

# The Effect of Misalignment to Vibration, Electric Current and Shaft Rotation Speed on Gear Transmission

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## ABSTRACT

Gear is a rotating machine that is widely used as a power transfer transmission in many industries. Gear has a long life times. However, the gears can be damaged due to many factors such as out of the maintenance, which one factor of misalignment. This study aim is to determine the effect of misalignment on the gear transmission to vibration, electric current and shaft rotation speed. In this study, was done alignment process with variations of misalignment on the gear transmission alignment kit and was done measurement value of vibration, electric current and shaft rotation speed. The study results show the greater the misalignment, the greater the vibration that occurs either radially or axially for all conditions measured. The shaft rotation was slower with the greater misalignment. The misalignment can affect the decrease in the rotation speed of the shaft. Therefore, it can reduce the efficiency for power transmission of engine.

**KEYWORDS:** *Misalignment, Gear, Vibration, Electric current, Shaft rotation speed.*

## 1.0 INTRODUCTION

All industries require a transmission system to transmit power from the source of each stage of production. Maintaining the condition of the transmission system to always be in good condition is important. By maintaining the transmission system, it can avoid the occurrence of one of the maintenance problems [1]-[3]. Hence, it can avoid production losses and additional costs for maintenance or equipment changes if damaged. Maximizing the ability of a machine is an important requirement to achieve maximum productivity levels. One of the power transmission systems in the industrial world is the gear.

The gears are part of a rotating machine that is useful for transmitting power. The gears have teeth that intersect with the teeth of the other gears. Two or more gears that intersect and work together are referred to as gear transmissions and can generate mechanical gains through the ratio of the number of gears [4]. The gears are capable of changing the rotary speed, torque and direction of power to the power source. Gears have very wide uses, such as transmission in vehicles, mechanical buildings, mechanical machines, generating systems, and so on. The strength and age of the gears are greatly influenced by the dimensions of geometry and the type of material used [5]. Therefore, these two things are usually the main focus in designing gears. Gears have a very important role because they concern some vital aspects in the system itself e.g. gears are related to assembly. Less suitable gears will result in poor transmission. So, it will heat up quickly and wear out on the gears. As a result the rotation on the engine will be slower, so the engine rotation is not maximal [6].

In the installation of gears should be alignment to avoid damage to the engine and the pair of gears themselves [7]. Gears can be damaged in the form of tooth fracturing wear on its surface and scratched surface due to the rupture of lubricating oil membranes. The strength of the teeth against flexibility and surface pressure is the most important thing to note. Alignment is a job that straightens or aligns two axis of the shaft to the centrist (between the drive shaft and the axis of the moved shaft). The purpose of alignment is to get straightness or eccentricity between the two player shafts (drivers) and shafts that are rotated (driven). The friction, vibration, and others that can shorten the life of an engine, which is certainly increase the cost of spending on repair and replacement of the engine [8],[9].

Misalignment is an aberration of the axis line to the two connected shafts, both parallel and axial direction (angular), so that there is an inline of the two connected shafts. Misalignment can occur because the engine experiences soft foot on the legs of the engine and there is run out on the clutch and engine shaft, which can result in parallel misalignment and angular misalignment [7]. Soft foot is a limp that occurs in the legs of the machine, where the legs of the machine do not sit perfectly on the base plate. Misalignment can cause problems with transmission systems including gear transmissions such as unbalances, and defect

bearings that will be a new source of vibration that increases vibration in the transmission. Equipment that experiences excessive vibration will receive repeated dynamic loads and this will end in equipment failure. In previous study [10], research has been conducted to find out how the effect of misalignment on the use of electric current, vibrations that occur and the rotation of the shaft or motor on the clutch transmission system. On this occasion, researchers wanted to re-examine how misalignment affects the use of electric current, vibrations that occur and rotation of shafts in other transmission systems.

The purpose of this study is to find out and analyses the influencing of misalignment at a gear transmission system on vibration, electric current, and axis rotation speed with variations in misalignment in 3 conditions, namely backlash area, vertical shaft misalignment and horizontal shaft misalignment.

