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Maximize steam unit performance with precise torque monitoring

All turbomachinery is subject to degradation that, over time, will affect the system's efficiency and operational performance. Precise monitoring of turbomachinery performance with continuous torque-monitoring systems can be used to identify gradual efficiency loss, allowing for the development of a more focused maintenance scope to return the system to its optimum operation and efficiency.

Torque monitoring based on heat balance, energy balance and other methods utilize numerous parameters such as pressure, temperature, flowrate, gas composition, etc., which require precise instrumentation to measure with low uncertainty.[1] 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 torque-monitoring system was recently installed on a cracked-gas compressor train at Qenos Olefins in Australia to determine the causes of a power limitation. The torque-meter coupling utilizes phase displacement technology for long-term reliability, eliminating the need for recalibration.

Torque meter installation. The meter consists of two rings with pickup teeth installed on a torsionally soft spacer and intermeshed at a central location. Two monopole sensors 180° 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. Due to the intermeshed pickup teeth, the system is referred to as a single channel phase displacement system, producing two independent torque measurements (**FIG. 1**). The system will output torque, power, speed and temperature, which can be easily integrated with any DCS system (**FIG. 2**).

At the olefins plant, the operating cycle of the steam-driven, cracked-gas compressor train is seven to eight 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.

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, a torque meter was installed during the major eight-year shutdown.

The installation involved replacing the existing coupling spacer and flexible halves with the "drop-in" torque meter's integral flexible elements. The torque meter assembly was dynamically balanced to API standards, so it was not neces-

FIG. 1. Completed mechanical installation at Qenos Olefins.

FIG. 2. Torque-meter coupling retrofit at Qenos Olefins plant.

sary 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 (**FIGS. 3–5**).

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Results. On restarting the plant and having completed a number of compressor efficiency improvements, the torque meter clearly showed that 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 corrective online washing can be activated as soon as issues arise.

The historical data collected from the torque meter will also provide a baseline of mechanical loading through the drive drain 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.

Furthermore, the value of the torque meter justified the installation of a second system for the olefins plant's second steam cracking plant turbine/compressor train in October 2012. HP

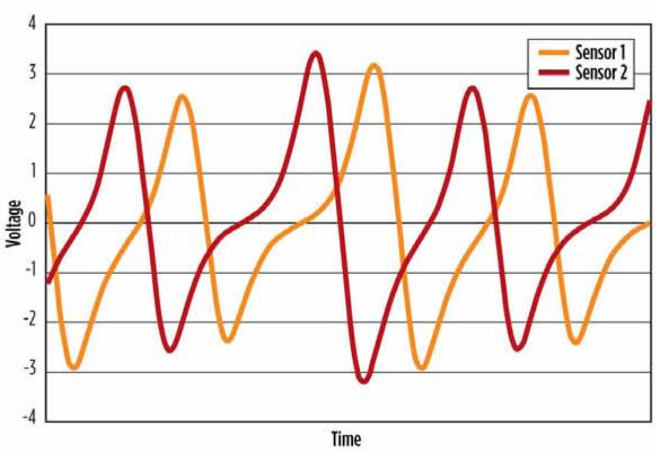

FIG. 3. The torque-meter coupling produces two independent torque signals.

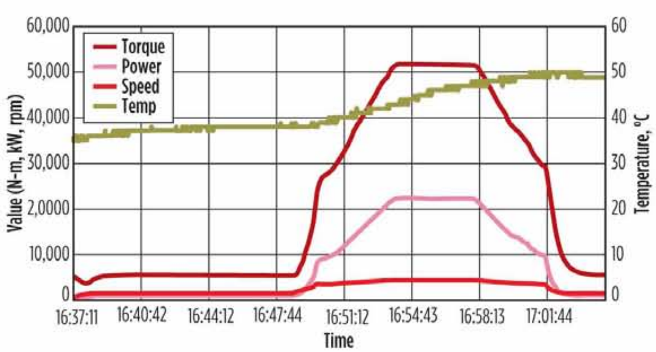

FIG. 4. Typical output from the torque-meter coupling.

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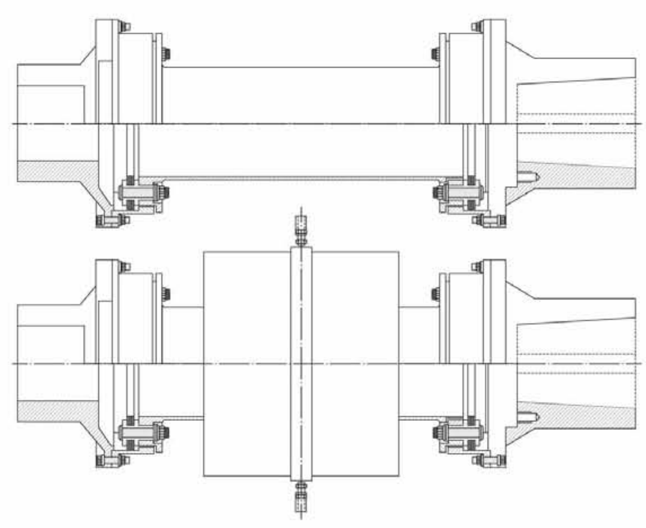

FIG. 5. Existing coupling arrangement (top) and retrofitted torque-meter coupling (bottom).