KNIGHTHAWK TECH NOTES

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November, 2018

Issue 18.01

Transient Loadings – Are They the Peak Loadings?

Many times, when we are designing static and rotating equipment, it starts with a specifications sheet that lists the performance expectations and requirements. Most often, it is the case that any startup or shutdown requirements are not listed. For static equipment, this could be heat up rates, or sequencing of process feeds to the equipment. For rotating equipment, it could be ramping conditions through critical speeds. Many times during the startup of a plant, opportunities for relatively high transient loadings are present. Let's discuss a few examples to "home in" on some design considerations.

The first example is the heat up rate of thick walled reactors and heat exchangers. When these components heat up, localized thermal gradients produce stresses. If the firing rate of the equipment is too quick, the thermal gradient induced can cause detrimental stress to the vessel. You might wonder how this happens if the peak temperature is not reached. Well, the key is to look at the transient heat transfer. The firing rate will be dependent on the process fluid conditions, geometry, and materials. Many times, the surface on the "hot side" will heat up fast and the outer surfaces will remain colder due to thermal lag. Because of this, the transient thermal gradient can be higher than steady state.

Another situation involves the startup of rotating equipment. Many times, a compressor or turbine is "false loaded" to bring the system on line. During these periods, there can be performance issues that can affect the equipment. Dynamic stresses during startup can be higher than normal. Also for compressors, there can be transient loads involving the loss of cooling on intercoolers. Sometimes the process fluid changes during startup due to yield achieved. This can also lead to response changes in the equipment. Some polymer equipment has polymer-lubricated bearings that interacts with heat, speed, and differential pressure. These affect the bearing performance.

Most of the startup issues discussed are not analyzed during the process and detailed design phase of the project. Many of these situations are too difficult to analyze and trial and error and experience are used to determine startup procedures. This is no longer the case for many applications. In the past, transient process and mechanical analysis was very rare, however it is now conducted on a regular basis. The reason is due to faster computers, better numerical methods, and economical solution methodologies.

The solution methodology for startup analysis of static equipment might be as follows:

1. Develop a finite element (FE) model of the equipment.
2. Calculate the transient heat transfer film coefficients which is film coefficient versus time.
3. Perform a transient heat transfer FE analysis
4. Perform a transient stress FE analysis.

The solution methodology for simulation of intercooler failure for a compressor might be as follows:

1. Set up parameters of the compressor performance model.
2. Evaluate the transient heat transfer in the intercooler.
3. Forward step the compressor performance model in time simulating the loss of cooling.

Remember the peak stresses are not always the steady state stresses. Don't let it "bite" you. New methodologies and tools can tell you what you need to know to operate your equipment safely and reliably.

Cliff's Notes:

Let me simply say that KnightHawk Engineering has pioneered and developed state of the art methodologies for evaluating transient events in static and rotating equipment. We will take the mystery out of the event and show you how the "phenomena" of the event is causing you a problem. Imagine having over 25 years of solving these problems for all sorts of industry and government agencies. One of the most complex we worked on, was the failure of the Deepwater Horizon. We modeled the well and the blow out preventer to understand what happened in that event.

Thanksgiving is coming up and we have a lot to be thankful for. May God Bless you and your family during this Thanksgiving season.

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KnightHawk Project Update

- CFD Analysis of Oxidizer
- CFD Analysis of Down Draft Gasifier
- PQE Nozzle Analysis
- Auxiliary Burner RCFA
- Fracking Manifold Design
- Valve Metallurgical Failure Analysis
- Pump Water Injection Design
- Fan Vibration Analysis
- Code Calculations for Vessel
- Brittle Fracture Assessment
- Lump Breaker Design
- Hydraulic Analysis of Hydro Tester
- Spent Air Duct System Analysis
- Gas to Liquids Equipment Design
- Furnace Tube Hanger Analysis
- Ball Valve Failure Investigation
- Ethylene Input Nozzle Redesign
- Compressor Wreck RCA
- Combined Cycle Generating Station Under Performance RCA
- Compressor Carryover Analysis
- Crude Oil Line Control System Analysis
- Turbine Pipe Stress Review
- Steam Turbine Leak RCA
- Air Cooled Condenser RCA