KNIGHTHAWK TECH NOTES

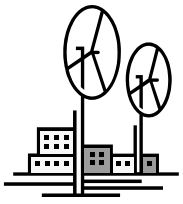
PHONE: (281) 282-9200 • FAX: (281) 282-9333
WEBSITE: www.knighthawk.com

Sept, 2006 *Issue 06.04*

"Upgrades "

Once again, a debottleneck project is complete and the plant is coming on line. As it turned out, Process Engineering had identified ways to achieve more #/hr by upgrading a quench tower with new trays and by adding a couple of new nozzles in the tower. The turnaround went smoothly and testing went well. One of the key components in the system was a turbine compressor train pushing cracked gas through the system. Things are looking good and as the plant rotating equipment engineer, you have made your rounds and all the equipment is within allowable ranges regarding temps and vibration. You go home with a good feeling and rest easy that night getting ready for the next day when the plant is slated to reach full production and start making product.

While the quench tower modifications were easy, the major part of the project involved the compressor upgrades consisting mainly of tilt pad bearings, impeller, and controls. New recycle lines, knockout drums and so forth were installed to handle the added capacity. It was not anticipated there would be any problems as previously this unit ran well in all aspects.



Things went "South" when the train went on recycle. The noise was louder than you've ever heard and operations reported cracking in one of the compressor drums. To make matters worse, the pedestal bearing between the turbine and compressor had unacceptable vibration levels. Since the train is critical to plant operation and the plant was unable to run, your office became a good stop over point for management to vent.

The problems that occurred with the upgrade are not unusual. The turbine and compressor were outfitted with the latest hardware as a technology upgrade in addition to the capacity increase with the change out of the impellers. The plant was "bit" by two problems with this upgrade. First, the reconfiguration of the recycle system along with the impeller upgrade excited the forth acoustical mode in the compressor recycle piping which coupled to the drum natural frequency leading to the failure. No acoustical analysis of the system was done; the drum diameter was unnecessarily large and could easily couple into any acoustic pulsation. The second problem was that no sensitivity study was done on the bearing stiffness when considering the new tilt pad bearing in the turbine. The pedestal bearing was too weak and there was an interference at the first mode that caused the pedestal to vibrate. Another part of the problem was that the bearing base plates were not rebuilt during the upgrade.

Some points to consider when upgrading a turbine compressor train such as this one is as follows:

1. Perform a complete process analysis of the new train.
2. Develop a new process specification sheet for the equipment.
3. Revisit the old rotordynamics studies of the existing equipment and operation. Determine that the old simulation properly identified the critical components in the system. It would probably be a good idea to revisit all previous work with the latest rotordynamics tools. Finally, develop a tuned or normalized model of the existing operating system.
4. Develop a finite element model of the pedestal bearing to determine actual stiffness.
5. Perform a complete rotordynamics study of the system.
6. Perform an acoustical analysis of the recycle piping and discharge. Make sure there is no interference with blade or vane pass in the system.
7. Conduct a review of results with process, maintenance, mechanical, and operations before signoff.

This is just a brief overview of the ball game. Turbine compressor trains are complex and each has it own unique characteristics. All work done should be reviewed and approved by a professional engineer that is competent in rotating equipment.

Cliff's Notes:

KnightHawk has been involved with many complex rotating equipment problems in industry and our track record has put us on "speed dial" for the largest industrial giants in the world to the smallest operations both on shore and off shore. We provide turnkey service with rotating equipment such as described above. We provide field services for diagnostics and complete engineering analysis such as rotordynamics, finite element, computational fluid dynamics, controls, process simulation, metallurgical, and acoustical analysis.

Summer is over and the kids are back in school. I hope each of you had a wonderful time as we go into this fall. Football is back in full swing. For me, I am rooting for my son's high school and of course, LSU, the Texans, and hopefully the Astros will do something on the baseball side. Let's remember all the Katrina and Rita victims and pray for them at this one year anniversary of the hurricane hitting the coast.

Cliff Knight
cknight@knighthawk.com

KnightHawk Project Update

- 400 MW Turbine Failure - Power
- Gear Box Failure - Paper
- Thermosyphon Measurement Field Services - Petrochemical
- Structural Dynamics - Power
- Reciprocating Compressor – Off Shore
- Ethylene Burner Analysis - Petrochemical
- CFD of Pumps - Petrochemical
- Valve Design – Heavy Industry
- CFD Review of Ethylene TLE - Petrochemical
- Burner Acoustic Field Study - Petrochemical
- CFD of Ethylene Furnace Burner – Petrochemical
- Flange Leak Finite Element – Petrochemical
- Pump Skid Design – Off Shore
- Rotordynamics – Off Shore
- Furnace Acoustics – Power
- Critical Pipe Stress – Crack Gas – Petrochemical
- Rotordynamics – Motor Compressor Train – Refinery
- Polymer Gear Pump Failure Analysis – Petrochemical
- Polymer Heat Exchanger – Petrochemical
- Boiler Failure – Power
- Waste Heat Boiler Failure Analysis and Redesign - Petrochemical
- Process Transients Field Data Acquisition – Petrochemical
- High Pressure Flange Design Riser – FEA – Off Shore
- Structural Vibration – Petrochemical
- Non Linear FEA - Petrochemical
- Inlet Cone Design for TLE's – Petrochemical