Why Permanently Installed Torque Meters Make Economic Sense

It's no secret that accurate knowledge of the individual performance of gas compression machinery used in the midstream and transmission markets is central to successful plant operation. After all, a large investment has been made. Because of this, and further influenced by prevailing fuel, feedstock and product prices, the success of a plant depends largely on good reliability and optimizing process efficiency and/or output continuously over the life of the plant.

Interstate gas transmission operations utilize large centrifugal pipeline compressors and condition monitoring here is universally viewed as an essential tool for improving plant reliability. However, tools to facilitate accurate continuous performance measurement have often been less reliable, costly and, therefore, not widely used.

In the petrochemical industry, and particularly in ethylene and fertilizer plants, torque meters on large turbomachinery compression trains have been recognized for the past decades as providing very valuable plant performance information allowing for optimizing process efficiency, debottlenecking and identifying individual machine performance.

With advances in technology the use of torque monitoring couplings continues to become an integral part of predictive maintenance programs wherever large turbo compression trains are being operated. More and more facilities are using permanently installed instrumented torque-measuring couplings in order to understand how their critical equipment is performing so that intervals between scheduled shutdowns can be chosen appropriately.

Field performance testing and monitoring of turbomachinery is also essential in assessing its current condition. For example, the objective of field-testing gas turbine driven compressor sets is to verify acceptance criteria such as heat rate, specific fuel consumption, turbine shaft power, and compressor gas power. Thirty years ago, a European gas transmission company recognized this need and decided to use torque meters routinely to test and verify the performance of their gas turbine driven pipeline compressors by fitting torque meter couplings on a temporary basis at the end of major inspections and overhauls. After a satisfactory field test they would dismantle the torque meter coupling to be mounted on another gas turbine package for the same purpose. This “wander coupling” concept allowed them to economize on the, at that time, hefty torque meter investment costs for every unit.

Field performance testing has become most useful in establishing a baseline from which the machinery's future health can be judged. Direct measurement of the shaft power between connected machinery enables operators to isolate which machine – driver or driven machine – is responsible for any performance deterioration. Continuous on-line monitoring of the machinery's output power provides operational trending data.

Torque variations can indicate performance problems such as blade fouling. Over-torque can lead to coupling, shaft or other component failures. When performance declines, more fuel is burned and *Nox* emission increases. Torque meters provide a cost-effective method for diagnosing these problems early on so operators can make the necessary adjustments to their system for a proactive maintenance plan. Permanently installed torque meters must be recognized as a machinery health monitoring tool.

Heat balance and energy balance methods rely on measurements of pressures, temperatures, flows, gas compositions, and mechanical losses. Each of these measured parameters has its own instrumentation tolerance, which contributes to the overall test result uncertainty. The largest instrumentation tolerance is due to gas composition (up to 5%), with other measurement errors due to pressure (up to 2%), flow (up to 2%), equation of state (up to 2.5%), and temperature (up to 4°F). If the shaft output power is known, the gas turbine heat rate and efficiency can be determined. If a torque meter is used, the total uncertainty for the gas turbine power can be reduced from around 7 percent to about 1 to 1.5 %[1].

Similarly, the accurate performance measurement of a centrifugal compressor is dependent on the quality of the field data. Again, an important parameter is the shaft horsepower, which can be calculated directly and accurately in real time from indicated rpm and torque if a torque meter is installed. Otherwise, a heat balance method is recommended by ASME PTC 10 (1997). Outright calculation of shaft horsepower absorbed by a compressor is fraught with the attendant measurement tolerances or errors.

Currently there are several varieties of instrumented torque meter couplings available.[2] Each is capable of providing torque measurement through non-contacting means so there is no longer a need for the extra bearing supports associated with a torque meter of years past.

All torque meter coupling designs are faced with the task of detecting a physical change due to torsion in the coupling while it is rotating, and getting this information to a stationary output device that is generally located in the control room. The challenge for accurate and reliable torque measurement is that each system is faced with determining those physical changes associated with torque alone while the coupling is subjected to a combination of torque, bending, thrust, centrifugal loads, and increased temperatures. Torque meters are generally classified as either strain gage or phase shift based. Each type has of course its own advantages and disadvantages.

Phase shift systems are known for greater long-term reliability and accuracy, while strain gage systems can obtain torque data at higher data acquisition rates.

Incorporation of digital signal processing increases the reliability and accuracy of torque meter systems, lowers the installed cost of the system, and allows for direct connectivity to the user's data acquisition system.

To sum up: Torque monitoring devices have matured and should be considered by bottom-line conscious turbomachinery users.

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[1] Kurz, Brun, Legrand, 1999

[2] www.koppers.com