Performance monitoring

to increase power plant efficiency

The style of operation and maintenance of power generation and cogeneration plant is important. Here, Vincenzo Piscitelli describes how performance monitoring of critical assets at one cogeneration plant in Italy increased efficiency by more than 1%.

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Since every increase in power plant efficiency boosts production incrementally, even small operational improvements can result in significant profits. For example, by simply optimizing the maintenance of inlet filters on two gas turbines, the 150 MW combined cycle Centro Energia cogeneration plant in Teverola, Italy, is contributing strongly to an overall efficiency improvement of more than 1%. This is the story of how that feat was accomplished.

Even in plants like Centro Energia Teverola, where there is a strong commitment to operating efficiently, unseen performance issues are constantly evolving to undermine the conscientious efforts of smart, proactive personnel. By recognizing this fact and being willing to change established maintenance practices and accept promising new technologies, one can mitigate the negative factors that reduce power production, including equipment degradation, machinery failures, and unexpected downtime. By continually monitoring the performance characteristics of key assets, the causes of reduced production can be identified very early so timely action can prevent losses resulting from downtime and emergency repairs.

The Centro Energia Teverola plant, owned jointly by E.ON and Foster Wheeler Italy, has two Ansaldo-Siemens gas turbines, two Foster Wheeler heat recovery steam generators, and one Ansaldo steam turbine. Our mission is 'to achieve maximum efficiency through the extreme conversion of heat', and plant management is committed to pursuing any potential efficiency improvement that might increase profitability.

MONITORING PERFORMANCE

In that regard, a six-month trial of Emerson's AMS Suite: Equipment Performance Monitor was initiated a few years ago to aid in maintenance planning, including an evaluation of the return on maintenance costs. The core of this technology is a computer-based thermodynamic model of the equipment. A stream of current data from an operating plant is transmitted to this computer, which produces useful comparisons of actual performance versus the optimum model.

Analysis of equipment performance can lead to fault detection and rectification, improved maintenance cycles, and process gains. Predictive decision making based on the derived performance and economic data removes guesswork from maintenance planning and execution, saving countless hours.

To initiate the trial of this technology, Emerson engineers built a thermodynamic model of the two gas turbines using original design data and specifications. They compiled such information as power consumption, throughput,

