

RESOLUTION OF SPEED SENSOR ANOMALY

By Tony Rubino, P.E.

A refinery FCCU expander recently encountered unexpected overspeed trips during post turnaround startup. Both the speed pickups and the rotor shaft were new. The expander train start was initiated several times and consistently tripped due to false overspeed indication. Replacement of suspected faulty probes did not resolve the problem.

Since the startup turbine probes were functioning normally, it was decided to compare the turbine probe signatures to the expander. The comparison is presented in the photographs below.

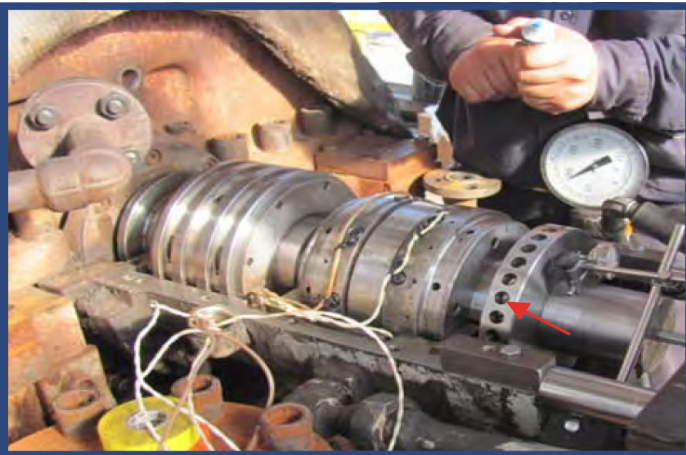


Figure 1: The red arrow points to the turbine speed probe targets. Note the spacing of the targets relative to the target diameter.



Figure 2: The red arrow points to the expander speed probe targets. Note the expander targets are more widely spaced than the turbine targets.

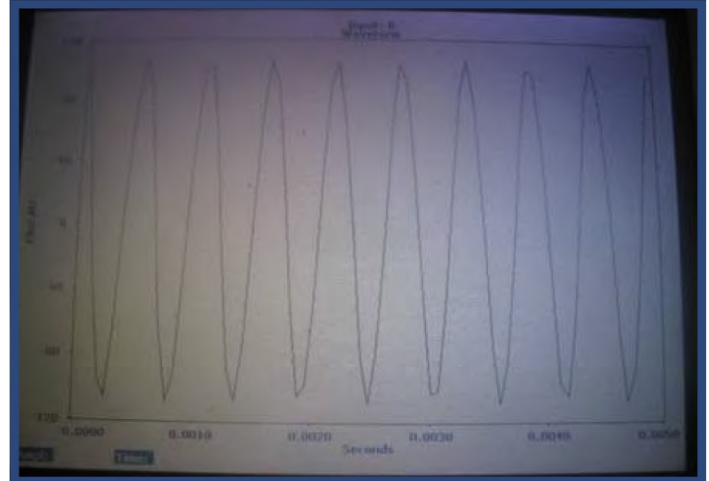


Figure 3: The turbine sensor waveform from an oscilloscope is almost perfectly sinusoidal due to the configuration of the target. This waveform was taken at full speed (36,000 rpm). The wave form has similar shape but smaller magnitude at slow roll.

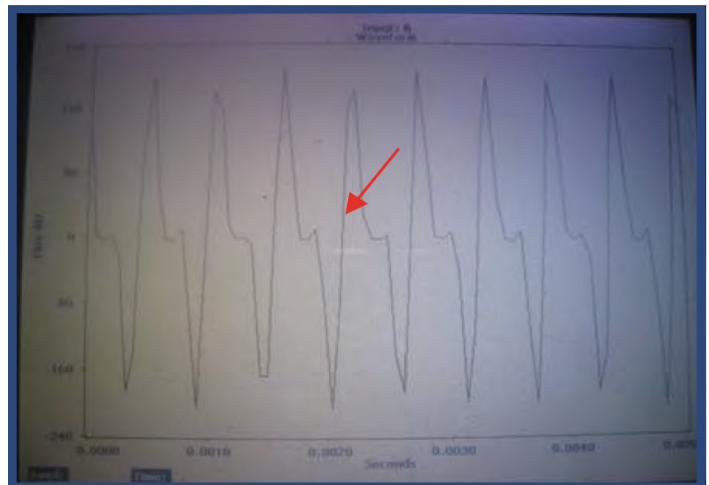


Figure 4: The expander wave form exhibited a knee or shoulder due to the spacing of the targets. The short peak at the end of the knee (see red arrow) proved problematic at elevated speed.

