UNIVERSITI TEKNIKAL MALAYSIA MELAKA

STUDY ON THERMAL GROWTH EFFECT ON MACHINERY ALIGNMENT

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTEM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Process) with Honours

By

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FACULTY OF MANUFACTURING ENGINEERING

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DECLARATION

I hereby, declared this report entitled "Study on thermal growth effect on machinery alignment" is the results of my own research except as cited in references.

Signature	:	………………………………………….
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Date	:	10 APRIL 2009

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTEM as partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Process) with Honours. The members of the supervisory committee are as follow:

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(En Mohd Shahir Kasim)

(Official Stamp of Supervisor)

ABSTRACT

Shaft alignment is a technical skill that requires expensive measurement instrument and calculation capabilities. Shaft alignment is very important to maximize equipment reliability and longer life span, because misalignment introduces a high level of vibration by moving part creates friction that built up heat causing the machinery housing to expand and need for frequently repair. This expansion called thermal growth factor. By neglecting the thermal growth factor, alignment process will be simpler but unsatisfactory result will be introduced and for short time misalignment symptom will appear. This show that the relationship thermal growth with shaft alignment very closely. For observation, the value of vibration data was used based on machine classes by compared ISO 2372 standard. From the vibration severity, can knowing the machine "healthy" .Any different indicated before and after thermal growth factor was taken. In shaft alignment technique, reverse dial indicator method was used by solving using two type of technique, graphical modeling solving and mathematical solving.

ABSTRAK

Penjajaran aci merupakan teknik yang memerlukan alat ukuran yang mahal dan kemampuan dalam pengiraan. Penjajaran aci adalah sangat penting untuk memaksimakan kegunaannya dan jangka hayat, ini kerana ketidak jajaran memberikan kadar getaran yang tinggi dengan menjadikan pergeseran yang berlaku menghasilkan hawa panas menyebabkan perumah mesin mengembang dan memerlukan pembaikan yang kerapkali. Perkembangan ini dipanggil faktor “thermal growth”. Dengan mengabaikan faktor “thermal growth”, proses penjajaran akan lebih mudah tetapi menghasilkan keputusan yang tidak tepat dan dalam jangka masa pendek gejala ketidak jajaran akan muncul. Ini menunjukkan ada hubungan yang rapat diantara peningkatan suhu dan penjajaran aci. Sebagai pemerhatian, nilai getaran yang digunakan adalah berdasarkan kelas mesin dengan membandingkan piawai ISO 23/72. Daripada ketegasan gataran ia menunjukkan “kesihatan” mesin . Sebarang perubahan yang muncul sebelum dan selepas faktor peningkatan suhu dicatatkan. Dalam teknik penjajaran aci, kaedah “Reverse Dial Indicator” telah digunakan bagi penyelesaian dengan menggunakan dua teknik iaitu penyelesaian model graf dan penyelesaian matematik.

DEDICATION

Specially dedicated for my beloved father, my mother, and who are very concerns, understanding patient and supporting. Thank you for everything to my supervisor Mr. Mohd Shahir Bin Kasim. The work and success will never be achieved without all of you.

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LIST OF ABBREVIATIONS

CPM	–	Cycle per minutes
FF	–	Far Foot
HA	–	Horizontal Angularity
HO	–	Horizontal Offset
Hz	–	Hertz
MTBF	–	Mean Time before Failure
MTBM	–	Machine to be moved
MTBS	–	Machine to be shim
NF	–	Near Foot
RMS	–	Root Mean Square
RPM	–	Revolution per minutes
TIR_{HM}	–	Total Indicator Reading on Horizontal Moveable
TIR_{HS}	–	Total Indicator Reading on Horizontal Stationery
TIR_{M}	–	Total Indicator Reading on Moveable
TIR_{S}	–	Total Indicator Reading on Stationery
VA	–	Vertical Angularity
VO	–	Vertical Offset

CHAPTER 1

INTRODUCTION

This chapter describes the background research of shaft alignment, problem statement that induce the relationship of thermal growth effect on shaft alignment, objective of study also scope of study

