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Top 5 Measurements in Energy Management

Your process plant is unique, but every plant can see the impact of high and rising energy costs. Yet, pinpointing where energy is being consumed, and where it could be saved, remains a challenge for many energy managers. Energy use within industrial facilities is very complex. There are thousands of manufacturing processes in operation and no two are exactly the same, even within the same organization. However, the opportunities for saving energy are significant, and the financial and environmental payoffs make just about any improvements worthwhile. So, the question is, where do you start?

In this report we identify five key measurement priorities that should be a concern for any plant management team who is looking to reduce energy use. For each of these areas, Emerson has some unique measurement and monitoring capabilities that will allow you to better manage energy use throughout your plant.

We believe some top measurement priorities you should consider are:

- **Steam System**– monitoring steam traps

  Barking Power found a leaking steam trap that was costing them $2,200 per day.

- **Utility Fluids** –metering flow and managing use

  A paper mill in New England is saving $1 million a year by keeping closer track of their steam, air and water.

- **Compressed Air** – measuring flow to identify leaks and manage use

  In South America, a chemical plant is saving $750,000 per year with a better way to measure the flow of their compressed air.

- **Boilers** – improving drum level measurement

  In the United States, a paper mill has minimized boiler trips during start-up through more accurate boiler level measurements.

- **Heat Exchangers** – predicting and detecting fouling

  Oil refineries are using wireless instrumentation to give operators visibility to heat exchanger performance for lower fuel usage and better product quality.

Following is an explanation of each priority, why it is important and what can be done to achieve energy savings.

1.1 Steam system – monitoring steam traps

Most industrial plants use steam heat to provide the energy that drives processes. The obvious components of this steam system are the boilers and steam distribution lines. A critical component of the steam system that is often overlooked is the steam traps; the mechanical valves that let condensed water out of your system, while keeping the steam in. A large plant can have thousands of steam traps distributed across the steam system.

When a steam trap fails, it occurs in one of two ways: open or closed. An open steam trap will leak steam, wasting valuable energy. A closed steam trap will allow condensed water to build up in the steam pipe, causing reliability issues and "water hammer" events that can damage the steam system and any connected plant equipment. Steam traps have an average expected life of about 5 years, so regular replacement of failed traps is essential to proper operation of your steam system.

Failed steam traps are not always obvious. They are usually detected during manual inspection rounds which are often scheduled on an annual, or even less frequent, basis. A typical plant's energy bill can be $20 million to $30 million per year and, according to the U.S. Department of Energy(1), "In steam systems that have not been maintained for 3 to 5 years, between 15% and 30% of the installed steam traps may have failed - thus allowing live steam to escape."

The Rosemount® 708 Wireless Acoustic Transmitter, operating on an Emerson Smart Wireless network, monitors steam traps continuously and identifies failed traps immediately. The device itself is very easy to install – and it's non-intrusive. You simply attach it to the pipe upstream from the steam trap with the supplied stainless steel mounting bands. It's a very small, lightweight device that can be readily put in tight spots and hazardous areas. We recommend you monitor your critical traps – those that have high potential for steam loss if failed open – or those that play a critical role in your process. The Rosemount 708 Transmitters will self-organize into a network that will give you real-time information about the health of your steam system.

At Barking Power in the UK, 35 acoustic transmitters were installed on steam traps. In the first week of operation, this new technology identified a leak from a high-pressure superheater steam trap. The cost of that leak was estimated to be over €1400 ($2,200) for every 24 hours of operation. "These devices give us a better picture of what is happening," said Tony Turp, Senior Control Engineer. He also noted that Barking Power can now better use their maintenance resources by planning repairs in advance. "Overall, we have improved plant efficiency, reduced steam losses, and improved the safety and productivity of our people," He said.

South African petrochemical company, Sasol Technology, installed acoustic transmitters on 20 critical steam traps for an estimated $42,000 annual savings in steam costs. And, because manual inspections on those traps are now reduced to a few manual inspections per year, Sasol realized a savings of $15,627 in annual maintenance costs. "With on-line acoustic monitoring, the facility now gets an early warning when steam traps fail," said Dr. André Joubert, Control Systems and Instrumentation Manager. "Overall, the smart acoustic transmitters paid for themselves in under 3 months," he concluded.