The understanding of three key items led to the resolution of the problem. First, the output of the sensor was a function of target surface speed and gap from the probe to the surface. Higher rotor speed and smaller gap both increased sensor output voltage. Second, increased sensor output amplified the noise as well as the desired target signal. A very sensitive monitor would count the noise as well as the target signal. Third,

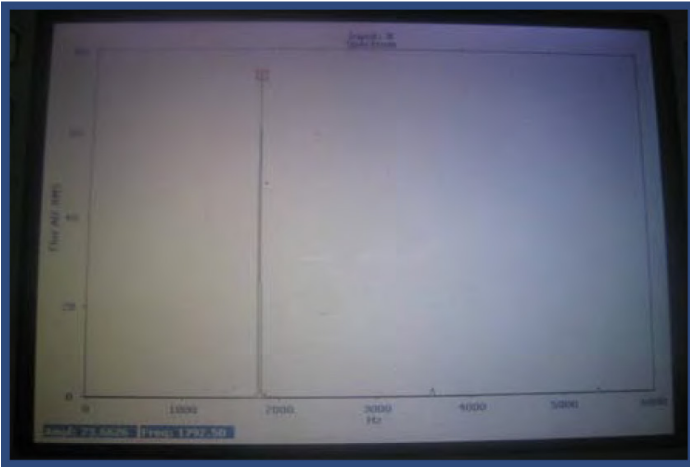


Figure 5: The turbine sensor spectrum was very clean exhibiting essentially only the target frequency of 1,800 Hz (30 targets X 60 Hz) at 3,600 rpm.

attenuation of the probe output greatly reduced the influence of the harmonic noise. Accordingly, a 1k Ohm resistor was added to the control circuit and the probe to surface gap was increased to attenuate the signal and to minimize the potential for electrical ringing. The final waveform and spectrum are show below.

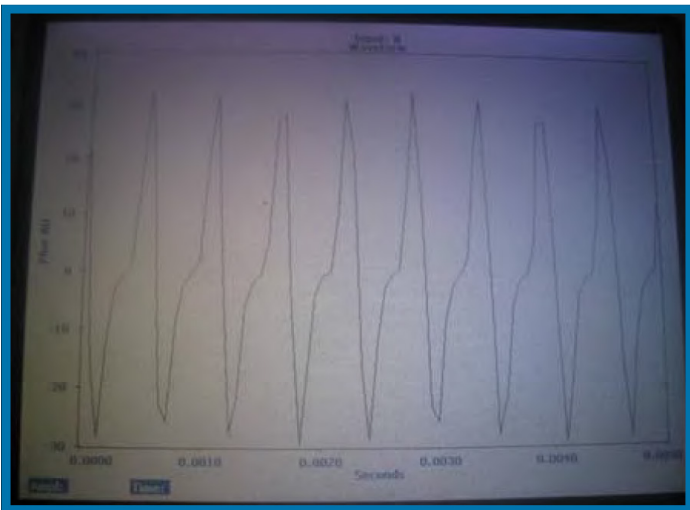


Figure 7: The attenuated signal shows almost complete removal of the "knee".

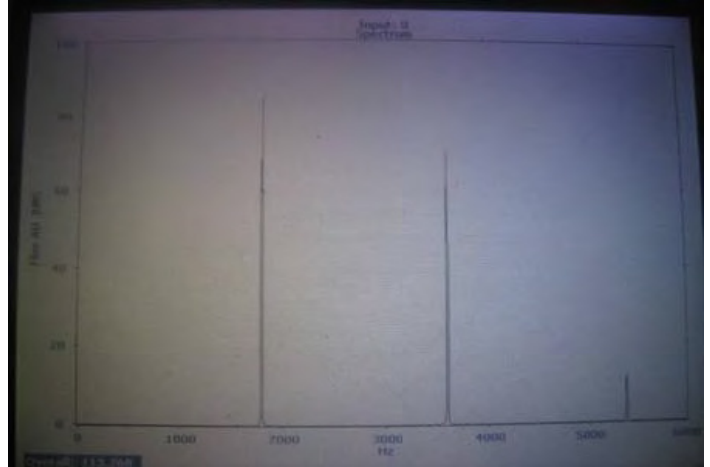


Figure 6: The expander sensor spectrum was noisy exhibiting the target frequency as well as a strong 2X harmonic.

The root cause for the phenomenon is still unknown. A possible difference between the two rotor shafts is suspect and will be investigated during the overhaul.

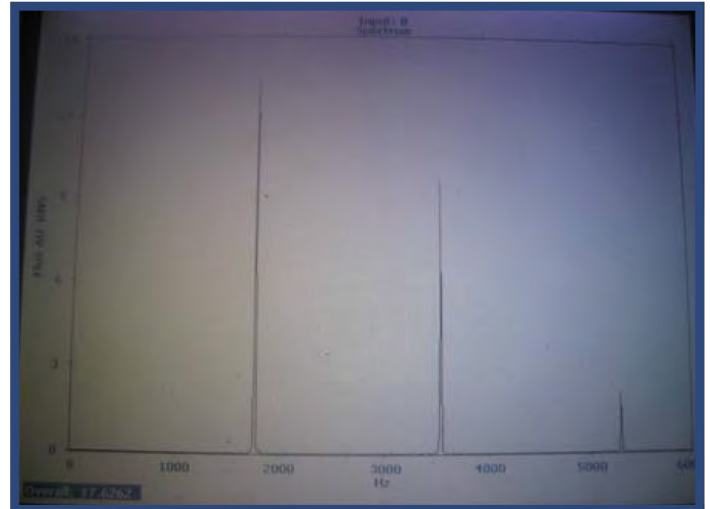


Figure 8: The harmonics are still present but sufficiently filtered to not affect the speed sensor monitor.

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