International Journal of Research in Advent Technology, Vol.5, No.4, April 2017
E-ISSN: 2321-9637
Available online at www.ijrat.org

Study of Vibration Response of Coupling under Misalignment Condition- A Review

S.M.Moghe [1], A.N.Mahure [2]
1,2 Assistant Professor Department of Mechanical Engg., JDIET, Yavatmal
Email: sachinmoghe1@gmail.com[1] ,mahure.ashish@gmail.com[2]

bstract:- Misalignment is considered as a most common problem for creating vibration in machinery. Coupling misalignment is a problem where axis of driver shaft and driven shaft are not co axial. The non co axial condition may be angular, parallel or combination of both type of misalignment. The vibration analysis had provided the characteristics spectra for misaligned coupled system depending on coupling used. The misalignment is observed as a series of harmonics at running speed. The real vibration is produced due to cyclic touching of internal part of coupling. Two times running speed frequency component is considered as an indication of misalignment in a system.

Index Terms—Vibration ,coupling misalignment.

1. INTRODUCTION

Misalignment across a coupling is one of the phenomena in rotor dynamics that has been studied due to the impact it has on vibrations. When the center line of a drive shaft and a rotor are not on the same axis, they are considered to be misaligned. Jackson [2] affirmed that at least 60% of the vibration analysis problems he had observed in the field were caused by misalignment. Such misalignment introduces static and dynamic forces which can result in damage to, and failure of, machinery components including bearings, seals, couplings and even shafts. Additional undesirable effects such as excessive noise and increased power consumption [3] have also been reported.

2. TYPES OF MISALIGNMENT

Mancuso [4] described three types of possible misalignment in a machine train: parallel, angular, and a combination of both parallel and angular misalignment. Parallel misalignment refers to an offset distance between the parallel centers lines of the two shafts connected by the coupling, and Angular misalignment refers to the angle of the centerline of one shaft with respect to centerline of the other shaft.

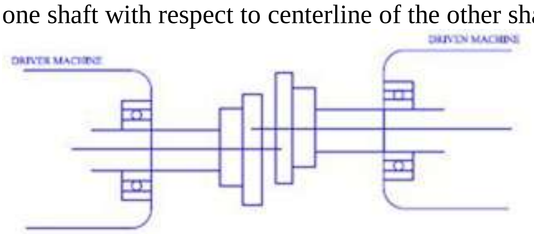

Fig. 1. Parallel misalignment

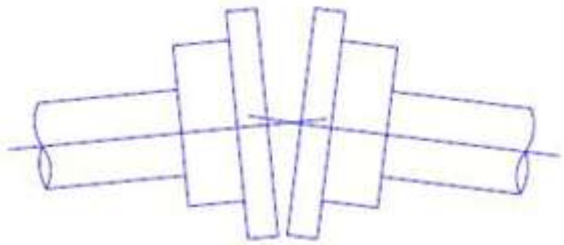

Fig. 2 - Angular misalignment.

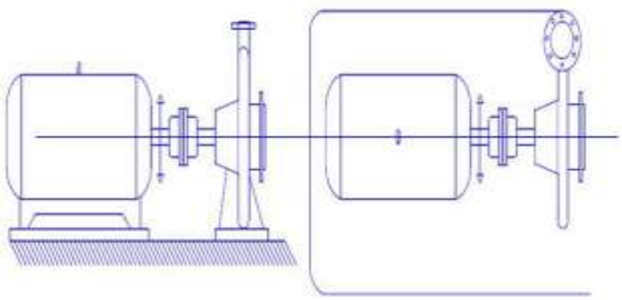

Fig. 3 - (a) Vertical alignment. (b) Horizontal alignment.

3. TYPE OF COUPLING

It is impossible in practice to achieve perfect alignment between the driving and driven shaft and it is for this reason that a flexible inter-connection is usually introduced with the aim of minimizing misalignment-imposed lateral forces while ensuring efficient torque transmission. Depending on the particular application a variety of coupling types are available. In the past, gear couplings were widely used in turbo machinery but their lubrication requirements and lack of flexibility created problems for users. Most turbo machinery manufacturers have shifted from gear to dry flexible couplings. There are different types of dry flexible couplings. The disc-pack couplings and the diaphragm couplings are frequently used in turbo machinery drive trains. Both disc-pack and diaphragm couplings generate smaller reaction forces and moments under misalignment when compared to a gear coupling under the same amount of misalignment [5].

