KNIGHTHAWK TECH NOTES

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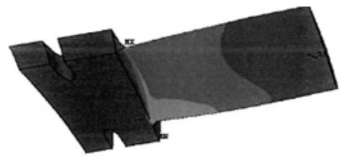
"Blade and Impeller Critical Frequencies "

This is your first year on the job and everything in your production facility is both exciting and interesting. You have finally finished the college thing and the "real life" is here. As the new kid on the block you get to do all the running around for all the senior folks, but at least you get to see a lot. Once again you're in the long term storage facility for critical rotating equipment parts at your production facility. Once again you have "crated up" the most recent failure of your rotor assembly. It is essentially a box full of broken blades and you could not imagine a worse situation. You have been told to "preserve the evidence". As you understand there is a disagreement among the experts what the root cause of the problem is. The problem lies in what the critical natural frequency is. The blades come from a compressor. You think to yourself after all these years the experts could get this one right, but it appears they don't.

The reality is the critical natural frequencies on an impeller can be quite complex. For discussion purposes, let's consider an open face impeller. The first thing that comes to your mind is to simply measure the natural frequencies with a "bump check" and see what the response is. Surely this would be the most accurate. Wrong! When the blades "spin up" stress stiffening occurs and the blades even change shape and the natural frequencies change. Oh yes, the boundary conditions matter such as a press fit of the impeller on the shaft or the tension on the mounting bolt. So what is the correct way of determining the natural frequencies of an impeller? KnightHawk has found the following method to be the most accurate.



1. Assuming you have access to the rotor and impeller, measure the response with a data acquisitions system. During the measurements determine the mode shape as well. If possible take the measurements with the impeller mounted on the rotor with any shrink fits.
2. Develop a finite element model (FEM) of the impeller and match the static condition that was measured.
3. Run the FEM at the operating RPM and determine the natural frequencies. Consider operating temperatures for the actual response.
4. In the case of failures evaluate interferences with any forcing functions that may be present.

Remember most of the "cookbook" interference diagrams do not consider cavity acoustics or secondary wake interaction that can fail the blades. The above methodology applies to turbine and axial compressor blades as well. It also applies to liquid ring compressor blades.

As with any critical application make sure the analysis is supervised and approved by a professional engineer that is competent in this area of expertise.

KnightHawk Project Update

- Bearing Fluid Flow Analysis – Subsea
- Gas Pipeline Coupling Failure – Oil & Gas
- Water Pump Failure Analysis – Nuclear
- Motor Thermal Analysis – Subsea
- Hydrolyzer Analysis – Petrochemical
- Centrifugal Compressor Failure Analysis – Petrochemical
- Gas Plant Explosion – Oil & Gas
- Deaerator Efficiency – Petrochemical
- Jacketed Reactor Vessel Design – Petrochemical
- Vessel Destructive Testing – Oil & Gas
- Critical Pipe Stress – Petrochemical
- Corrosion Analysis – Gas Pipeline
- Pump Vibration Analysis – Petrochemical
- Elevator Torque Measurements– Petrochemical
- Reactor Failure Analysis – Petrochemical
- Critical Pipe Stress – Petrochemical
- Balanced Torque Measurements – Power
- Creep Tensile Testing – Communications
- Gasifier Equipment Design – Power
- Pump Vibration Analysis – Petrochemical
- High Temperature Molten Salt Tank Design – Green Energy
- TLE Inlet Cone Design – Petrochemical
- Bearing Design – Heavy Manufacturing
- Vaporizer Design – Petrochemical
- Transient Fluid Dynamics – Petrochemical
- Waste Heat Boiler – Petrochemical

Cliff's Notes: KnightHawk is your one stop shop to turbomachinery analysis and design. We have a complete metallurgical lab, can perform the field service work, do the aero/thermo analysis, rotordynamics, and complete mechanical analysis. Our key staff has even operated major rotating equipment. As for size, we have worked on machines as large as 1200 MW. Yes, we have been the experts that have identified the "nontraditional" failure modes the OEM's don't want you to know about. KnightHawk was proud to be a presenter at the Texas A&M Turbomachinery Lab Middle East Conference presenting on Compressor Failure Case Studies.

On a personal note we continue to pray for the people of Japan and the devastation they have suffered. Regarding the nuclear plants, this has certainly opened up a debate that will last for years and likely effect the plants in the United States in some way.

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