## 2.0 METHODOLOGY

The experimental method was employed in this study. The flow chart of method used in this study can be seen in Figure 1.

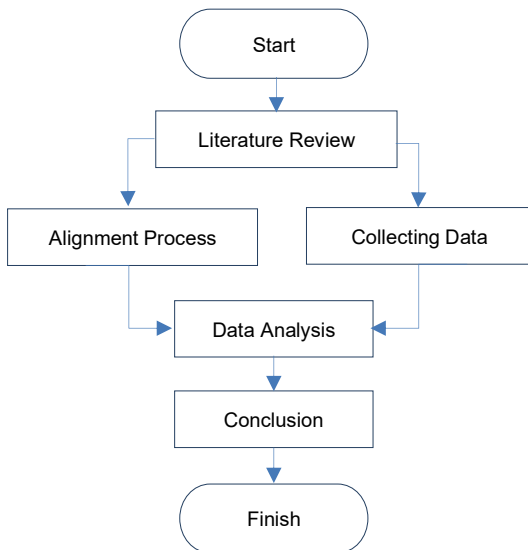


Figure 1: Flow chart of research method

### 2.1 Research Site

The research place was conducted at Polytechnic of Kampar, Machine Maintenance and Repair Study Program Workshop.

### 2.2 Research Tools and Materials

Some of the equipment needed for misalignment research on gear transmission includes the following:

- Gear Alignment Kit.  
This equipment is an equipment used as a practical medium for the practice of process alignment for gear transmission components. In this tool there is a component of transmission gear and electric motor.



Figure 2: Gear alignment kit

- Ampere meters  
Ampere meters are used to measure the electric current on the motor. The device used can only make three different measurements, namely electric current, voltage and resistance.



Figure 3: Ampere meter

- Tachometer  
Tachometer is used to measure the rotational speed of the motor shaft. This study, the tachometer can measure a speed of 99.999 RPM. The RPM powering used the sensor method on the tachometer.



Figure 4: Tachometer images

- **Straight Edge**  
The straight edge is used to see the flatness between two clutches in alignment.

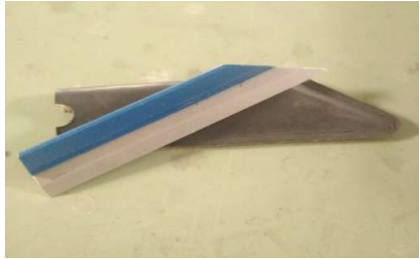


Figure 5: Straight Edge

- **Shims**  
Shims are iron sheets that have a thickness in line with standard German provisions. Shims have thicknesses of 0.05 mm, 0.10 mm, 0.25 mm, 0.5 mm, 1 mm and 2 mm. In this study shims are used to add grounding to the foot of the house bearings.



Figure 6: Shims

- **Vibration Meter**  
Vibration meter is a measuring device or instrument that serves to measure the vibration of an object, for example a motor, pumping other vibrating objects, especially in the industrial world. The vibration meter operation is by attaching the vibration sensor or magnetic base to the object or machine to be measured. Then magnetic base sends data through the cable to the reader unit. Thus, the vibration meter shows the value of vibration amplitude in the object or machine that is measured.



Figure 7: Vibration meter

- **Feeler Gauge**  
Feeler gauge is used to measure gaps or estrangements on two components. Feeler gauge has the size and thickness listed on each sheet, so to use it just adjust the specification needs.



Figure 8: Feeler gauge

### 2.3 Data Retrieval Process

The process of taking misalignment data in this study was carried out in 3 conditions, namely, in the backlash area, in the condition of misalignment of the axis of the gear shaft vertically and in the condition of horizontal alignment of the axis of the gear shaft.



Figure 8: Data retrieval process

The process of retrieving data in this study used experimental method where activities include:

- Take a maximum limit measurement of the misalignment that occurs in the gear transmission.
- Do the alignment process by sharing variations of misalignments
- In each misalignment, measurements of motor rotation speed, electric current, and vibration are carried out. The characteristic of vibration used is the vibration velocity with mm / s units.
- To determine the variation of misalignment in the backlash area, the indicator dial is used as a measuring instrument.
- For the misalignment condition of the axis vertically, misalignment variation is done by adding shims on the rear legs of the gear shaft.

