KNIGHTHAWK TECH NOTES

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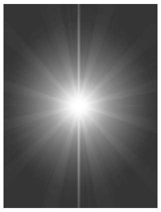
"Pedestal Bearings—The Rotordynamics Challenges"



It's the middle of the night and the phone rings. You know what it is about even before you answer. You are the Maintenance Manger at a major ethylene plant and before you left work today, vibration levels started to climb on one of the pedestal bearings on the turbine compressor train. Several times a year this happens and no one really knows why. You have brought in the original equipment manufacturer (OEM) and all sorts of consultants to study the problem, because this has shut the plant down at least three times in your tenure as Maintenance Manger. The "phenomenon" theories are free flowing and of course you have listened to opinions how operations are setting up system transients that are affecting the operational balance of the plant.

So you head out to the plant and once again it is shut down due to high vibration in this bearing. Having coffee at midnight with one of the 35 year operators who has lived with this equipment brought great insight. He told you that the problem did not start until the train was sped up by 300 rpm to increase production. He also told you the problem occurred with weather changes. It just so happened that a "Blue Northerner" came though the previous afternoon and the temperatures dropped 30º F. The structure is elevated and the turbine compressor train is on the second floor. In the mean time, you have to start the plant back up and you do what you always do to get it to run. You change the oil temperature to stabilize the bearing. As the night wears on you look at the rotordynamics reports from the last few years. All of the work indicates a stiffness change in the pedestal bearing, but none of the work, show where it comes from. The next day you investigate and discover that the stiffness estimate does not include the elevated structure or considers the ambient thermal growth effects on the structure. At this point, it all comes together for you…

Rotordynamics studies are conducted to insure the unit will operate as intended. However, many boundary conditions are assumed for the studies that may not always be valid. For example, the total structural stiffness of pedestal bearings. Two problems exist with pedestal bearings regardless of the specific bearing design itself. The pedal support stiffness will affect the calculated critical speeds of the compressor train and the pedestal itself can experience vibration problems as well.

One important parameter in the rotordynamics study is the support stiffness of the pedestal in all-principal directions. Of course the bearing damping coefficients and bearing type are important as well. The support stiffness of the pedestal bearing is not always easy to obtain. Sometimes the support structure should be figured into the ball game as well. The structural stiffness can be calculated using a finite element tool. A structural dyanmics model can be developed to determine the dynamic response of the support structure.

The boundary conditions can be derived from the finite element model and incorporated into a rotordynamics model. If problems exist, the pedestal model can be used to revise the pedestal design or its support structure as required to obtain the desired response.

Pedestal bearings are a major player in many turbine compressor and turbine generator trains. A suggested procedure for tackling the issue is as follows:

1. If the unit is existing, perform a field study to determine natural frequencies of the structure.
2. Create a base rotordynamics model of the train.
3. Perform a sensitivity study on the stiffness of the pedestal bearing.
4. Develop a finite element model of the equipment's support structure.
5. Incorporate the stiffness into the rotordynamics model. This should include any temperature effects.
6. Develop a detailed rotordynamics evaluation including the support structure.
7. Look at changes in bearing design and structure that can detune the system away from problematic critical speeds.

Every situation is unique to itself and each application should be reviewed by a professional engineer competent in rotordynamics.

Cliff's Notes:

KnightHawk has analyzed many turbine compressor and turbine generator trains over the past 20 years. We have performed extensive rotordynamics, field services, and finite element analysis of elevated structures containing this type equipment. In addition, KHE has key staff that has operated this equipment. Our production experience combined with the high analytical and field service capability makes us your one stop shop.

KnightHawk would like to wish everyone a very Merry Christmas and Happy New Year. May God bless you and your family during this holiday season.

Cliff Knight

KnightHawk Project Update

- Gasifier Process Analysis – Petrochemical
- Reactor Fit for Service – Petrochemical
- Furnace Failures – Petrochemical
- Waste Heat Boiler Failure – Petrochemical
- Casting Failure High Temp Application – Petrochemical
- Compressor Reverse Engineering & Analysis – Offshore
- Surge Drum Vibration Analysis – Petrochemical
- Clinker Grinder Design Assessment – Petrochemical
- Ignition System Redesign – Petrochemical
- Compress wreck – Offshore
- Syngas Heat Exchanger Design Assessment – Petrochemical
- Specialized Pump Skid Design – Offshore
- Pump Impeller Reverse Engineering – Manufacturing
- Fire Tube Boiler FFS – FFS -1/ API 579
- Titanium Tower FFS – 1 / API 579 Analysis – Petrochemical
- Pump Impeller Metallurgical Failure Analysis – Manufacturing
- Flange Leak Analysis – Off Shore
- Fitness for Service Waste Heat Boiler – Petrochemical
- Thermosyphon Analysis - Petrochemical
- Pump Metallurgical Assessment – Off shore - Africa
- Waste Heat Boiler Audit – Petrochemical – Middle East
- 15 MW Compressor Audit – Petrochemical - Asia
- Refinery Settling Vessel - Petrochemical
- Material Handling Audit – Offshore
- Compressor Vibration – Petrochemical
- Vessel Fluid Dynamics – Petrochemical
- Gasifier Failure Analysis – Petrochemical
- CFD of Exchanger - Petrochemical
- CFD of Pumps – Petrochemical
- Integrally Geared Compressor Redesign – Petrochemical