4.VIBRATION RESPONSE OF COUPLING

It is impossible to get the output shaft of one machine perfectly aligned to the input shaft of the driven machine; flexible couplings are available to take up the misalignment. Flexible couplings allow the two machines to operate but not necessarily smoothly. The further away from perfect alignment the shafts are, the more strain there is on the couplings. This strain causes a higher level of vibration.

Misalignment shows up in the frequency domain as a series of harmonics of the running speed. The harmonics occur because of the strain induced in the shaft. The harmonics are not really vibrations at those frequencies, but fallout of the digital signal process when motion is restricted.

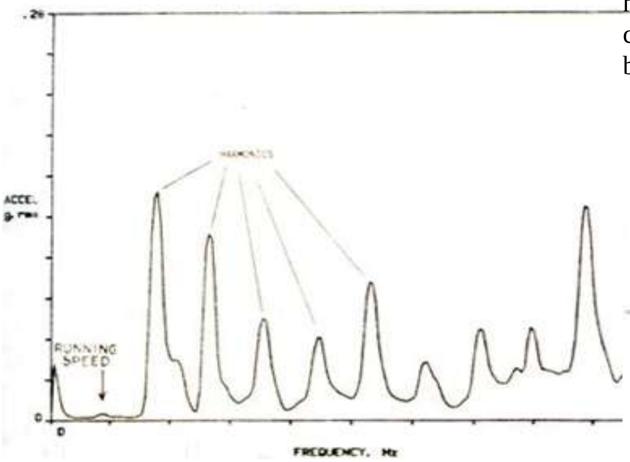

Fig. 5

When the two shafts are coupled together, they are now strained toward each other. When coupled and rotated together, the two shafts are cyclically strained at running speed. Steel shafts are very stiff, but they still deflect a small amount. This deflection creates forces on the nearby bearings and sets the entire housing of both machines into cyclical motion. The housings and bearings create reactionary forces that prevent the shaft from moving as much as it would tend to. These restrictions prevent the normal sine wave motion from achieving its full excursion in amplitude. In other words, the sine wave motion of shaft deflection is distorted at the extremes. It is this distortion that generates the harmonics.

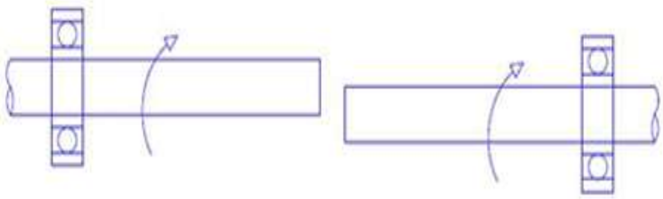

Fig. 6 - Uncoupled shafts free to rotate without binding.

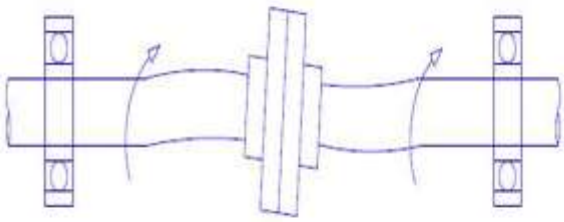

Figure 7 - Shafts coupled and strained.

The conservation of energy principal requires the generation of harmonics for distortion when the sine wave is clipped off. The missing part of the waveform is displaced to a different part of the spectrum, i.e., to higher frequencies. The unwanted shaft deflection also causes accelerated wear of the coupling and adjacent bearing and seals.

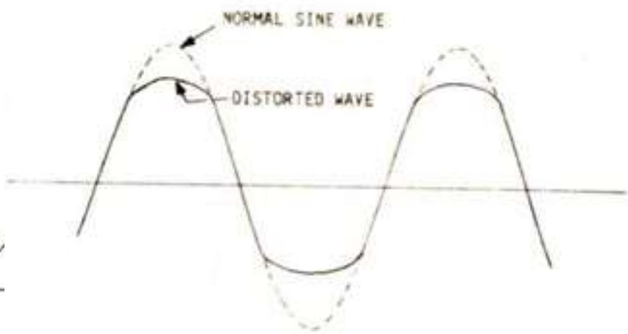

Fig. 8 - Distorted sine wave generates harmonics.