- For the misalignment conditions of the axis horizontally, misalignment variations are performed using steel bar and feeler gauge.
- The test tool operates for approximately 1 minute to take stable data.

### 3.0 RESULTS AND DISCUSSION

The results of data retrieval of misalignment influence on vibration, electric current and shaft rotation on gear transmission components can be seen in Table 1, Table 2 and Table 3.

Table 1: Data of research results in backlash area

Misalignment (mm)	Electric Current (Ampere)	Vibration Speed (mm/s)		Axis Round (rpm)
		Axial	Radial	
0.15	0.19	9.67	6.57	569.9
0.24	0.22	10.05	7.33	567.5
0.30	0.24	12.07	9.24	566.9
0.42	0.25	13.71	10.4	566.3

Table 2: Data of research results on vertically aligned wick alignment conditions

Misalignment (mm)	Electric Current (Ampere)	Vibration Speed (mm/s)		Axis Round (rpm)
		Axial	Radial	
0.00	0.19	9.21	6.57	569.9
0.25	0.20	10.97	7.13	568.3
0.45	0.22	11.52	7.89	567.9
0.55	0.25	13.17	8.05	565.8

Table 3: Data of research results on horizontal aligned wick alignment conditions

Misalignment (mm)	Electric Current (Ampere)	Vibration Speed (mm/s)		Axis Round (rpm)
		Axial	Radial	
1	0.22	7.04	4.47	569.5
2	0.22	10.6	4.69	568.3
3	0.24	12.61	6.50	567.7
4	0.25	13.05	7.10	565.5

#### 3.1 Effect of Misalignment on Vibration

Based on the data of the results of the study can be seen the effect of misalignment on vibration in all conditions. Based on Table 1, Table 2 and Table 3, the data showed an increase in vibration velocity values as the magnitude of the misalignment occurred both in the backlash area, the condition of the misalignment of the axis vertically and in the misalignment condition of the axis horizontally.

In Figure 9, Figure 10 and Figure 11 show a graph of the relationship between misalignment to engine vibrations that

occur in the backlash area, conditions of misalignment of the axis of the gear shaft vertically and in the condition of horizontal alignment of the gear shaft axis. It can be seen in the graph, the misalignment changes have a positive impact on the speed of vibrations that occur where the speed of vibration that occurs of getting bigger along with the greater the misalignment.

That occurred due to the larger the misalignment causes the engine to become unbalanced. Then, the rotation of the shaft becomes unstable. As a result the vibrations got higher. This should be avoided to prevent premature damage to the engine. From the graph it is also clear that the vibrations measured axial are greater than radial measured vibrations. The results of this study were the same as the results of previously conducted studies where in the study the transmission component was used the clutch component [10].

#### 3.2 Effect of Misalignment on Electric Current

Based on the data of the results of the study can be seen the effect of misalignment on vibration in all conditions. Based on Table 1, Table 2 and Table 3, the data shows an increase in the value of electric current as the magnitude of the misalignment occurs both in the backlash area, the condition of the misalignment of the axis vertically and in the condition of horizontal axis misalignment.

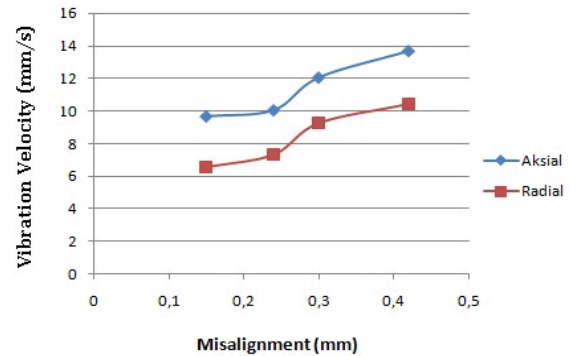


Figure 9: Misalignment versus vibration speed (backlash) graphic (backlash)