(1) *U.S. department of Energy. Advanced Manufacturing Office. Energy Efficiency & Renewable Energy. Steam Tip Sheet #1. DOE/GO-102012-3401. January 2012. PDF file.*

1.2 Utility fluids – metering flow and managing use

Utility fluids are the life blood of your plant. Water, air, gas and steam are all crucial to your operations; while a shortage of any one of these could cause your plant to shut down. Customers often tell us: "Sure, I can tell you how much natural gas we buy in a year, but I have no idea how much is used by each process unit." Every plant is different, but it is reasonable to say for most plants, that 5 to 15% of a site's energy is wasted in the form of lost or misused utility fluids. This could be an opportunity to save between $1 million to $15 million per year.

It is commonly said that "You can't manage what you don't measure." You need flowmetering of all utility fluids in your plant so that you can understand the usage patterns throughout your plant. With this information, you can balance flows of energy to key use points, detect leaks or other unusual changes in consumption, prioritize energy-saving actions, and communicate key performance indicators (KPI's) for energy so that plant personnel understand how they can best improve performance.

Emerson makes many different flowmeters, each appropriate for different fluids, enabling the best performance and accuracy for your various utility fluid flow measurement applications. For example, so-called "integrated differential pressure (DP) flowmeters" have much lower installed cost compared than conventional orifice meters. Another technology available to reduce installation costs for your system is wireless. Rosemount Smart Wireless instruments can be installed for as little as a quarter of the cost of wired instruments.

We recommend that you measure flow of each key utility fluid at all energy account centers, the key consumers of energy or major sub-sections of the plant. These meters provide information to an Energy Management Information System (EMIS), which interprets and analyzes the information to alert you to changes representing wasted energy. The Emerson Energy Advisor™ EMIS software is a simple bolt-on to the world's leading historian software, OSI PI. With this software, you have a comprehensive information system that gives you visibility and energy decision-making capability for the life of your plant. In short, Rosemount flowmetering, along with EMIS software, gives you a chance to get back that 15% of wasted energy in your utility fluids systems.

To help offset the costs of rising fuel prices, a pulp and paper mill in New England implemented a comprehensive energy management program. "We quickly realized that to save energy, we needed to measure it," said the mill's energy manager. "We knew our total energy usage, but had never measured individual energy areas." After considering many different flow measurement technologies, the mill installed two wireless networks, each with a Smart Wireless Gateway that integrates seamlessly into their DeltaV control system. A total of 60 Rosemount Wireless 3051SFA Annubar® Flowmeters were installed on lines carrying steam, air, warm water, fresh water and condensate. "We can now account for nearly all energy use within the mill," said the project engineer. "The wireless information has enabled us to focus our attention on high energy areas first, and those which have the biggest impact on our cost position." The result for this mill is that the project paid for itself in less than eight months, with savings well over $1 million in energy costs the first year.

1.3 Compressed air – measuring flow to identify leaks and manage use

The compressed air system in your plant is a major energy user. Compressed air systems generally have many leaks and other sources of waste. Measuring flow in a compressed air system helps identify leaks and manage air use. Measurement of air use is best done with several points of flow measurement throughout the compressed air system. Flow measurements can be made at each compressor, at the header, and at each major branch line. More points of flow measurement allow tighter control of leaks and better management of the compressed air system health.

Measuring flow can be done in various ways, and each type of flow measurement will cause a permanent pressure loss (PPL) for each measurement point. The most common form of flow measurement is an orifice plate flowmeter. Unfortunately, the orifice plate creates a large permanent pressure loss in the compressed air system. Each of the permanent pressure losses add up, and result in a large waste of energy drawn by the compressors. This is why it is critical to consider to the permanent pressure loss of any new flowmeter that may be installed into a compressed air system.