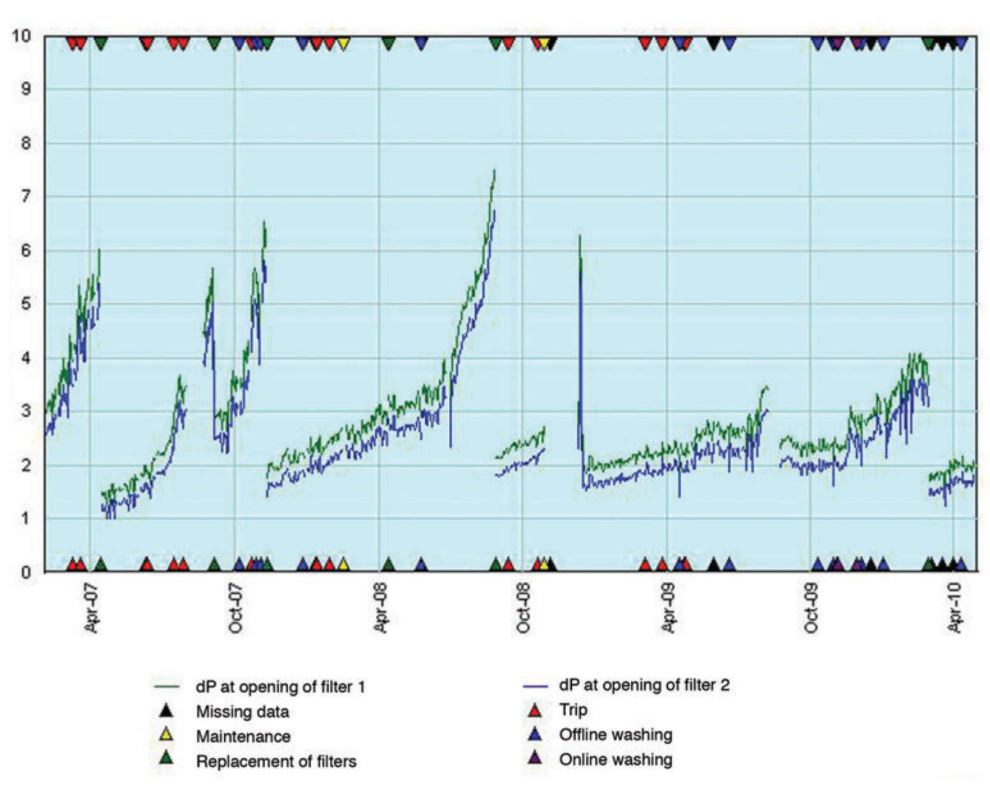

Figure 1. An indication of inlet filter fouling

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pressure ratios, etc. at various points to reflect the operation of new equipment under all possible load conditions.

Since the software is web-based, operating data can be transmitted from anywhere to the central file server with the thermodynamic models. No additional hardware is required on-site, so the system was implemented very quickly once the model was configured. Following established guidelines, plant personnel collect operating data periodically and transmit it to the central server, where software detects and corrects measurement errors. The result was an accurate portrait of the current performance of the monitored equipment for analysis by Emerson experts.

Their subsequent reports, which highlight existing or potential problems along with suggestions for recovering efficiency, are returned via the Internet. We use this intelligence to determine corrective actions to optimize each machine's performance, extending availability and improving power production.

The monitoring is continuous, so further analyses reveal the effect of changes, allowing for still more improvements and the adoption of best maintenance practices.

INLET FILTER FOULING

The total investment in time by Centro Energia staff to get the performance monitoring trial up and running after the kick-off meeting was just one day. Soon, the thermodynamic models were built and ready. Almost immediately thereafter, Emerson analysts noticed a severe pressure drop in the air flow into one turbine – an indication of inlet filter fouling; see Figure 1.

Plant personnel were impressed by this 'catch' as they knew the filters were prone to fouling, often requiring unplanned downtime for replacement. The AMS Performance Monitor application calculated the cost of the resulting reduction in turbine performance, which can vary with loading. This enabled maintenance supervisors to determine when to replace the blocked filter at the lowest cost.

An unexpected benefit was a reduction in the average time required to change a filter from seven to two hours. Our technicians now know exactly what is causing the performance issue, and replacement filters are ready when they begin the repair procedure.

In another case, the performance monitor application revealed lagging compressor efficiency, and the analysts suggested washing was needed. The early warning let supervisors choose between online and offline washing. After the maintenance procedure, operating efficiency was recovered and availability increased – see Figure 2.

Following the success of the six month trial, performance monitoring was expanded to include the two heat recovery steam generators and the steam turbine. The historical trend line shown in Figure 3 highlights the true potential efficiency improvement possible with this technology.

TWO YEAR PAYBACK PERIOD

With the AMS Performance Monitor, the return on investment (ROI) is very fast; a single filter change paid for this service for two years. This technology has enabled us to assess the effectiveness and economic value of our maintenance activities, allowing us to determine, in a strategic and effective way, when maintenance work should be done to improve equipment performance. We have been able to forecast major events, focusing on results-based work.

This combination of software and analytical service has let Centro Energia Teverola optimize maintenance strategy, enabling an overall efficiency improvement of over 1%.

Without question, this is the best efficiency application in Italy. Proactivity is the secret to achieving maximum results.

