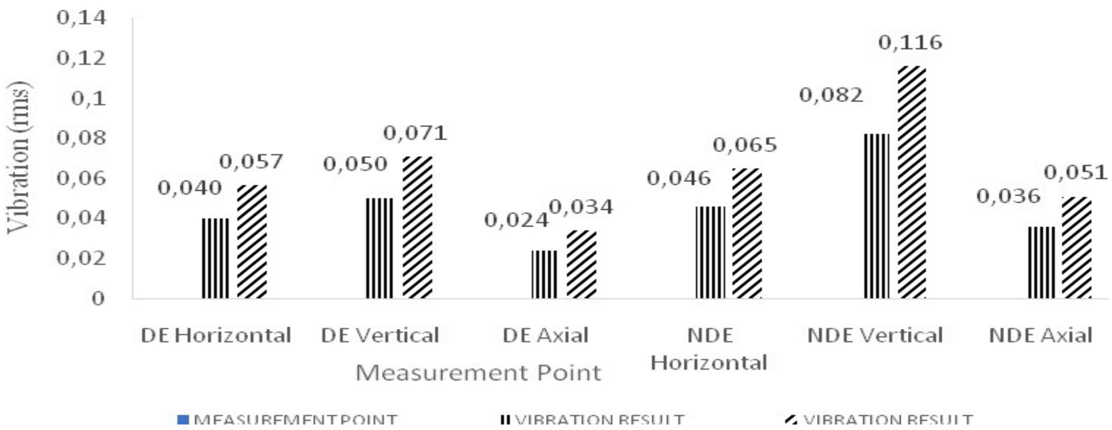

Figure 3: Vibration graph on 20 minutes machine work

3.2.3 The Third Stage Testing

The 30 minutes test can be concluded that the electric motor is in a condition that is worthy of operation show in the Table 4. The overall electric motor vibration value did not change significantly when compared to the vibration value at minutes 10 and 20. The vibration value in the horizontal DE - NDE direction shows a very good value of 0.046 rms with the highest value of 0.065^0-Peak. The vibration value in the axial DE - NDE direction is lower than in other directions, which indicates that the axial movement in the electric motor is quite small and still below the threshold. The vibration value in the vertical DE- NDE direction is in the moderate category of 0.082 rms with the highest value of 0.116^0 - Peak, this indicates that the electric motor foot level is uneven as in Figure 4.

Table 4: Vibrations in 30 minutes

Vibration Monitoring Result (Inc/S)				
Measurement Point	Vibration Result		Status	Remarks
	RMS*	0-PEAK		
DE Horizontal	0.040	0.057	Good	
DE Vertical	0.050	0.071	Moderate	
DE Axial	0.024	0.034	Good	
NDE Horizontal	0.046	0.065	Good	
NDE Vertical	0.082	0.116	Moderate	Highest
NDE Axial	0.036	0.051	Good	

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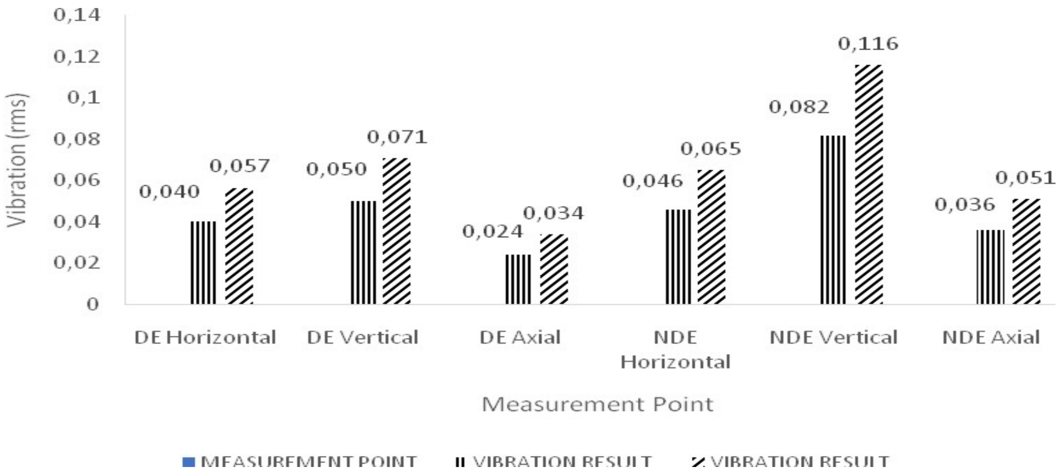