The Rosemount Annubar Flowmeter creates much less permanent pressure loss than other measurements, averaging only 5% of the permanent pressure loss of an orifice plate flowmeter. This reduced level of permanent pressure loss is negligible in the calculation of energy consumed in the compressed air system.

In one documented case, a South American chemical plant achieved a dramatic increase in compressed air system efficiency, and reduced electricity costs. In this case, usage of compressed air was rising rapidly, increasing operational costs and driving a need for increased capacity. This plant was also concerned with the risk of compressed air shortages, which could lead to failure of pneumatic equipment. Engineers found that orifice plate flowmeters were creating high permanent pressure loss in the compressed air system. Their solution involved the removal of the orifice plate flowmeters, and installation of ten Rosemount Annubar Flowmeters; nine to monitor the output of each of the nine compressors and one to measure flow on the main header. These ten points of flow measurement allow the operators to identify increased usage early without unnecessary system pressure loss, which was greatly reduced when the orifice plates were replaced by low-pressure-loss Annubar flowmeters. The result of this was an increase in overall compressed air system efficiency of 10%, and a reduction in electricity costs of $750,000 per year. An added benefit was improved line pressure at remote locations in their system.

1.4 Boilers – improving drum level measurement

In boilers, the water level in the steam drum must be precisely controlled to optimize steam production, maximize boiler efficiency and maintain safe operation. If water level is too low, there is a risk of damaging the boiler and significant risk of costly boiler trips. If water level is too high, water could be carried with the steam, which reduces heat transfer effectiveness and can cause damage to the downstream turbine. The most efficient performance of your steam system is when the boilers are operating stably, and costly cycles of shut-down, purge and re-start are avoided. Reliable drum level measurements are a very important part of achieving that desired operating condition.

Traditionally, steam boiler water level has been measured by multiple methods, including simple mechanical mechanisms, and various electronic gauging systems. The boiler and pressure vessel code (BPVC) requires a local, visual indication of drum water level. This is provided by the use of sight glasses, magnetic level indicators or systems such as the Emerson Hydrastep electronic gauging system. The BPVC also requires additional, redundant level measurement of the liquid in the boiler drum. These are often more advanced, electronic systems used to control the boiler water level.

More advanced systems for boiler drum level control employ differential pressure (DP) level measurements. However, a DP level measurement must be corrected based on temperature and pressure conditions in the boiler, which will cause changes in the density of the liquid being measured. This density compensation is especially important during the transient conditions of changing steam demand and during start-up or shut-down.

Guided Wave Radar (GWR) transmitters provide an alternative for steam drum level measurement, as they offer a number of important advantages over DP level technology. GWR transmitters measure level in a way that is completely independent of liquid density, so the complexity of density compensation is not required. Further, GWR transmitters are able to measure level at temperatures up to 400°C and pressures up to 345 bar. They provide accurate and reliable measurements of liquid level even when the operating environment includes mechanical vibration and high turbulence. Finally, GWR transmitters have no moving parts, providing low maintenance and high reliability.

In a typical installation, the GWR transmitter is mounted on top of a chamber that is external to the boiler, with a probe extending from the GWR to the full depth of the chamber. A low energy microwave pulse is sent down the probe, and when it reaches the liquid surface, a reflection is sent back up to the transmitter. The transmitter measures the time taken for the pulse to reach the liquid surface and be reflected back, and an on-board microprocessor calculates the liquid level. In this way, the boiler drum level is measured directly, with no liquid density correction required.

To meet the BPVC requirements for local indication and redundancy in boiler drum level applications, we recommend a combination of a magnetic level gauge and a Guided Wave Radar transmitter installed in an adjacent chamber. When redundant drum level measurements are required or desired, a DP level measurement can be used in addition to the guided wave radar. Together these devices provide a low-maintenance solution that provides easy-to-read local indication for operators and a high degree of accuracy for control of boiler drum level.