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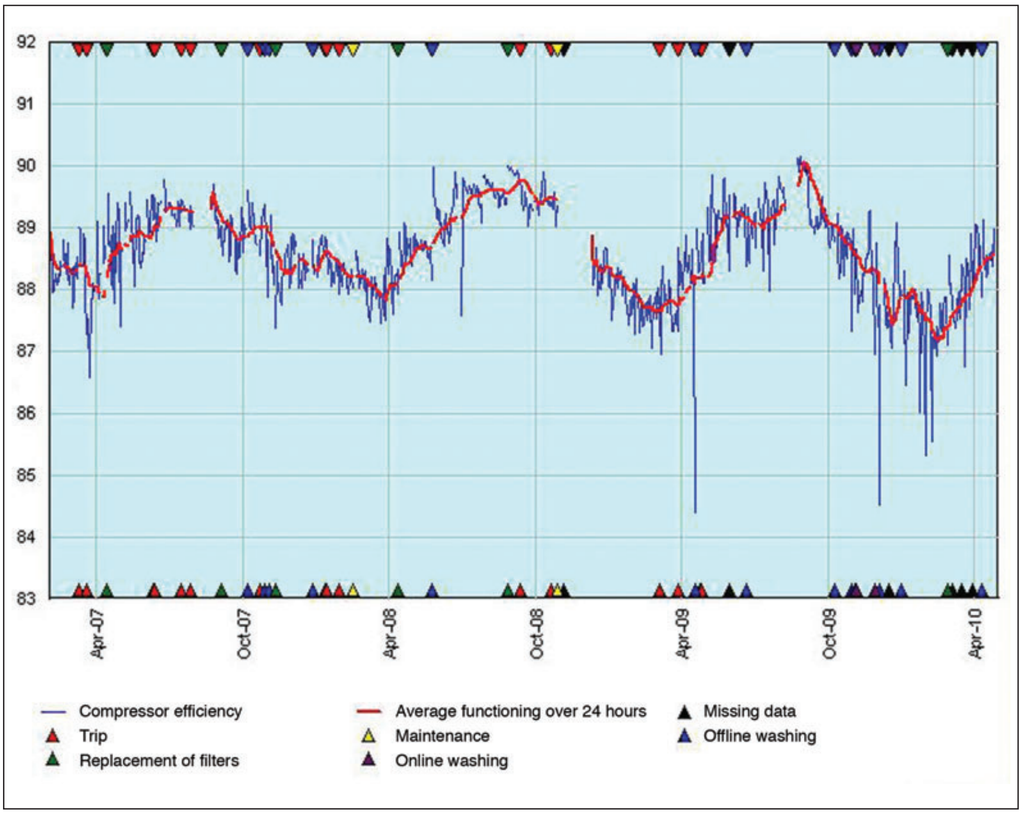

Figure 2. Monitoring compressor efficiency

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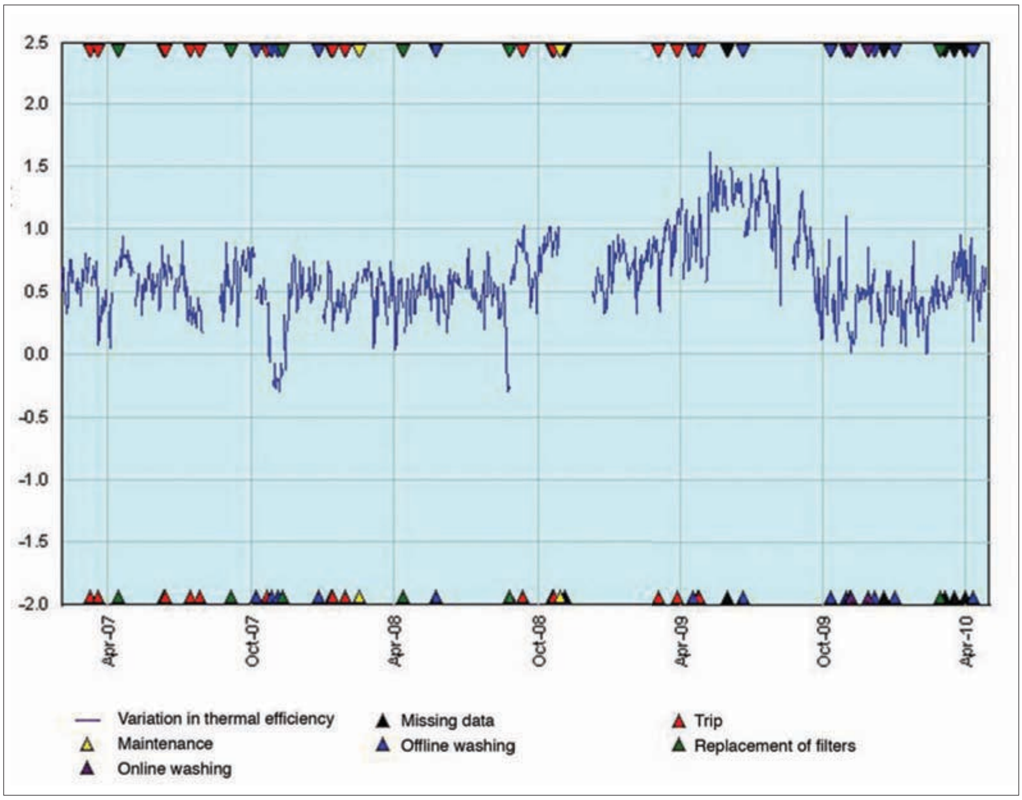

