

KNIGHTHAWK TECH NOTES

PHONE: (281) 282-9200 • FAX: (281) 282-9333

WEBSITE: www.knighthawk.com

November, 2009

Issue 9.4

“Acoustical Driven Vibrations—Don’t Let it Fail You”

Acoustical driven vibrations can lead to failure and performance problems. Well I am sure the first thought in your mind is what is acoustical driven vibration? Fair question. Every contained volume has an acoustical response. Many times acoustics or noise is welcome like at a concert or event. Acoustics physics and its harmful interactions can be explained as follows:

- **First there has to be a noise or acoustical source that corresponds to the acoustical natural frequency of a contained volume.**



Now I know this still may not make sense to you, so let’s go into more detail. Every contained volume has a set of acoustical natural frequencies. You know when you are in some rooms with many people you cannot hear anything while in others you can hear just fine, even with the rooms being the approximate same size and with the same number of people. Well, the difference is the acoustical response, one may have acoustical lagging to change the response and dampen out the noise. Examples in industry of the contained volume may be a building, rotating equipment case, piping, pressure vessels, heat exchangers, tanks or piping.

- **The acoustical source could drive the contained volume at one or more of its natural frequencies.** This means that the source may excite the contained volume’s acoustic natural frequencies. These excitations cause noise leading to pressure pulsations in the system. Usually exciters are equipment or devices that cause radical changes in the momentum and pressure of the fluid within the contained volume. Usually these conditions lead to some type of fluid pulsations as a primary driver. Unique or complex process dynamics can also drive the acoustics.

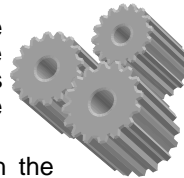
Examples of exciters might be:

- Reciprocating compressors and pumps.
- Axial, screw, liquid ring, or centrifugal compressors.
- Let down or recycle valves.
- Two phase flow conditions.

- **The acoustical natural frequencies may correspond to the mechanical natural frequencies.** Every structure has mechanical natural frequencies. If the acoustical natural frequencies and the mechanical natural frequencies correspond, the structure can vibrate.

Now that you know all of this, how do you identify the problem and solve it. Let’s first go over a few points regarding these type problems.

1. These problems are frequently complex and have to be diagnosed and calculated precisely.
2. The quick fix rarely works and can make matters worse.
3. The details of the actual physical geometry and fluid physical problems are important.
4. The frequencies causing problems are typically the higher modes with lower amplitudes.
5. Sometimes during the course of operation, the vibration will “tune in and out”
6. No shortcuts can be implemented on the typical solutions methodology and be successful.
7. The analysis must match the physical situation.



The solution methodology is as follows:

- Execute a field study with a data acquisition system to evaluate vibration and pressure pulsations.
- Develop a tuned acoustical model to

match the physical situation.

- Rework analytically
- Design implementation

Computational Fluid Dynamics and finite element codes are more advanced than ever to aid in addressing complex acoustical problems. KnightHawk has been involved in advanced studies of cavity acoustics i.e. the study of acoustic responses within the rotating equipment enclosures. The result of this work has been able to answer “phenomena” failures that have occurred in open face impeller in compressors.

Any of these problems are complex and should be under the direction of a professional engineer competent in acoustical driven vibration.

KnightHawk Project Update

- Turbocharger Failure Analysis – Transportation
- CFD Ethylene Furnace – Petrochemical
- TLE Failure Analysis – Petrochemical
- Transient Fluid Dynamics – Petrochemical
- Skid Design – Off Shore
- Vessel failure – Refinery
- Reactor failure – Petrochemical
- Compressor Failure – Petrochemical
- Pump – Reverse Engineering
- Oxidizer Failure and Redesign – Petrochemical
- Fan Vibration – Nuclear
- Turboexpander Failure Analysis – Gas Plant
- Bearing Design – Heavy Manufacturing
- Vaporizer Design – Petrochemical
- Mechanical equipment design – Off Shore
- Waste Heat Boiler Failure – Petrochemical
- Liquids & Solids Separation Technology Development – Coal
- Gear drive failure – Petrochemical.
- Valve Failure – Offshore
- Compress wreck – Offshore
- Vessel Nozzle FFS – Power
- Titanium Tower FFS – 1 / API 579 Analysis – Petrochemical
- Flange Leak – Off Shore
- Main Oil Pump Failure – Petrochemical
- Structural Dynamics – Off Shore
- Gas Turbine Failure Analysis – Refinery
- Fitness for Service Waste Heat Boiler – Petrochemical
- Thermosyphon Analysis – Petrochemical
- Waste Heat Boiler Audit – Petrochemical – Middle East
- Rotordynamics – Motor Pump Train – Off-shore
- Inlet Cone Design for TLE’s – Petrochemical

Cliff’s Notes:

KnightHawk has a long history in complex acoustical analysis within the internals of rotating equipment. We are your one stop source for field service, metallurgical, and specialty engineering. Facilities around the world call upon KnightHawk to solve some of industries most challenging problems.

I hope everyone had a great summer and are enjoying the fall activities. I was particularly happy with LSU winning the baseball national title. Football is here and we are behind the Tigers. Hopefully the Tigers will put together a pretty good season. Praise the Lord there were no “Hurricane Ikes” this year as it made great challenges for us all last year.

Cliff Knight

cknight@knighthawk.com

