Pitfalls and Analysis of the Pre-Load Conditions of a Journal Sleeve Bearing

Summary: This article describes the limitations and pitfalls of single-channel data as opposed to dual-channel data in the analysis of a journal sleeve bearing.

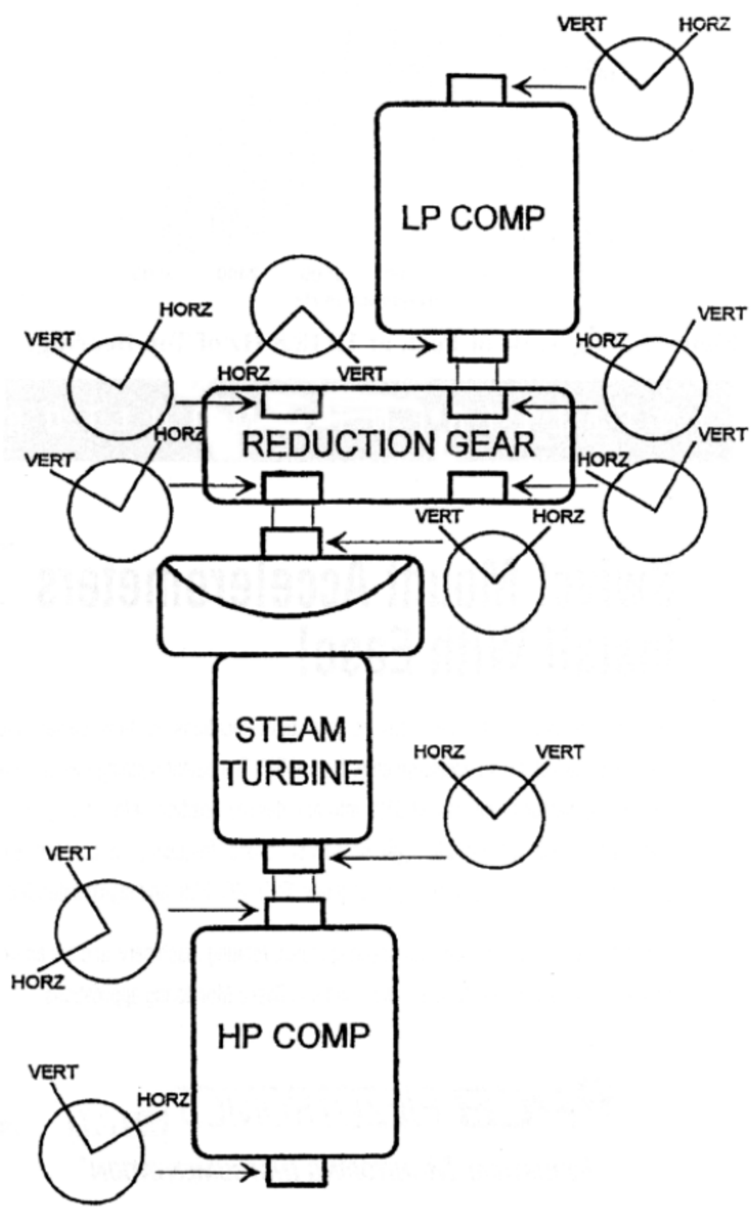
This article is concerned with the analysis of displacement data in mils peak to peak taken from a permanently installed multi-channel monitoring system. The proximity probes on a multi-stage compressor train are monitored weekly using a single-channel portable data collection system. The probes are mounted at approximate X-Y positions at each bearing (Figure 1). Many of the probes are not the typical X-Y position because of piping location, mechanical design and reversed probe wiring. The data show the effects of this reverse convention and non-traditional orientation. Data are collected on each proximity probe from 0 to $15xf_{max}$. One parameter monitors synchronous amplitude vs. phase to detect phase shifts.

The normal operating amplitude of the horizontal proximity probe at the high-pressure (HP) compressor drive end is 0.5 mil peak to peak (Figure 2). During this period the unit was shut down for about 12 hours as a result of auxiliary equipment problems.

The HP compressor typically experiences buildup of by-product, especially when shut down. Maintenance personnel involved in evaluating the problem assumed that the elevated amplitude was a result of mass unbalance forces on the rotor assembly. The reasons were that the primary source of the vibration was at the operating speed; a substantial phase shift occurred, from 298 to 358 degrees; and the discovery that the by-product was fouling the process gas.

We collected dual-channel data simultaneously at each X-Y position. The data showed that the orbits of the HP compressor bearings had an elongated fi gure-eight pattern (Figure 3). Note the reversal of the pattern on the lower plot. The reversal is a result of the convention of the X-Y probes. The elongated fi gure-eight pattern was due to pre-load conditions on the HP compressor bearings. The pre-load condition indi-

Figure 1. Proximity Probe Positions



cates significant buildup of by-product on the case and seals, which were off loading the compressor bearings and causing the increased vibration.