Figure 3. Thermal efficiency deviation

Diagnostic technologies

One of the most effective ways for cogeneration plants to achieve peak operating performance and to reduce unwanted downtime is to employ predictive maintenance based on advanced diagnostic technologies.

Diagnostic information can be obtained from smart field instrumentation and digital valve controllers, by monitoring mechanical equipment for changes in vibration levels, and through analysis of lubricating fluids. These and other advanced technologies aid plant personnel by providing indications of trouble long before commonly recognized symptoms appear – which may occur too late to avoid unexpected failures and costly downtime.

Companies applying predictive technology to safeguard the health of important production equipment are seeing plant productivity improve while costs go down. For example, the Gainesville Regional Utility in Florida experienced a 50% reduction in time spent troubleshooting suspected valve problems, and faster fixes resulted in productivity increases.

Predictive maintenance

Under the concept of predictive maintenance, critical production assets whose failure could cause an unexpected plant shutdown receive priority attention by maintenance personnel in order to prevent a failure. Pieces of equipment that won't adversely influence plant operations in the event of failure receive limited maintenance, which can be planned in advance to best fit the overall maintenance schedule.

Effective predictive maintenance requires accurate operating information gathered from various sources, so plant personnel can determine when critical production equipment must receive maintenance in order to avoid problems.

Such information has been difficult to obtain in the past because condition reports generally depended on human inputs, which were inconsistent at best and inaccurate at worst. Today's predictive maintenance programmes rely largely on intelligence delivered to asset management software by advanced monitoring and analysis technologies. These systems are capable of raising alarms if components suddenly develop symptoms of impending failure, so immediate corrective action can be taken.

Accurate diagnostic information is gathered from smart field devices and valve controllers as well as vibration monitors on pumps, motors, fans, turbines, compressors, heat exchangers, etc.

Plant personnel can then accurately determine how long repairs can be delayed until the most appropriate time. Actions based on such predictions increase equipment reliability, and costly interruptions are reduced significantly.

Interestingly, predictive maintenance is less expensive than preventive maintenance where technicians often waste time on tasks that are unnecessary and have little bearing on keeping productivity high. The most expensive option of all is reactive maintenance, under which personnel wait for disaster to strike before going going into emergency mode.

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Device management

Using intelligent field devices in cogeneration plants goes well beyond basic measurement and control functionality. These instruments, with their embedded microprocessor chips, generate a vast amount of information about their own condition and the condition of equipment on which they are mounted.

That data can be accessed from the control system communications and processed with Emerson's AMS Suite predictive maintenance software. Detailed information on every instrument on the control network is maintained in a database for use in routine maintenance tasks such as loop checkout, configuration, calibration, troubleshooting, and accurate documentation of maintenance activities.

