

## Acoustical Driven Vibrations - Don't Let it Fail You

**A**coustical 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. Acoustic 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 be very clear, so let's go into more detail. Every contained volume has a set of natural frequencies. For example, when you are in some rooms with many people you cannot hear anything due to the noise, 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, or tanks.

**The acoustical source must drive the contained volume at one or more of its natural frequencies.** This means that the source must excite the contained volume acoustic natural frequencies. This excitation causes noise leading to

pressure pulsations in the system. In industry, the exciters are typically 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 and screw pumps.
- ◆ Let-down or recycle valves.
- ◆ Two phase flow conditions.

**The acoustical natural frequencies must correspond to the mechanical natural frequencies.** Every structure has 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 types of problems.

1. These problems are frequently complex and have to be diagnosed and calculated precisely.
2. The "Bubba" quick fix rarely works and can make matters worse.
3. The details of the actual physical geometry and fluid physical characteristics are important.
4. The frequencies causing problems are typically the higher modes with lower amplitudes, but not always.
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:

- A field study with a data acquisition system to look at vibration and pressure pulsation.
- A tuned acoustical model to match the physical situation.
- Rework analytically.
- Design implementation.

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



### **KnightHawk Project Update**

- CFD of Extruder Nozzle – Food Industry
- Structural Dynamics – Refinery
- Centrifugal Compressor Analysis – Petrochemical
- Axial Compressor Analysis – Petrochemical
- TLE inlet aerodynamics - Petrochemical
- TLE Failure Analysis – Petrochemical
- Pelletizing Die Design – Petrochemical
- Piping Acoustic Vibration – Petrochemical
- Furnace Design CFD – Petrochemical
- Exchanger Failure – Petrochemical
- Pipe Stress – Refinery
- Structural Dynamics – Rotating Equipment - Power
- TLE Coking Analysis – Petrochemical
- Piping Failure – Refinery
- Secondary TLE analysis – CFD, FEA, Custom Software Petrochemical
- Structural Dynamics – Petrochemical
- Waste Heat Boiler Analysis – Petrochemical

### **Cliff's Notes:**

KHE has silenced many problems with acoustics and is your turnkey source for these problems. One of our recent success stories was an acoustical analysis of a screw pump on a lift oil system for the main steam turbines at a nuclear power plant.

We are pleased to have Dr. Hannah Xu join our company as a Senior Mechanical Engineer. Hannah has 7 years of Mechanical Experience. She received her PhD in Mechanical Engineering from North Carolina. She is an expert in finite element analysis of mechanical systems. Welcome Hannah.

It is the fourth of July and we should count our blessings. Recently I was in Russia on a church trip to Vladivostok, on the Far East Russian Coast above Japan. (Home of the Russian Pacific Fleet) I worked in three orphanages; soup lines for the homeless, spent time in a Russian prison for young people, and worked at the universities. The experience had a profound effect on my life in a positive way. I suggest you take such a trip as well if you can, it will change your life.

*Cliff Knight*

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