Engineer Insight Report

Top 5 Measurements for Energy Efficiency

EMERSON
Process Management

Top 5 Measurements for Energy Efficiency

Your process plant is unique, and 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 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 looking to gain better insight into process energy use. For each of these areas, effective measurement and monitoring practices will allow you to better manage energy use throughout your plant.

Here are some of the top measurement priorities for improving energy efficiency, as well as increasing safety and reliability:

- **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.

- **Steam system** – monitoring steam traps

  Barking Power, a power generation plant in the UK, found a leaking steam trap that was costing them $2,200 per day.

The following is an explanation of each example, why it is important and what can be done to achieve energy savings.

Utility fluids – metering flow and managing use

Utility fluids are the lifeblood of your plant. Water, air, gas, and steam are all crucial to your operations. 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 and $15 million per year.

Metering the flow of all utility fluids in your plant is important to understanding usage patterns. Flowmeters provide process flow measurements that are essential to energy management. Metering flow at multiple process locations helps to inform activities that are important to improving energy efficiency, such as balancing the flow of energy to use points, detecting leaks and unusual changes in consumption, prioritizing energy-saving actions, and communicating key performance indicators (KPIs) to plant personnel.

The Rosemount™ 3051SFA Annubar™ Flowmeter is just one of the many flowmeters offered by Emerson™. Each one has unique characteristics or features that make it suitable for specific types of fluids and applications. For example, integrated differential pressure (DP) flowmeters have a much lower installed cost than some conventional meters. If installation cost and time is a major concern, you should also consider implementing a wireless system. Rosemount Smart Wireless instruments can be installed for as little as one-fourth of the cost of wired instruments.

We recommend measuring the flow of each utility fluid at all energy account centers—the main consumers of energy or major sub-sections of the plant. Flowmeters feed information into an energy management information system (EMIS), which interprets and analyzes the information, and can alert you to changes indicating wasted energy. The Emerson Energy Advisor software is a simple bolt-on to the industry-leading OSIsoft® PI System and other historian applications. 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 some of the 15% of wasted energy in your utility systems.

To help offset the cost 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.

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 issues leading to waste. Measuring flow in a compressed air system helps identify areas of excessive use and better manage air use overall. 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 headers 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. These permanent pressure losses add up to a large waste of the energy that's being drawn by the compressors. For this reason, it is critical to account for the PPL caused by installing additional flowmeters into a compressed air system. The Rosemount 3051SFA Annubar Flowmeter has a much lower impact on pressure than other measurement instruments. For example, it averages only 5% of the PPL of an orifice plate flowmeter, the most commonly used form of flow measurement device. This lower level of PPL 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 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 PPL in the compressed air system. Their solution involved the removal of the orifice plate flowmeters, and installation of 10 Rosemount Annubar Flowmeters: nine to monitor the output of each of the nine compressors and one to measure flow on the main header. These 10 points of flow measurement allowed the operators to identify increased usage early, without the unnecessary system pressure loss that was being caused by the orifice plates. As a result of the installation of low-pressure-loss Annubar Flowmeters, this plant saw a 10% improvement in overall compressed air system efficiency, and a $750,000 per year reduction in electricity cost, with the added benefit of improved line pressure at remote locations in their system.

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 shutdown, 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. More advanced, electronic systems are used to control the boiler water level. These advanced systems for boiler drum level control employ DP level measurements. These measurements can be fine-tuned with boiler temperature and pressure parameters to compensate for density and achieve better level calculations.

In some situations, a Guided Wave Radar (GWR) transmitter provides an alternative for steam drum level measurement. GWR transmitters can measure level in a way that is completely independent of liquid density, so the complexity of density compensation is not required. 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. By using level information in the control strategy, drum level control can be achieved.

To meet the BPVC requirements for redundancy in boiler drum level applications, a DP level measurement can be used in addition to the guided wave radar. Together, these devices offer a low-maintenance solution that provides a high degree of accuracy for boiler drum level control.

Here's an example: 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 was 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 caused errors in the DP level readings. 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 have been minimized. This paper mill now enjoys increased boiler efficiency, minimized unplanned process shutdowns and increased production.

Heat exchangers – predicting and detecting fouling

Process facilities may have hundreds of heat exchangers, which can foul over time, directly affecting 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, many heat exchangers may only be checked periodically, during field rounds. Operators using visual and manual measurement methods are often challenged to spot signs of contamination and, over time, build-up occurs. Build-up impedes heat transfer, reduces throughput and drives up energy consumption. Energy costs rise when fouling requires more heat to be supplied for a needed temperature change.

Wouldn't it be great if you could sustain optimal production capacity, and stem energy losses by up to 10% each year, because you always knew when it was time to clean your heat exchangers? Both of these outcomes are possible with the use of the Emerson Heat Exchanger Health 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 Health 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 a 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. 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 health monitoring can improve your turnaround planning by allowing you to precisely schedule cleanings of the most fouled heat exchangers in order to sustain optimal heat transfer and reduce energy loss by up to 10%.

Heat exchanger health monitoring has produced great results for oil refiners. In each oil refinery there are hundreds of 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, which can then limit refinery production and reduce product quality. Adding wireless pressure and temperature instruments is economical and easy to implement, and it gives operators visibility into heat exchanger performance. By monitoring the inlet and outlet temperatures, and both hot- and cold-side process flows, operators can lower fuel usage and reduce energy costs, as well as ensure greater unit utilization and more consistent product quality.

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

Failed steam traps are not always obvious. Usually, they are detected during manual inspection rounds that are scheduled only annually, or even less frequently. 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 three to five years, between 15% and 30% of the installed steam traps may have failed, 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 non-intrusive and very easy to install: it simply attaches to the pipe with stainless steel mounting bands, upstream from the steam trap. Small and lightweight, this device can be readily installed in tight spots and hazardous areas. We recommend monitoring all of your critical traps: those that have high potential for steam loss if failed open, and those that play a critical role in your process. The Rosemount 708 Transmitters will self-organize into a network that will provide real-time information about the health of your steam system.

At Barking Power, a power generation plant 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 the plant is now better able to use its maintenance resources by planning for repairs in advance. “Overall, we have improved plant efficiency, reduced steam losses and improved the safety and productivity of our people,” Turp said.

South African petrochemical company Sasol Technology installed acoustic transmitters on 20 critical steam traps, gaining an estimated $42,000 annual savings in steam costs. And because manual inspections on those traps are now reduced to a few per year, the company also realized a savings of $15,627 in annual maintenance costs. “With online acoustic monitoring, the facility now gets an early warning when steam traps fail,” said Dr. André Joubert, control systems and instrumentation manager for Sasol. “Overall, the smart acoustic transmitters paid for themselves in under three months.”

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.*

You can't manage what you don't measure

Above are several instances where industrial plants have used better measurement technologies to save energy and subsequently reduce operational costs. A paper mill in New England is saving $1 million a year by keeping closer track of their steam, air and water usage. 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. A power generation plant found a leaking steam trap that was costing them $2,200 per day. And a South African petrochemical company saved an estimated $42,000 annually on steam costs by installing acoustic transmitters. Your situation is unique, but implementing even one of these five measurement strategies will start you on the road to energy savings in your plant.

For additional resources about using measurement to increase energy efficiency and reliability throughout your plant, visit www.EmersonProcess.com/Rosemount-energy

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00870-0200-3001, Rev AB, October 2015

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