A major paper mill in the United States was experiencing lost production and increased utility costs due to boiler trips during routine start-ups. Boiler trips were caused by an error in the boiler level reading of a DP transmitter installed with impulse lines. The DP level transmitter is calibrated for full boiler operating pressure and temperature. However, during start-up when the boiler was cold, water and steam density differences in the impulse lines were causing an error in the DP level reading. The solution was to supplement the DP measurement with a Rosemount 5301 Guided Wave Radar with Dynamic vapor Compensation. With more accurate level readings during all process conditions from start-up to full output, boiler trips during start-up are minimized. This paper mill now enjoys increased boiler efficiency, minimized unplanned process shutdowns and increased production.

1.5 Heat exchangers – predicting and detecting fouling

Process facilities may have hundreds of heat exchangers, which can foul over time, and can directly affect production capacity, maintenance costs and energy use. Heat exchanger fouling can be accelerated by many factors, including sediment, corrosion, decomposition and crystallization. However, due to the difficulty and perceived high cost of real-time monitoring, heat exchangers are likely only checked periodically during field rounds. Operators using visual and manual measurement methods are unable to spot signs of contamination and over time build-up occurs—impeding heat transfer, negatively impacting throughput and requiring increased energy use. Energy costs rise when fouling forces downstream process heaters to supply more energy.

What if you could reduce capacity and energy losses by up to 10% a year, and know the optimal time to clean your heat exchangers? Both of these outcomes are possible with the use of the Emerson Heat Exchanger Monitoring solution. It provides temperature and pressure measurements that are trended, chronicled and analyzed to alert operators to potential fouling or design issues before they arise. These tools provide your operators with calculated heat transfer, exchanger heat transfer coefficient, fouling factors, and the cost of degradation; all of the information your engineers need to keep your heat exchangers running at optimal performance.

The Emerson Heat Exchanger Monitoring solution is built around off-the-shelf instruments and software. Rosemount Wireless Pressure Transmitters are used to detect increases in differential pressure across hot or cold sides of the heat exchanger, indicating that specific exchanger needs cleaning. Rosemount Wireless DP Flowmeters measure the flow through either side of the exchanger, for heat transfer calculations and high fouling-rate detection. Rosemount Wireless Multi-Point Temperature Transmitters can monitor up to four temperature channels, allowing for the measurement of inlet/outlet temperature differentials for hot and cold sides of the exchanger for heat transfer calculations and high fouling-rate detection. A Smart Wireless Gateway connects the self-organizing instrument network with the host system and data applications. The Emerson AMS® Suite: Asset Graphics for Operations provides real-time graphical displays that indicate abnormal operation, including high fouling-rate or exchanger cleaning-required notifications.

Implementing Heat Exchanger Monitoring Solutions from Emerson can improve your turnaround planning by allowing you to schedule precision cleanings of fouled heat exchangers in order to sustain optimal heat transfer and reduce energy loss by up to 10%.

Heat exchanger monitoring has produced great results for oil refiners. In each oil refinery there are hundreds heat exchangers. Gradual fouling of the heat exchangers reduces heat transfer, requiring more fuel to be burned. Eventually the crude heater will reach its maximum capacity and can then limit refinery production and reduce product quality. Adding wireless pressure and temperature instruments is economical and easy to implement and gives operators visibility to heat exchanger performance. By monitoring the inlet and outlet temperatures and the hot and cold side process flows operators can lower fuel usage and energy costs, as well as ensure greater unit utilization and product quality.

1.6 You can't manage what you don't measure

We have shown you five instances where industrial plants have used better measurement technologies to save energy and shave their costs of operation. Barking Power found a leaking steam trap that was costing them $2,200 per day. A paper mill in New England is saving $1 million a year by keeping closer track of their steam, air and water. In South America, a chemical plant is saving $750,000 per year with a better way to measure the flow of their compressed air. In the United States, a paper mill has minimized boiler trips during start-up through more accurate boiler level measurements. Oil refineries are using wireless instrumentation to give operators visibility to heat exchanger performance for lower fuel usage and better product quality. Your situation is unique, but the consideration of one of these five measurement priorities just might get you started down the road to energy savings.

Find out how to get the information you need for more effective energy management in your plant at www.rosemount.com/energy.

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