1.1 Background of Study

Shaft alignment is proper positioning of the shaft centerlines of the driver and driven component such pump, gearbox and airlock that make the machine drive train (Mobley.R.K, 1999). The basic alignment method are either shimming and/or moving the machine component. The objective of accurate alignment is to increase the life of rotating machine and to obtain the common axis of rotation at operating equilibrium for two shaft couple. To achieve proper alignment, machinery component commonly to fail must be operating within their design limit .It must accurately align to given result (Piotrowski.J, 2007):

a) Reduce excessive axial and radial forces on the bearing to insure longer bearing life and rotor stability under dynamic operating condition.
b) Eliminate the possibility of shaft failure from cyclic fatigue.
c) Minimize amount of wear in the coupling component.

d) Minimize amount shaft bending from the point of power transmission in the coupling to the coupling end bearing.
e) Reduce power consumption.
f) Lower vibration level in machine casing, bearing housing and rotor.

Shaft alignment means positioning of the rotational center of two or more shaft so stayed in collinear condition when normal operating condition. Collinear refers to the condition when rotational centerlines of two mating shaft are parallel and intersect (Mobley.R.K, 1999). Misalignment is defined when the deviation of relative shaft position from the collinear axis of rotation measured at the point of power transmission when equipment is running at normal operating condition (Piotrowski.J, 2007).Figure 1.1 below shows the condition of the two shafts when are slightly misalignment. When two shafts are subjected to misalignment condition, the coupling connecting of two shafts internally flexes together to accept the misalignment condition. The shafts rotate the internal parts of the coupling continually have to move around, bend in one direction then the other or stretch then compress. The problem that caused misalignments are cyclic fatigue of rotor component, excessive radial and axial force transmitted to bearing, shaft seal rubbing heavier at one side and mechanical seal rotating component not running concentric to stationery seal member. (Piotrowski.J, 2007).

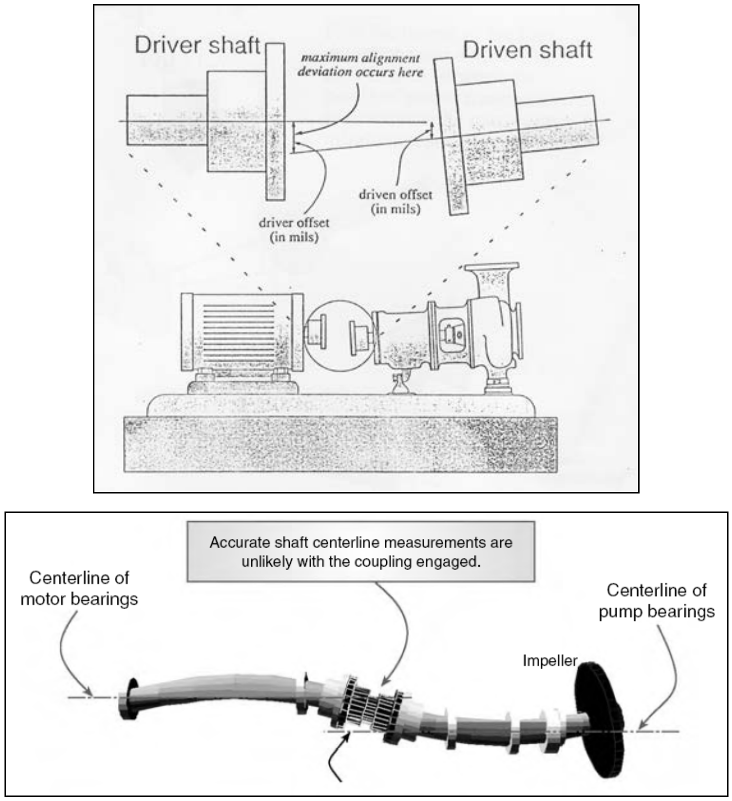

Figure 1.1: Misalignment condition.

