KNIGHTHAWK TECH NOTES

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Transient Loads in Rotating Equipment

Was it in the Design Requirements?

It's a conference room meeting full of folks. The plant manager, maintenance manager, engineering manager, process-engineering manager, and maintenance manager are all discussing the compressor wreck that just happened overnight. You are in line to give a presentation on the state of the union with nice digital photos of the wreck and preliminary assessments to the extent you can give them.

This compressor has been running for years and has on occasion experienced failures. Of course the compressor manufacturer has stated the cause to be surge, stall, or slugging from liquid carryover. But there has always been one aspect that you have observed in the fracture surface that has bugged you. It has been a high cycle mechanical failure in most every instance.

Your message to management was as follows:

1. No vibration was indicated outside limits on the vibration monitoring system, which happens to be the best in the business.
2. The process conditions were within the limits.
3. The reliability engineers reported that this machine was in good working condition and scheduled maintenance was not for at least two years.
4. You also showed all the time history with supporting plots.
5. Parts for the wreck were brought into the room and you show your management the fracture surface. Most, being highly experienced, could look at it and see that is was mechanical fatigue. At the same presentation, your metallurgist confirmed this.
6. You field questions but you really don't have any good answers.
7. The action plan is laid out, but management reminds you this is the same song and dance as when you were in the conference room last year. The heat is on because margins are down and this failure greatly impacts the bottom line.

This time you are going to approach things a little differently. While you have a good relationship with the compressor manufacturer, and you want to keep it, you are not going to accept surge, stall, or slugging without proof.

The question is: What is the problem? Have you thought of the possibilities for the root cause of failure, besides the phenomena BS? One key to solving this problem is taking your "Mechanical" engineer's hat off and putting on an engineer's hat. The one piece of data you have is that the failure was mechanical fatigue. The other point is that since the vibration monitoring system did not pick up the vibration, it must have been high frequency with low amplitude, exciting the blades only. If we have mechanical failure and it is a high frequency (in this case probably over 500 Hz) then it would not take long for a failure to occur. Well then, you must start asking yourself questions about a transient event serving as a driving force.

I have been involved with several compressor failures along these lines. In each case, these compressor failures were caused by acoustical vibration flow disturbances. In the case of acoustic driven responses, these occurred during normal changes in process conditions where the molecular weight changed due to process, ambient conditions, or intercooler fouling. This caused a coupling effect between the blades and the driving forces leading to the failure. In the case of flow disturbances, the aerodynamics were affected leading to local surge conditions only within inter-stages. In order to be successful on any of these problems, all the physics must be considered and included in the problem. More often than not, that is the case. In our company, we use a methodology we call the Integrated Systems Approach to accomplish this. There are other cause and effect methods available as well.

The message from this TechNote is to identify the approach and solution methodology. The right approach and solution methodology is the key to these difficult problems.

Cliff's Notes:

Our team at KnightHawk has fought the battle to determine deferential transient events that are contained within normal process operation. We have an excellent track record of diagnosis and solution of these problems.

We believe 2002 will turn out to be the best year ever for KnightHawk and we look forward to 2003.

We appreciate everyone's business and I want to wish everyone a happy holiday season with many blessings.

Merry Christmas and Happy New Year

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KnightHawk Project Update

- Coal Gasification Reactor Failure Analysis – Power
- Waste Heat Boiler Code Assessment – Division II Appendix 4 – Petrochemical
- Optical Measurement Device – Manufacturing
- Rail Car Structural Dynamics – Petrochemical Transportation
- Custom Riser Flange Design – Off Shore
- Valve Research and Development - NASA
- Transient Heat Transfer FEA – Refinery
- Axial Compressor Analysis – Petrochemical
- TLE inlet aerodynamics - Petrochemical
- TLE Failure Analysis – Petrochemical
- Pelletizing Die Design Second Order – Petrochemical
- Piping Acoustical Vibration – Petrochemical
- Exchanger Failure – Petrochemical
- Pipe Stress – Refinery
- Structural Dynamics – Rotating Equipment - Petrochemical
- TLE Coking Analysis – Petrochemical
- Piping Failure – Refinery
- Pipe Stress – Refinery
- Waste Heat Boiler Failure Analysis - Petrochemical