Case History	Self-Excited Vibration Induced by Gear Coupling	Rotating machinery (compressor)
Self-excited Vibration		

Object Machine

Centrifugal compressor

Observed Phenomena

A centrifugal compressor (Fig.1-(a)) had been operated smoothly for several years, but thereafter vibrations gradually increased, so that, if left as they were, they would reach unallowable limit to cause tripping.

Cause Presumed

Since variations gradually increased due to secular change, attention was paid to increase in unbalance or rubbing wear of the labyrinth section and gears.

Analysis and Data Processing

Analysis of vibration waveforms at the position A of the casing produced charts as shown in Fig.1 (b), where a vibration of 72 Hz that is different from the frequencies of both the input and output shafts is predominant. Its frequency of vibration is close to 1/3 of that of the output side high speed shaft, thus making it difficult to identify whether this vibration was a self-excited vibration or a subharmonic resonance. By changing load pressures, it has become evident that, as given in Fig.1 (b), vibration frequencies change to some extent even at the same rotating speed, which has led us to determine that it is a self-excited vibration.
The cause was estimated and analyzed as follows: Since a gear coupling is used, the displacement of the coupling changed during operation. This combined with the influence of wear of the tooth surface due to secular change, thus increasing the internal friction and resulting in the occurrence of whirl of the primary mode induced by an internal friction-coupled spring effect. An analysis using a program ROTAS(★1) also produced a natural frequency close to 72 Hz.

Countermeasures and Results

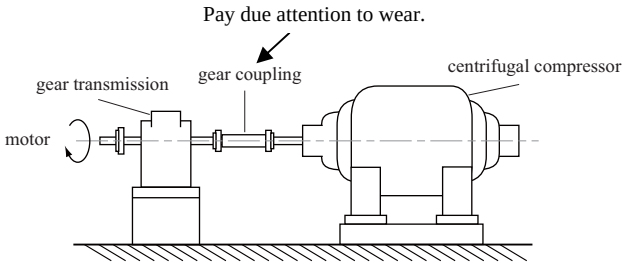
As a countermeasure, the gear coupling was changed with a diaphragm coupling. In addition, hot alignment was undertaken, and thus the problem was solved.

Lesson Learned

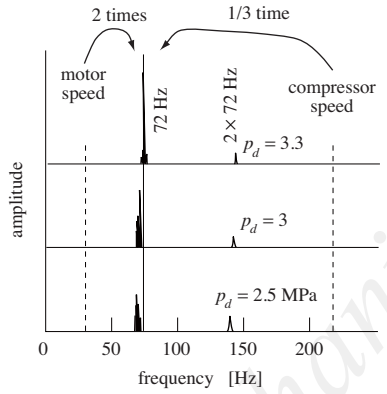
(★1) A rotor system vibration analysis program developed by the person who submitted this Case.

References

Fujikawa. 1984. *Research of Machine* 36(1): 149



(a)



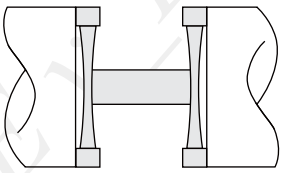
(b)

Pd: parameter
Generated frequencies change slightly depending on pressure Pd, even for the same number of revolutions.
↓
Self-excited vibration

Fig.1: Self-excited vibration of centrifugal compressor

★ A forced vibration swings at the frequency of an applied force, while a self-excited vibration at its natural frequency. In this case, the natural frequency varied depending on the load changes. Internal friction causes the self-excited vibration to occur.

Better in terms of vibration



Diaphragm coupling (expensive, for high speed and low load)