The misaligned shafts also cause a strain on the coupling and cause the internal parts of the coupling to press against each other every revolution. The parts touch, press together, come apart, then touch again on the next rotation, and continue his cycle. This cyclical touching causes a real vibration at the frequency of the coupling elements contacting. This frequency is the number of elements times the rotational speed.

Engineers in the turbo machinery industry generally believe that if the vibration frequency spectrum of a machine shows a two-times (2N) running speed frequency component, the machine is misaligned.

Gibbons [6] stated that misalignment causes reaction forces to be formed in the coupling, and these forces are often a major cause of machinery vibration.

Dewell and Mitchell (1984) showed experimentally that 2X and 4X vibration components are largely dependent upon coupling misalignment.

Xu and Marangoni (1994a, b) [7] showed that the vibration responses due to coupling misalignment mainly occur at the even multiples of the rotational speed.

5.VIBRATION SIGNATURES OF COMMON FLEXIBLE COUPLINGS

As previously mentioned, vibration can and does occur on rotating machinery that is being subjected to misalignment conditions. Case Studies have shown samples of the vibration levels that occur.

Over the past ten years, several individuals have conducted controlled tests on rotating machinery where the drive train was subjected to misalignment conditions and vibration data was collected and observed. In addition, data was collected on machinery where there was a known misalignment condition present.

As you review these figures you will notice that the vibration patterns on equipment with the same coupling design is not exactly the same and in some cases radically different or nonexistent.