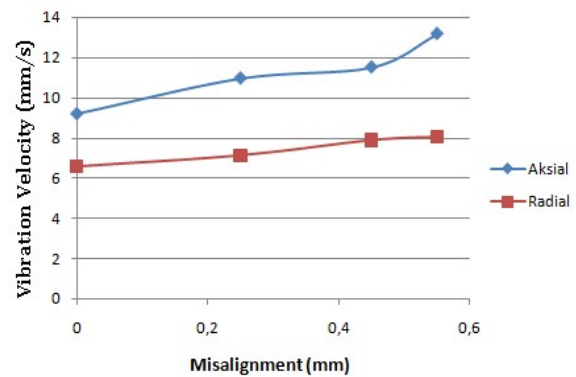


Figure 10: Misalignment versus vibration speed graph (vertical axis misalignment)

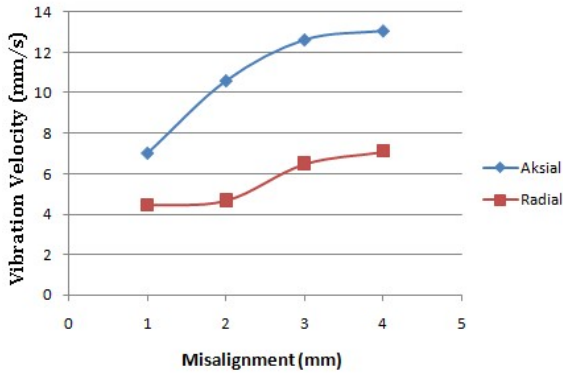


Figure 11: Misalignment versus vibration speed graph (horizontal axis misalignment)

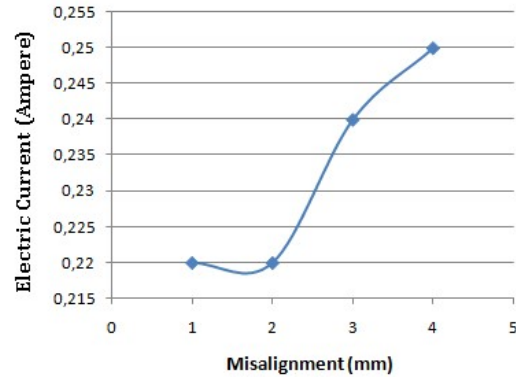


Figure 14: Misalignment versus electric current graph (Horizontal axis misalignment)

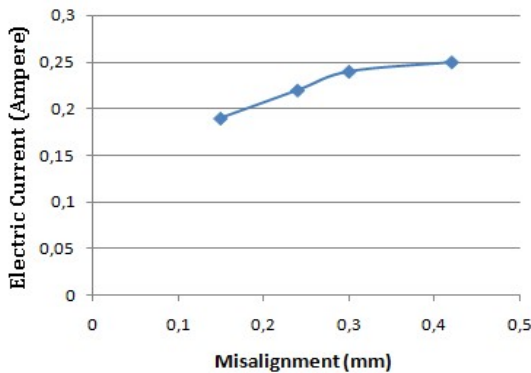


Figure 12: Misalignment versus electric current graphic (backlash)

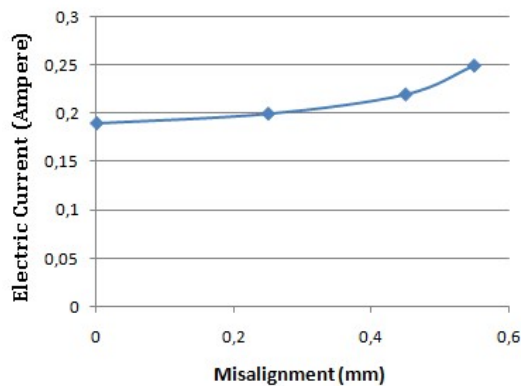


Figure 13: Misalignment vs Electric Current Graph (Vertical Axis Misalignment)

Figure 12, Figure 13 and Figure 14 show a graph of the relationship between misalignment to electric current in the backlash area, the misalignment of the gear shaft axis vertically and the misalignment of the gear shaft axis horizontally. From the graph it is clear that misalignment changes have a positive impact on the electric current that occurs where the electric current that occurs is getting bigger along with the greater the misalignment. This indicates that the larger the misalignment causes greater energy consumption so that this should be avoided. The problem occurs due to excessive load due to misalignment, so that the current needed to rotate the motor increases [11].