Although the machinery has been aligned properly during installation or during maintenance, misalignment still can occurs in very short time potentially caused by foundation movement, accidentally bumping the machine with another equipment, thermal expansion, distortion from piping connection, loosened hold-down nut, expended ground, rusting of shim and crack experienced at coupling, seal and bearing. The misalignment symptoms are (Piotrowski.J, 2007):

a) Premature bearing, seal, shaft, or coupling failures.
b) Elevated temperatures at or near the bearings or high discharge oil temperatures.
c) Excessive amount of lubricant leakage at the bearing seals.
d) Certain types of flexible couplings will exhibit higher than normal temperatures when running or will be hot immediately after the unit is shut down. If the coupling is an electrometric type, look for rubber powder inside the coupling shroud.
e) Similar pieces of equipment seem to have a longer operating life.

f) Unusually high number of coupling failures or them wears quickly. The shafts are breaking or cracking at or close to the inboard bearings or coupling hubs.
g) Excessive amounts of grease or oil on the inside of the coupling guard.
h) Loose foundation bolts, typically caused by a ‘‘soft foot’’ condition, are exacerbated by misalignment.
i) Loose or broken coupling bolts. This is frequently due to improperly torque the coupling bolts and aggravated by a misalignment condition.

In alignment plant, has both offset and angular component covered four alignment parameter which are horizontal angularity (HA), the horizontal offset (HO), vertical angularity (VA) and vertical offset (VO). But in general misalignment problem, the common discussed are (Piotrowski.J, 2007):

a) Angular mismatch, if centerlines of the two shafts were extended, would cross one another rather being superimposed or running along common line.

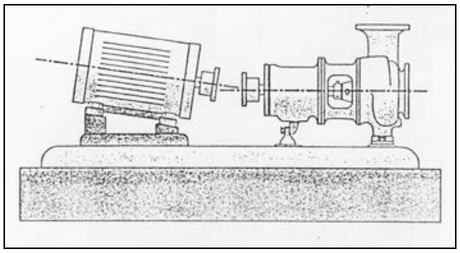

Figure 1.2: Angular mismatch.

b) Parallel misalignment, which centerlines of two shafts are parallel but in the same line.

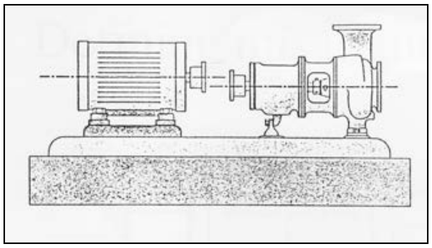

Figure 1.3: Parallel misalignment.

c) Combined angular and parallel misalignment

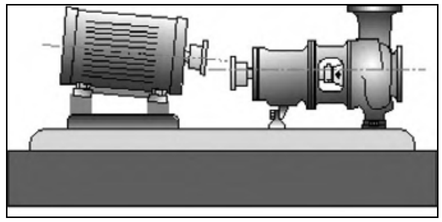

Figure 1.4: Combined angular and parallel misalignment.

Shaft misalignment may highly induce a thermal effect especially at shaft and bearing which causes rapid wear of machine bearing. The misalignment can be measure by the amount of offset and angularity which exists between them. The offset can be determined from the distance between the two rotational centerline either horizontal or vertical directions whereas angularity refer to angle between two centerlines.

In alignment technique, the Figure 1.5 shows reverse indicator method (also knowing as indicator-reverse method) was used to solve alignment problem. Reverse indicator method using dial gauge indicator measure offset at two points and the amount of horizontal and vertical correction for offset and angularity is calculated. (Mobley.R.K, 1999).

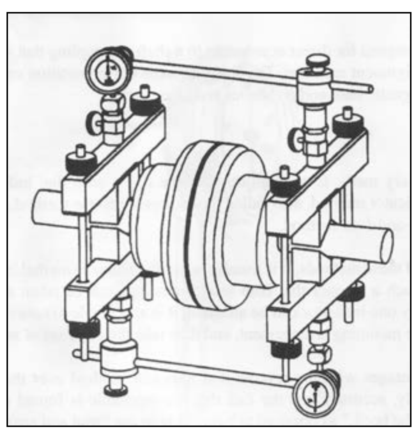

Figure 1.5: Reverse dial indicator fixture and mounting