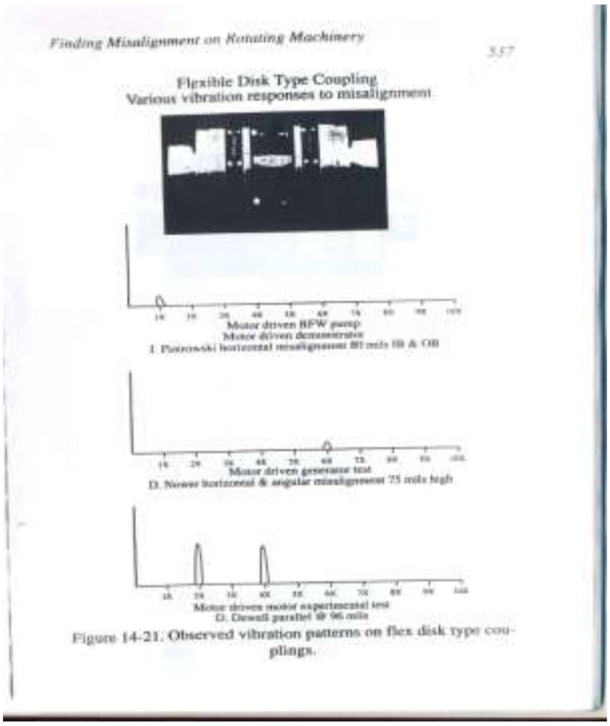

Fig. 9. Vibration pattern on flexible disc type coupling

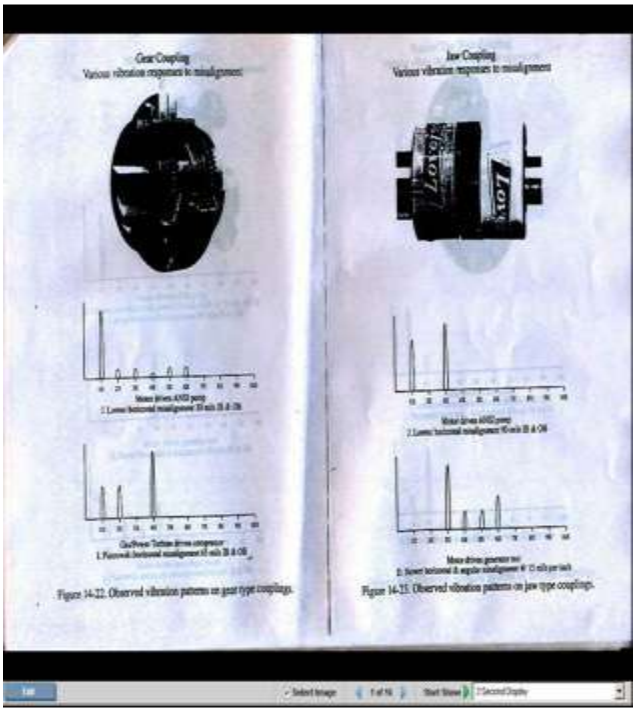

Fig. 10. Vibration pattern of (a) gear coupling (b) jaw type coupling

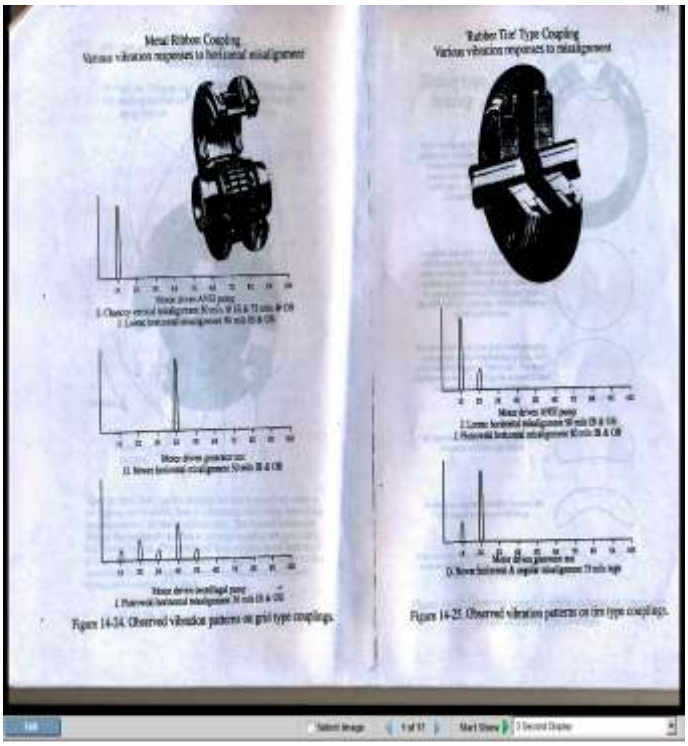

Fig. 11. Vibration pattern of (a) grid type coupling (b) tire type coupling

6. CONCLUSION

Misalignment has an adverse effect on machine element such as bearing, coupling etc. It is identified as a series of harmonics at running speed of shaft. For compensating misalignment a flexible coupling is used for connecting driver and driven shaft. The type of coupling use depends on the application. Vibration signature pattern is different for different types of coupling. Coupling misalignment is generally observed as a peak at two times running speed.

REFERENCES:

[1] Piotrowski, J. "Shaft Alignment Handbook", Marcel Dekker Inc., New York. 2"d Edn., 1995.
[2] Jackson, C., 1973, "Cold and Hot Alignment Techniques of Turbomachinery," Proc. 2nd Turbomachinery Symposium, Turbomachinery Laboratory, Texas A&M University, College Station, Texas, pp. 1-7.
[3].Gabsrson, H.A. "Energy Losses Caused by Machinery Misalignment and Unbalance", Intl. Modal Analysis Conf., San Antonio, Texas, 2oo0, ~~1322 - 1327.
[4] Mancuso, J., 1994, "General Purpose Vs Special Purpose Couplings," Proc. 23rd Turbomachinery Symposium, Turbomachinery Laboratory, Texas A&M University, College Station, Texas, pp. 167-177.
[5]Machinery vibration by victor wock
[5] An analysis of the impact of flexible coupling misalignment on rotordynamics a thesis by raul david avendano ovalle submitted to the office of graduate studies of texas a&m university.
[6] Gibbons, c., 1976, "coupling misalignment forces," proc. 5th turbomachinery symposium, turbomachinery laboratory, texas a&m university, college station, texas, pp. 111-116.
[7] Xu, m., and marangoni, r., 1994, "vibration analysis of a motor-flexible coupling: rotor system subject to misalignment and unbalance, part i i: experimental validation," journal of sound and vibration, **176**(5), pp. 681- 691.