GEARBOX VIBRATION ANALYSIS

Miloš PROKOP, Master Degree Programme (4)
Department of Electrical Engineering & Information Technology
University of Applied Sciences Pforzheim, Germany
E-mail: milosprokop@seznam.cz

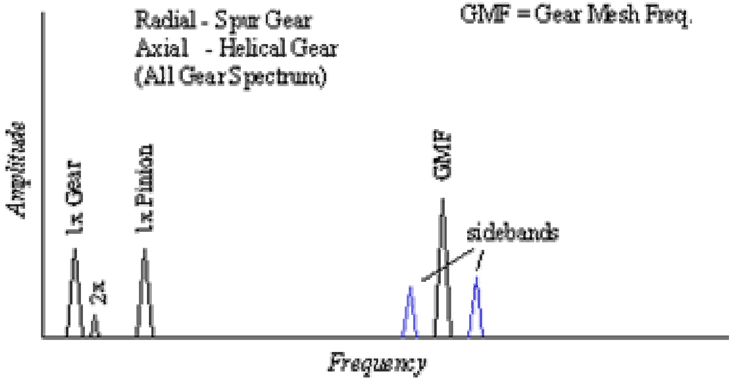
Supervised by: Prof. Friedemann Mohr

ABSTRACT

Each unit of mechanical equipment has a different signature in the frequency spectrum. The vibration spectrum shows the areas of stress and undue energy. Vibration measurements trend changes at different locations along the units to predict problems. The key benefits include: monitoring equipment life, increasing equipment uptime, managing and scheduling maintenance work. Vibration analysis can determine misalignment unbalance, mechanical looseness, eccentric shafts, gear wear, broken teeth, and bearing wear. Using Laser Vibrometer is possible to get the data that are processed in different methods like FFT, Spectrogram, Cepstrum, Wavelet transform and Cyclostationary analysis.

1 INTRODUCTION

Most modern techniques for gear diagnostics are based on the analysis of vibration signals picked up from the gearbox casing. The common target is to detect the presence and the type of fault at an early stage of development and to monitor its evolution, in order to estimate the machine's residual life and choose an adequate plan of maintenance. It is well known that the most important components in gear vibration spectra are the gear meshing frequency (GMF) and its harmonics, together with sidebands due to modulation phenomena. The increment in the number and amplitude of such sidebands may indicate a fault condition. Moreover, the spacing of the sidebands is related to their source.



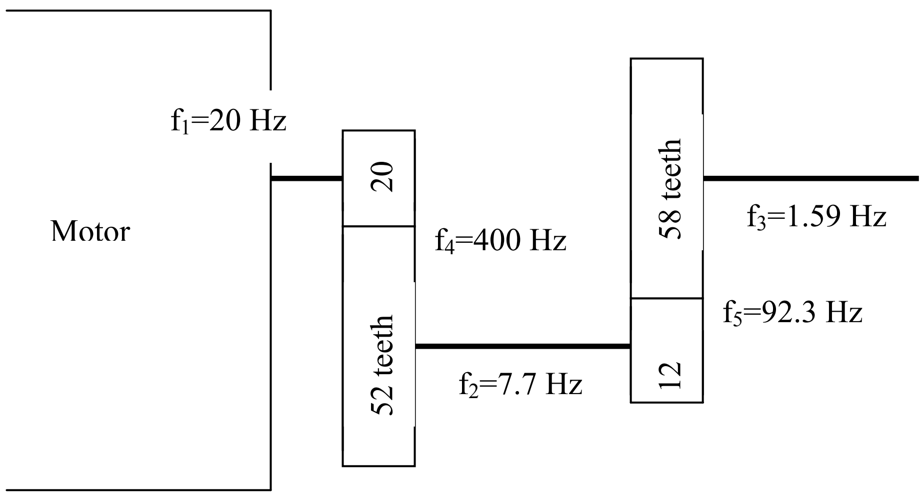
Normal Spectrum shows 1x and 2x RPM, along with Gear Mesh Frequency (GMF). GMF commonly will have running speed sidebands around it relative to the shaft speed, which the gear is attached to. All peaks are of low amplitude and no natural gear frequencies are excited.

1.1 EXPERIMENTAL RESULTS AND DISCUSSION

It was chosen the revolution of 1200 rpm = 20 Hz. On this revolution all measuring were taken.

The frequencies of Gearbox:

From the shafts it is possible to get by the gear conversion frequencies of f_1=20 Hz, f_2=7.7 Hz and f_3=1.59 Hz. The Gear Mesh Frequency are f_4=400 Hz and f_5=92.3 Hz. Theoretically it should be easier to measure highest frequencies, because the noise is quite low. By the low frequencies like f_3 or f_2 the influence and disturbing of noise is so big, that it is almost impossible to measure these frequencies only if the measurements are taken on the outer casing. It is also assumed that the outer casing absorbs certain frequencies, probably most f_3 and f_2.



2 CONCLUSION

We noticed that the most appropriate revolutions of the motor are nearly on the maximum level. The higher the revolutions go, the resolution of the frequency spectrum is better and it the GMFs are easier to find. If the revolutions reach the maximum according the manufacturer recommendation, the whole system starts to resonate.

The best place for measuring was found - by measuring from the axial position on the shaft and all Gear Mesh Frequencies were found. Although measuring on the rotating part is not the best technique, it can cause a misalignment both on the laser beam and the shaft. The additional error can also occur, because the rotating object doesn't have a constant surface. Therefore, it is important to point the laser beam in the center of the shaft. If the beam is very small in diameter and is well centered, we can eliminate the influence of changeable surface.

The highest influence on the spectrum of the gearbox has the vibration of the motor. Theoretically should add both the vibration frequencies from the motor and gearbox. However, in the reality the heavy connection between these two devices cause the reduction of the measurable frequencies. It is also caused by the way of attaching to the ground, possibly to the desk.

Moreover, another disturbing effect is the noise from the ball bearings. In addition, additional frequencies are caused by electrical problems, mechanical looseness, alignment between the motor and the gearbox, etc.

On the other hand, there are a few factors decreasing the vibrations. Besides the contact to the ground, it is the oil bath in the gearbox, which is very important for the device service life.

In the case of the experimental results considered in this paper, we found out that the measured gearbox was in excellent condition and it didn't demonstrate any damage or faults.

Except processing methods used (Time Frequency, Spectrogram), there are another methods like Cepstrum, Cyclostationary analysis or Wavelet transform.

REFERENCES

[1] David Stevens: Machinery Vibration Diagnostics 05/02/2003 http://www.vibanalysis.co.uk/

[2] G. Dalpiaz, A. Rivola and R. Rubini: 1999 Gear Fault Monitoring: Comparison of Vibration Analysis Techniques