Figure 4: Vibration graph on 30 minutes machine work

The vibration checks carried out found the vibration values at the highest DE and NDE vertical measurement positions of: 0.05 rms and 0.083 rms as in the Figure 5. Based in the ISO 10816-3 Table, the vibration velocity value obtained is in the yellow zone and is stated in that zone the machine is in a "moderate" condition and is still suitable for use. However, to change to the green zone condition, it is necessary to eliminate the structural looseness and static unbalance that occurs. To verify the condition of the electric motor, the temperature was taken on the Drive-End and Non-Drive End sides and the results showed normal conditions with a value of 155^0 F.

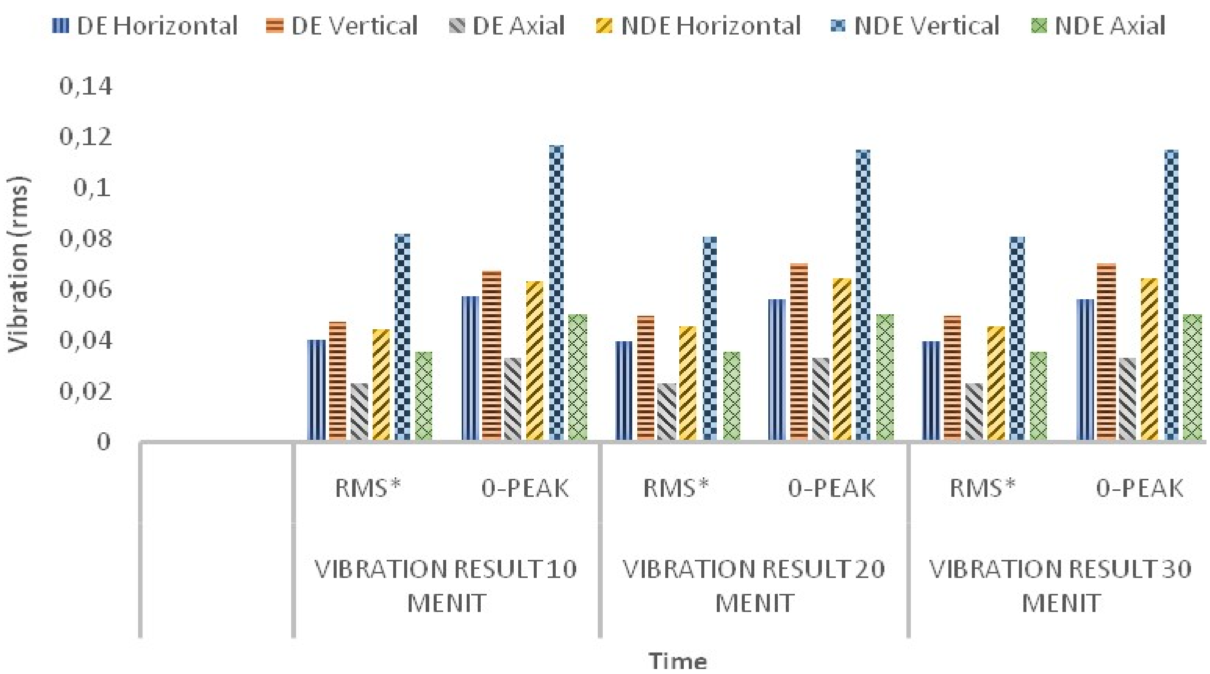

Figure 5: Vibration graph on running electric motor

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5.0 CONCLUSION

The results of the vibration analysis obtained from this study found that the vibration values on the Drive-End and Non-Drive End sides were still moderate and suitable for operation. The highest vibration value occurred in the first 10-minute test in the NDE vertical direction with an rms value of 0.083 inch/s. The vibrations that occur are caused by structural looseness and static unbalance, this is due to the uneven condition of the electric motor legs and requires good alignment of the electric motor unit in the field. This study also found no mechanical damage to the electric motor, and was proven by good sleeve bearing temperatures.

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