Maximizing Steam Turbine/Compressor Performance With Precise Torque Monitoring At The Coupling
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Daniel Phillips
Manager, Field Service Engineering
Kop-Flex, Inc., Regal Power Transmission Solutions
7565 Harmans Road Hanover, MD 21076
Office +1 410 787 8515 Mobile +1 443 831 1782
Email: Daniel.phillips@regalbeloit.com

Trevor Mayne
Machinery Engineer
Qenos Olefins Australia
Office – 61-9-258-7516
Email trevor.mayne@qenos.com

Mark Ellul
Qens I & E Specialist
Qenos Olefins Australia
Mark.Ellul@qenos.com

FLORENCE, KY – All turbo machinery is subject to degradation that, over time, will affect the system’s efficiency and operational performance. Precise monitoring of turbo machinery performance with continuous torque-monitoring systems can be used to identify gradual efficiency loss, allowing a more focused maintenance scope to be developed to return the system to its optimum operation and efficiency.

Torque monitoring based on heat balance, energy balance, and other methods utilizes numerous parameters such as pressure, temperature, flow rate, gas composition, etc., which require precise instrumentation to properly measure with low uncertainty. [Kurz, R., Brun, K., and Legrand, D., 1999, “Field Performance Testing of Gas Turbine Driven Centrifugal Compressors,” Proceedings of the 28th Turbomachinery Symposium, Turbomachinery Laboratory, Texas A&M University, College Station, Texas, pp. 216-220.] However, phase displacement technology can be used to accurately measure torque directly at the coupling to within 1% of full-scale torque, a combination of all electrical and mechanical sources of error. This accuracy provides the lowest amount of uncertainty when computing efficiency, compared to alternative methods.

A system of this type was recently installed on a cracked-gas compressor train at Qenos Olefins in Australia to determine the causes of a power limitation. The Kop-Flex Powerlign system utilizes phase displacement technology for long-term reliability, eliminating need for re-calibration. Two rings with pickup teeth are installed on a torsionally soft spacer, and intermeshed at a central location. Two monopole sensors 180 degrees apart are mounted on the coupling guard. As the coupling rotates, the ferromagnetic teeth create an AC voltage waveform in the sensor coil, which is digitally processed using known calibration parameters. Because of the intermeshed pickup teeth, the system is referred to as a single channel phase displacement system, producing two independent torque measurements (Figure 1). The Powerlign system will output torque, power, speed, and temperature, which can be easily integrated with any DCS system (Figure 2).

At the Olefins plant the operating cycle of the steam-driven, cracked-gas compressor train is 7-8 years. During this cycle the plant reaches production limitations because this compressor train encounters a power limit. To determine the cause of the power limit as “turbine fouling” or “compressor fouling” or a combination of both was not confidently possible with the instrumentation installed. The cause had long been the subject of an engineering debate between the Machinery group, Process Engineering group and Operations department. One option to add more power by upgrading the turbine power rating from 7.5 MW to 9 MW was investigated. This required a capital investment of...
$2 million. The plant elected to defer this investment and instead installed a torque meter at the major 8-year shutdown.

The installation involved replacing the existing coupling spacer and flexible halves with a “drop-in” torque meter and integral flexible elements (Figure 3). The torque meter assembly was dynamically balanced to API standards so it was not necessary for the user to return any coupling components for the retrofit. The coupling guard was modified so that the two variable-reluctance sensors could be installed, completing the mechanical installation (Photographs 1-3).

On restarting the plant and having completed a number of compressor efficiency improvements, the torque meter clearly showed the 7.5 MW turbine did not require an uprate and that the major power losses were coming from the compressor. The torque meter also allowed online tuning of the seal gas system of the compressor to establish the lowest power draw from the recycles that the seal system introduces. An additional 200 kW of power was reduced from the turbine load with the manual adjustments made on the seal gas system.

The torque meter is now being used to monitor turbine steam fouling issues and process related compressor fouling so that the corrective online washing can be activated as soon as issues arise.

The historical data collected from the torque meter will also provide a basis of mechanical loading through the drive train of the cracked-gas compressor over time. This data will be used to determine if increases in the maximum continuous operating speed rating of the compressor and the turbine can be accomplished at minimal costs. This would achieve increases in the operating envelope of the compressor.

The value of the torque meter has justified the installation of a second system for the Olefins plant’s second steam cracking plant turbine/compressor train in October 2012.

For more information, an interactive page-flip version of Regal Power Transmission Solutions’ Industrial Coupling Catalog is online at RegalPTScatalogs.com. Printed copies can be ordered at http://www.RegalPTS.com.