The OEM representative recommended continued operation of the compressor and stated that elevated case heating would eventually liquefy the buildup of by-product and eliminate the mass unbalance of the rotor. Although we did not agree with this analysis or their prediction that the amplitude would decrease, we did agree that continued operation at 2.7 mils peak to peak would not damage the compressor because the bearing clearances were 10 mils. During the next four months of operation, the vibration amplitudes on the HP compressor remained constant (Figure 4).

At the next scheduled outage, the HP compressor case was cleaned and a new rotor assembly with new labyrinth seals was installed. No evidence of excessive product buildup was found on the old rotor (Figure 5). However, severe buildup was found in the labyrinth seals and was the source of the pre-load (Figure 6). At start-up, the amplitudes were at normal levels (Figure 7). During the past four years a procedure for minimizing buildup has been initiated and the catalyst has been changed. No pre-load effects have occurred in the many shut downs of the HP compressor (Figure 8). A continuous monitoring system has recently been installed that captures dual-channel steady-state and transient data.

It can be concluded that analysis based on single-channel data collection for X-Y proximity probes can be misleading. Such data can be useful in trending but were not suffi cient for proper analysis of this problem. Simultaneous data acquisition at each X-Y position was required to provide the correct answer. Dual-channel displays of shaft orbits, centerline plots and phase measurements are critical in analyzing rotor-dynamic responses.

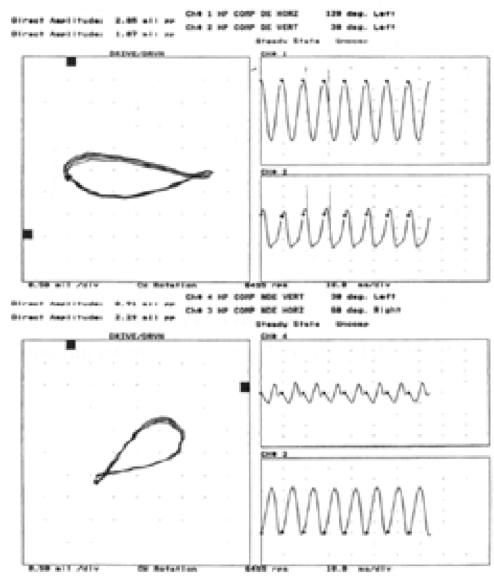


Figure 3. Dual Channel X-Y Probe Orbit of Elevated Amplitude.

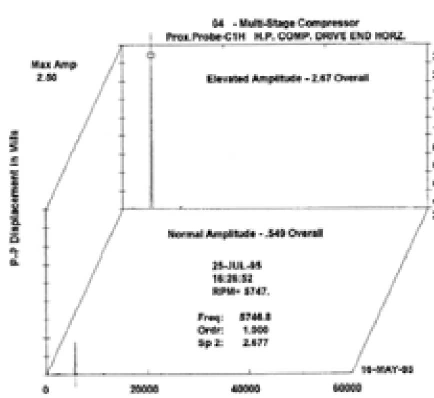


Figure 2. Comparison of Normal and Elevated Amplitudes Over a Two-Month Period.

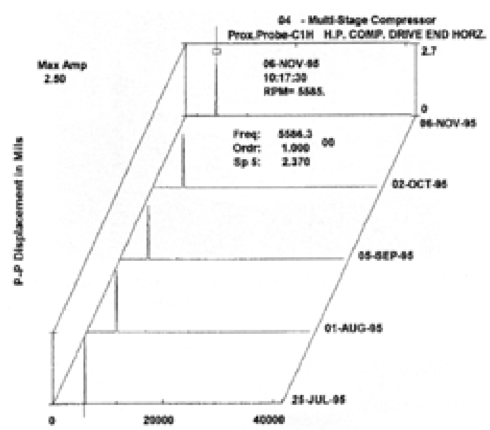


Figure 4. Elevated Amplitude Over a Four-Month Period.

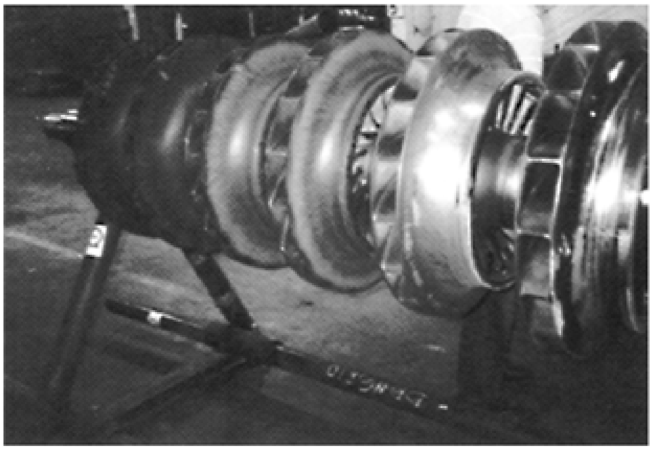


Figure 5. Rotor Conditions After Shut Down.

