KNIGHTHAWK TECH NOTES

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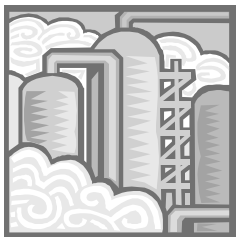
Two Phase Flow – A Vibration Culprit?

Your plant has been experiencing slugging problems in one of the plant process units. The slugging occurs at random and everyone is not sure of the source. Sometimes it takes the form of random vibration that comes and goes. The process is a continuous process and it makes no sense at all why it would come and go, after the entire unit runs a steady 98% of design capacity and there are no upsets. This slugging causes pressure waves up and down the system that affects the process control. The operators are having to fight the system to get back where it needs to be. Leaks in the systems have occurred and sometimes serious failure has occurred meaning the unit had to be shut down. All the experts have been called in to fix the problem with no results. The mechanical group has run one vibration study after the other and no problem is found. Metallurgical analysis of all the failures reveal bending fatigue with subsequent ductile over load. Everyone is frustrated as to the source of the problems. You are in the conference room and the Plant Manger tells you to solve the problem, you are under the gun.



You bring all the players in one room. The results of each group is as follows:

1. Metallurgy is O.K.
2. Mechanical Design is O.K.
3. Process is O.K and operating within design limits.
4. Controls are O.K.

At this time you are shaking your head. Everything has been evaluated and still nothing is found. As you look at the problem you go back to basics. First, the vibration and slugging does not happen all the time so you now convince yourself that it must be some sort of transient event. But the equipment is operating under steady state conditions and this puzzles you as the source of the problem. At this point you feel you have a real mystery on your hands. Now it's time to hit this hard. You talk to the operators and you find out that this problem goes and comes during parts of the year. Furthermore you find out this happens during the day time on hot days. Finally, you have something to work with. At this point you have set things up with the operators to call you when things start to rock and roll. Sure enough you are called in and see what is happening.

You find out the vibration was caused by a slipstream injection off a process that is being cooled by fin fan coolers. The coolers were slightly undersized for the plant when running up to close to 100% capacity, above 90%. During the higher flows and process conditions, a low pressure zone on the backside of a control value flashed out some components causing a pulse in the system that initiated the vibration and slugging.

What was described above occurs many times in industry. During the design and initial operation of the plant facility it is difficult to consider all the transient events that may or may not occur. A typical methodology for these type problems are as follows:

1. Characterize the vibration through a field study
2. Capture the process conditions at the time of the event if possible.
3. Review the structural dynamics of the system.
4. On hardware control valves, mixers, orifices, or check valves upstream of the vibration consider local flow effects. In the case above consider low flow zones leading to flashing.
5. Perform a fluid dynamics study using computational fluid dynamics (CFD) tools.
6. Calculate any driving forces.
7. Perform a transient forced vibration analysis.

Typical solutions available are from the structural end or the process side. Typically the most economical way of fixing these problems is from the process. In all case have a professional engineer competent in these problems review and confirm the study and proposed solution.

Cliff's Notes:

KnightHawk has made its mark in industry in solving complex flow induced vibration problems. We can provide complete turnkey service for providing the field study, process, mechanical, and metallurgical analysis. Because of our vast experience concerning these problems, many times we have discussed the nature of the problem and provide plan of attack and cost with just a phone call.

I appreciate all the feedback I get on these newsletters. Fall is approaching and school for the kids is back in full swing. Recently I went to my son's school where he plays football. All the kids were giants and I pondered, the question is not "where is the beef" but "what was in the beef we feed them".

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KnightHawk Project Update

- 750 HP compressor motor vibration - Petrochemical
- Field Services High Pressure Off Shore Pipe Clamp Test – Manufacturing
- Furnace Wall Heat Transfer Analysis – E&C
- 240 MW Gas Turbine Failure Analysis – Petrochemical
- Boiler Failure analysis – Petrochemical
- Valve Analysis – NASA
- Non Linear FEA - Petrochemical
- Inlet Cone Design for TLE's – Petrochemical
- Integrally Geared Compressor Failure Analysis – Petrochemical
- Aerodynamic Study of TLE Inlet– Petrochemical
- High Temperature Mixer Analysis – Petrochemical
- Coal Gasification Reactor Failure Analysis – Power
- Rail Car Structural Dynamics – Petrochemical Transportation
- Custom Riser Flange Design – Off Shore
- Pelletizing Die Analysis – Petrochemical
- Exchanger Failure – Petrochemical
- Structural Dynamics of Rotating Equipment - Petrochemical
- TLE Coking Analysis – Petrochemical
- Piping Failure – Refinery
- Pipe Stress – Refinery
- Waste Heat Boiler Failure Analysis - Petrochemical