### 3.3 Misalignment Effect on Axis Rotational Speed

Based on the data of the results of the study can be seen the effect of misalignment on the rotation of the shaft on all conditions. Based on Table 1, Table 2 and Table 3, the data shows a decrease in shaft rotation as the amount of misalignment occurs both in the backlash area, the condition of the misalignment of the axis vertically and in the condition of horizontal axis misalignment.

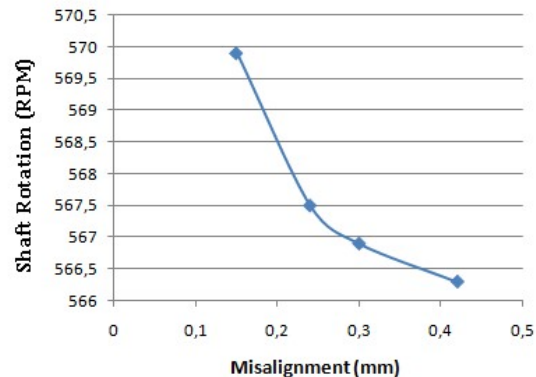


Figure 15: Misalignment graph versus axis round (backlash)

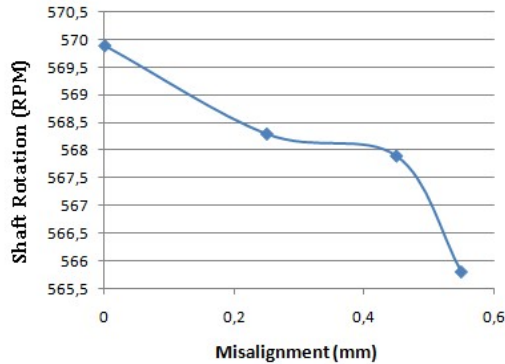


Figure 16: Misalignment graph versus axis rotation (vertical axis misalignment)

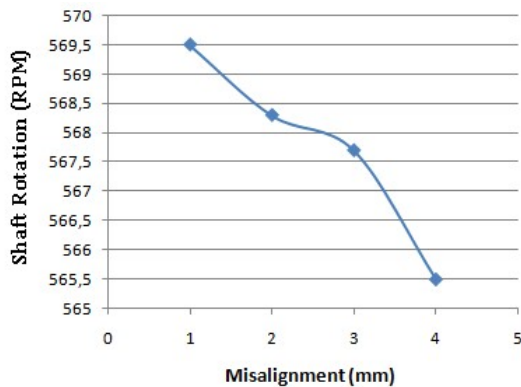


Figure 17: Misalignment graph versus axis rotation (horizontal axis misalignment)

Figure 15, Figure 16 and Figure 17 show a graph of the relationship between misalignment to the rotation of the shaft in the backlash area, the misalignment of the axis of the gear shaft vertically and the misalignment of the gear shaft axis horizontally. From the graph it is clear that the rotation of the shaft is getting slower with the greater the misalignment. This indicates that misalignment can affect the decrease in the rotation speed of the shaft, so the efficiency for transmission power would also be reduced [10].

#### 4.0 CONCLUSION

This study was carry out an experimental methods to analyses the influencing of misalignment at a gear transmission system on vibration, electric current, and axis rotation speed with variations in misalignment in 3 conditions, namely backlash area, vertical shaft misalignment and horizontal shaft misalignment. The results showed that the greater the misalignment, the greater the vibration that occurs either radially or axially for all conditions measured. This should be avoided to prevent premature damage to the engine. The results also showed that the greater the misalignment, the greater the electric current that occurs for all conditions measured. This indicates that the greater the misalignment causes greater energy consumption. Meanwhile, for

the effect of misalignment on the rotation of the shaft, the results showed that the greater the misalignment causes the speed of the shaft rotation that occurs the smaller for all conditions measured so that this can reduce the performance efficiency of an engine.

#### ACKNOWLEDGEMENT

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