[ENGINEERING SPECS BY KNIGHTHAWK ENGINEERING]

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Upgrading rotating equipment

Once again, a debottleneck project is finished, and the plant is complete and coming on line. As it turns out, Process Engineering identified ways to achieve more pounds per hour 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 temperatures and vibration. You go home with a good feeling and rest easy as you get 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 that consisted mainly of tilt pad bearings, impellers and controls. New recycle lines, knockout drums and so forth were installed to handle the added capacity. It was not anticipated that there would be any problems, as this unit had previously run well in all aspects.

However, 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 this 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 fourth acoustical mode in the compressor recycle piping, which coupled to the drum natural frequency and led 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 are 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 also be a good idea to revisit all previous analysis 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.

Turbine compressor trains are complex and each has its own characteristics.

7. Conduct a review of results with process, maintenance, mechanical and operations before signoff.

This is just a brief review of the ballgame. Turbine compressor trains are complex, and each has its own characteristics. All work should be reviewed and approved by a professional engineer that is competent in rotating equipment.

For more information, please visit KnightHawk Engineering on the Web at www.knighthawk.com or call the company at (281) 282-9200. ❑