

# KNIGHTHAWK TECH NOTES

PHONE: (281) 282-9200 • FAX: (281) 282-

WEBSITE: [www.knighthawk.com](http://www.knighthawk.com)

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## “Acoustical Energy – Has It Bitten Your Bottom Line”

There are many problems in industry resulting from harmful vibration that is generated by detrimental pressure pulsation. This problem is often complex in nature and is often recognized in piping systems. These acoustical driven problems are due to the fact that the acoustical natural frequencies of the systems couple with any pulsating driving forces, which in turn couple with the mechanical natural frequency of the structure.

One classic case of this is reciprocating compressors that cause piping to vibrate. The reciprocating pump generates pressure pulsation due to the motion of the piston. This pulsation coincides with the acoustic natural frequency of the piping system. Then if you are really unlucky, this couples to the mechanical natural frequency and the system vibrates. This pulsation can cause fatigue cracks in the piping system that lead to failure.

There are several ways to fix the problem:

- Detune the system mechanically by adding supports or changing the structural configuration of the piping.
- Detune the system acoustically. This is done by changing the

geometry of the systems, adding pulsation bottles, or perforated plates to the system.

- Change the process conditions.

In fact, sometimes there are process transients where a molecular weight change can cause the problem.

With all that said, there is one area that is typically not addressed. This is the acoustical response inside the machinery casing. The main reason it has been neglected is the difficulty in capturing and proving the existence of an acoustical resonance. When a compressor experiences a failure, this cause is often overlooked. Usually surge is blamed or some other phenomena. Just like a piping system, the acoustical natural frequency of the case couples to the mechanical natural frequency of the blades and the blades fail. The pulsation might not always be present since the acoustical response is a function of molecular weight. Often the “exciter” is the blade pass frequency, pocket pass, or vane pass. Through instrumentation and acoustical modeling of the case using the finite element tool, one can diagnose and remedy the problem.

These problems are known to exist in liquid ring, screw, axial, and centrifugal compressors.

A good methodology for troubleshooting this problem is:

1. Review process data.
2. Capture data on any transients.
3. Perform a field study with a high-speed data acquisition system.
4. Evaluate the “exciter”.
5. Develop a finite element model of the case.
6. Diagnose the problem.
7. Remedy the problem by reconfiguring the hardware or changing the process conditions or both.

Acoustical problems are some of the toughest problems to solve. Part of the problem is due to the fact that the driving forces are typically the third, fourth, or fifth modes. Getting “Bubba” to change the parts just won’t work.



### *Knighthawk Project Update*

- Furnace Tube Failures
- Heat Exchanger Tube Failures
- Structural Analysis
- Motor Driven Structural Vibration
- Pump Design Assessment
- Coke Drum Failure Assessment
- Process Valve Fit for Service
- Corrosion Failure Analysis
- Structural Vibration Caused by Acoustic Pulsation.
- Steam Let down Valve Vibration
- TLE Failure Analysis
- Compressor Vibration
- 3rd Party Design Review
- Time Lapse Corrosion Testing
- Pump Failure
- Rupture Disk Failure Analysis
- Pipe Stress
- Acoustical Vibration - Reciprocating Compressor
- Compressor Vibration Field Services
- TLE Design Audit
- Low Temperature Brittle Fracture Analysis

#### Cliff's Notes:

At KnightHawk Engineering we have diagnosed and remedied many situations involving acoustical problems. We have the equipment to perform the field studies and the right people to model complex systems. Our methodologies have been breaking new ground in case acoustics in turbomachinery.

Well summer is upon us. My wife and I are planning a trip to Israel. We've been before, but I ended up working the whole time and feel like I didn't get to see much. I hope this time I am a little more focused on the trip. I hope everyone has a fun and safe summer.

Take care and God Bless,

*Cliff Knight*

[cknight@knighthawk.com](mailto:cknight@knighthawk.com)