The Gainesville Regional Utility is saving more than 600 hours of technician time per year in configuration and calibration of about 150 field devices. The ongoing savings possible through the application of field-based data, are reported to be as much as $997 per device per year.

Health management

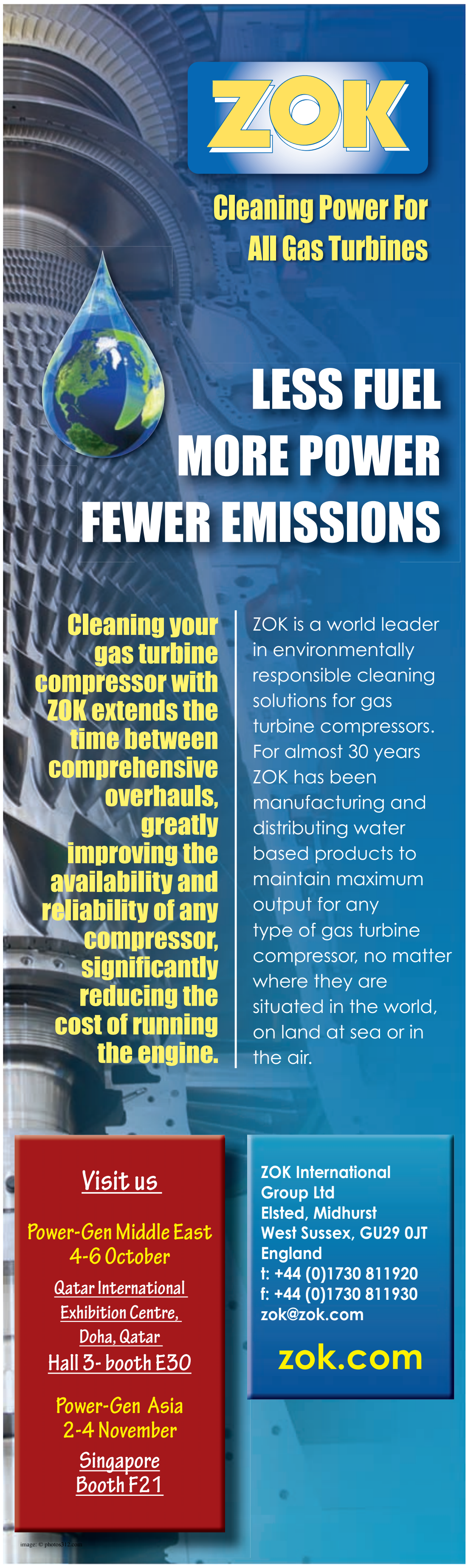
The operating condition of critically important rotating machinery can be monitored continuously using permanently installed sensors that make it possible to communicate vibration information continuously. Vibration levels of support machinery can also be measured periodically in the field by plant personnel using portable equipment. In both cases, the data are processed by machinery health management software, providing in-plant vibration analysts with a complete picture of the operating condition of their machinery. The ability to overlay frequencies, and match fault frequencies to peaks allows trained personnel to efficiently analyze the data, and to determine the condition of a specific piece of machinery at the time the data was gathered. Alarm reports enable decision makers to quickly evaluate a situation and take appropriate action to prevent a breakdown.

Periodic sampling and analysis of machine lubricating oils is another important way to evaluate equipment health. By analyzing samples of lube oils, users can effectively determine the severity of mechanical wear and the root cause of problems. Special analytical software precisely computes oil contaminants by parts per million and size distribution, both of which are key characteristics that help analysts determine the type and severity of lubricant contamination and corrective action to be taken.

Asset optimization

In simple terms, focused asset management supports maximum output while incurring minimum costs. Output is maximized by fast, reliable startups, by adopting predictive maintenance strategies to assure reliability of essential production assets, and by utilizing field-based information and diagnostics to identify and avoid potential trouble. Careful planning and execution of plant turnarounds minimizes their duration and extend intervals between them.

A predictive maintenance programme can be expected to bring a 1% to 3% improvement in product throughput, generating enough additional revenue for payback in three to six months.



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