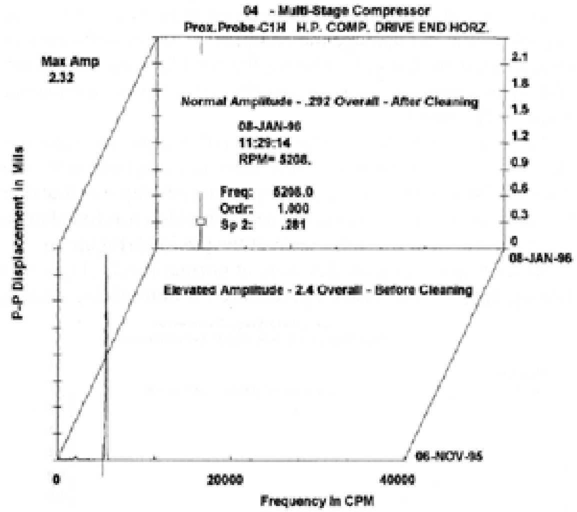


Figure 7. Comparison of Elevated and Normal Amplitudes After and Before Cleaning.

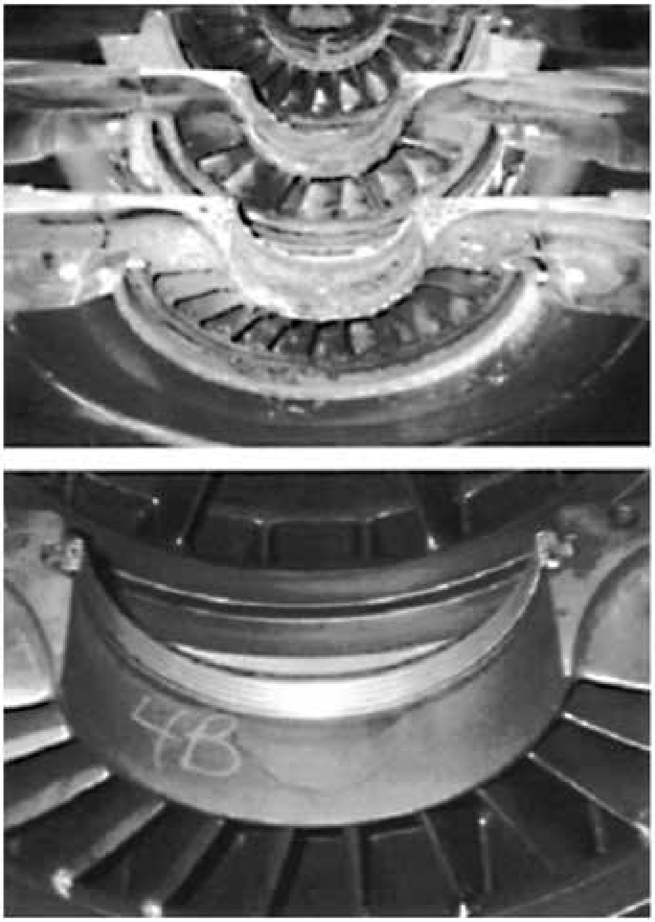


Figure 6. Labyrinth Seals Before Cleaning (top) and After Cleaning (bottom).

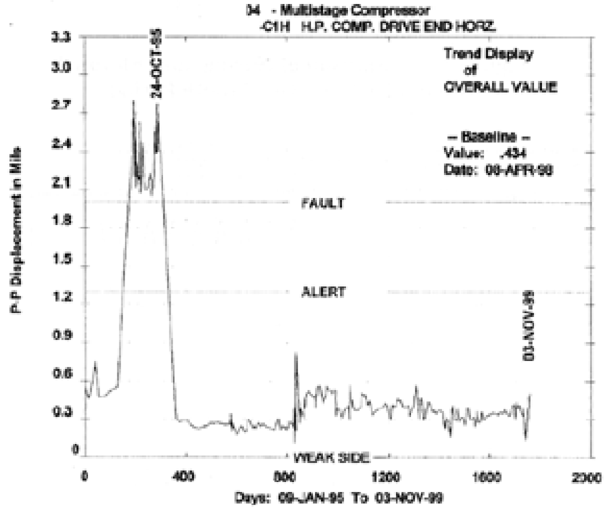


Figure 8. Five-Year Trend of Overall Amplitude.