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Throwback Thursday :: Torque Measurements Result in Performance Optimization

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the Orbit

Bently Nevada has a rich history of machinery condition monitoring experience and has always placed a high priority on educating and helping customers manage & maintain their equipment better. Every week, an article or Application Note that was published by Bently Nevada 'back in the day' will be highlighted. Although the format may be dated, the information is just as valid and informative as the original printing.

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Torque Measurements Result in Performance Optimization

Torque measurements identify performance deterioration of rotating machinery such as steam and gas turbines, and axial and centrifugal air and gas compressors.

Fouling deposits on blading or nozzles causes performance deterioration of steam and gas turbines. In steam turbines, evidence of these deposits is frequently not discovered until the steam flow increases to a point where no additional steam can be passed through the unit. The turbine can no longer carry an assigned load under these conditions. In gas turbine air compressors, fouling deposits reduce the amount of air available for efficient combustion. Excessive fuel consumption or reduced load carrying capacity may result. Similarly, process gas compressors often polymerize. The resulting flow impediment can seriously influence process operation and mechanical perfonnance. On-line torque measurement systems provide an easy method of measuring produced power. Comparing fuel consumption, load conditions and torque enable you to decide whether further steps need to be taken.

Turbomachinery performance can be restored by judicious application of on-stream cleaning methods. Abrasion cleaning and solvent cleaning (water washing) are the two principal

approaches. Literature, which can be obtained from original equipment manufacturers, provides ample details of suitable procedures and their relative merit. The problem, to date, has been to figure out conveniently and accurately when to initiate the on-stream cleaning process.

In pure economic terms, on-stream cleaning should commence when the cumulative cost of power lost due to fouling since the last cleaning cycle equals the cost of the cleaning procedure. This is where the on-line torque measuring system comes into play. Installed to monitor torque at the coupling, the device also shows related speed and power. Peak torque, speed and power values are also provided. The indicator can be connected to a computerized monitoring system, strip chart recorders, or tied into a process control computer or programmable logic controller. This additional equipment allows accessing of and correlation with steam or fuel flowmeters and heat rate tables.

Axial compressor fouling continues to be a common and persistent cause of reduced gas turbine efficiency. A one percent reduction in axial compressor efficiency accounts for approximately 1112 percent increase in heat rate for a given power output. Even compressor stations, not subjected to industrial pollutants or salty atmospheres are frequently prone to fouling. Torque measurements provide an early indicator of changes in efficiency.

Performance deterioration of gas turbines can be detected by combining turbine fuel flow rate with power output. Monitoring systems should incorporate readouts of power. In a computer system, this value can be easily compared to produced power per cfm of fuel consumed. Turbine manufacturers provide teststand verified performance curves. This data is helpful in determining the degree of performance deterioration by comparing actual (fouled) condition and ideal (clean) condition specific fuel consumption rates. For efficiency optimization an operation should monitor the average fuel wastage, or average turbine efficiency, at regular time intervals.

Continuous torque sensing devices can provide valuable information in other areas as well. With torque limitations on one or both of the coupled shafts, a torque indicator can serve as a constraint control. Torque sensing can allow process optimization for computer-controlled compressors where several levels of refrigeration are available. Some turbocompressors can be configured to get desired flow and head by such methods as varying speed, varying stator blade angle and varying guide vane angle. On large axial compressors, combination of stator blade adjustment and speed variation of about 10-15% improves the part-load efficiency of the compressor and increases the stable operating range. When given sufficient attention, appreciable differences in energy consumption may result and savings of power may be realized by using torque data.

Increased energy input to the driver due to perfonnance decay of the driver or driven equipment can be detected effectively by torque measurements. The case of a gas turbine driving a centrifugal compressor best illustrates how the issue can be resolved by measuring torque. High driver fuel consumption and high coupling power shows that the driven machine is a) more highly loaded, b) mechanically deficient or c) internally fouled. Using the dynamic torque signals and diagnostic and analytical instrumentation, procedures are available to figure out which of these

three possible causes is most probable. For example, high driver fuel consumption and nonnal coupling power would show that the most probable cause of the efficiency decay is turbine fouling.

Torque measurements and subsequent action can reduce energy waste in compressors incorporating anti surge controls.

Torque measurements pinpoint causes of failure

Many methods exist for determining how a component failed. Torque measurements show what caused it to fail and provides clues on how to avoid repeat failures. Looking at broken pieces can tell you how something failed. Comprehensive maintenance records can help you predict when something will fail again. Yet, these methods do little to identify the cause of failure or prevent future re-occurrences.

It can be difficult to figure out the cause of failure with insufficient accurate information on system loading during machine operation. Is it a running overload problem? Is it a resonant-related frequency or vibration-related problem? These and other questions can be answered by measuring torque on a running system. The data should reveal both the steady state and dynamic torque.

Bently Nevada Torque Measurement

The TorXimitor™ transducer provides a simple and reliable method of measuring torque on rotating machinery. The 3300/85 Torque Indicator provides continuous indication of torque. In addition, with a Keyphasor® signal input, the indicator provides speed and power indications. The instrument provides recorder outputs of these three variables and allows easy connection to Bently Nevada's computerized monitoring systems- Transient and Dynamic Data Manager®. Through the monitoring system's engineered interface, the signals can be conveniently and directly connected to a plant or process control computer or programmable logic controller. Additionally, the torque indicator stores and displays peak torque, peak speed and peak power as obtained over a certain period.

The Bently Nevada torque system supplies you with valuable and easy accessible information on power produced and power absorbed by the machinery. Evaluation of torque, a meaningful parameter in mechanical engineering, is valuable on many types of rotating machinery. Included are electric and hydraulic motors, steam, gas and hydro turbines, engines, pumps, fans, generators, gear boxes, alternators, and centrifugal and axial compressors.

Summary

On-line torque measurements provided by the Bently Nevada torque system provide a simple, reliable solution to torque measurement problems. Detection of performance deterioration, performance analysis, analyzing machine or coupling failures and machine or process efficiency monitoring are all possible with a Bently Nevada torque measurement. The Bently Nevada Torque

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Monitoring System provides you with a total system solution. This solution spans from transducer to indicator to computer to a worldwide service organization. It supports reliable long-term performance, is easy to maintain and simple to install.

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