

APPLICATION NOTE

CONDUCTIVITY MONITORING WITH HACH SENSORS FOR CRITICAL BOILERS

Comanche Power Station Upgrades On-Line Conductivity Monitoring for Critical Boilers

This application note features Hach technology that has remained a mainstay of the industry for years, but there may be newer models of controllers and instruments available today than those represented here.

Xcel Energy's Comanche Power Station, near Pueblo, Colorado, recently upgraded on-line conductivity monitoring of its steam-water cycles, providing continuous surveillance at multiple conductivity points while improving their confidence in key measurements—especially in on-line data logging for real-time and historical trending.

Good sampling, monitoring and analysis in the steam-water cycle are essential for maintaining optimal boiler performance. This is especially true for utility power plants such as Xcel Energy's Comanche Station, which operates critical boilers requiring ultrapure water. Here, conductivity measurement is one of the most important criteria in characterizing water purity. The accuracy and reliability of these analytical results, and operators' confidence in these results, increasingly depend upon the high performance of on-line instrumentation.



System Overview

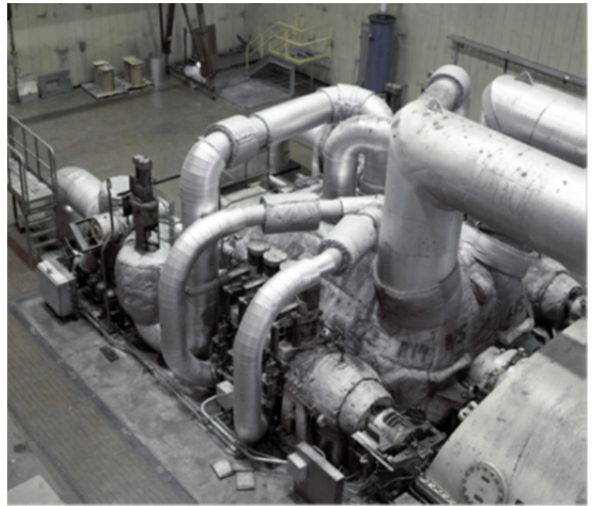
The coal-fired, steam-electric generating station has two operating units with a combined power production capability of 700 megawatts (MW). Its fuel source is low-sulfur coal from the Powder River Basin near Gillette, Wyoming. The Comanche Station uses about 10,000 acre-feet of water each year for cooling equipment and for producing steam that turns the turbine generators.

Steam is supplied by two boilers, each designed to generate 2.5 million lbs./hr. of steam at 2,500 psi and 1,000° F, with an economizer inlet temperature of 480° F. The source of make-up water for steam is surface water from the Pueblo Reservoir. The raw water is treated by clarification, cold-lime softening, and filtration through reverse osmosis followed by demineralization.

Conductivity in the boilers must be no more than 50 micromhos per centimeter (micromhos/cm, or microsiemens per centimeter ($\mu\text{S}/\text{cm}$)). "That's the maximum," says Dennis Kendall, system chemist for the Comanche Station. "We don't like to get even close to that high." He says the critical specification for steam quality, however, is cation conductivity, which is limited to 0.3 micromhos per centimeter (or $\mu\text{S}/\text{cm}$)

in the boiler feedwater and condensate pump discharge. “This is to avoid water quality conditions in which contaminants volatilize into the steam and carry over into the turbine, creating operational and maintenance problems.”

Cation conductivity is also an effective analysis for detecting even minor condenser leaks. Because cooling water leakage can quickly consume phosphate in the boiler water, on-line conductivity monitoring is one of the most important monitoring schemes in the whole system. In addition, the Comanche Station’s all-volatile treatment (AVT) program, using hydrazine to control pH and residual oxygen, depends heavily on reliable and accurate low-cation conductivity measurements for success.



Monitoring of the entire steam-water circuits for both boilers is critical because the potential for condenser leaks can occur due to transient conditions at many locations via a variety of mechanisms. Conductivity is monitored on-line at seven different points for each boiler circuit: saturated steam; de-aerator; feedwater; boiler water; condensate intake and discharge; and re-heat steam. All but the boiler and condensate discharge monitoring points monitor cation conductivity.

4-20 mA Drift

On-line conductivity monitoring has been carried out in some capacity at the Comanche Station since it went into service in 1973 (Unit 1) and 1975 (Unit 2). Back then, like at most power plants, membrane-based laboratory instrumentation was basically modified and adapted for on-line analysis.

“They were very high maintenance—a nightmare,” says James Ayalla, instrument technician for the Comanche Station. “They also required frequent calibration and adjustment and it was difficult meeting the accuracy requirements for on-line monitoring. Then came steel probe sensors, which worked a lot better, and have since been further refined and now work really well.”



The station recently changed out its on-line conductivity monitors. Ayalla says the instrument upgrade was made for several reasons, but primarily for improving the facility’s data logging capabilities and to prevent false alarms, which had been a chronic problem at the station.

“The units we had in there were pretty good, but it finally became a compatibility issue. They had been fairly accurate, but their 4-20mA output was always erratic—it drifted a lot,” he says. “The monitor’s readout would be quite different than what was being recorded on its data logger. For example, we would have a meter reading of 0.2 micromhos ($\mu\text{S}/\text{cm}$) in our condensate pump discharge, but the meter’s output would be reading anywhere from 1.0 micromhos to 8.8 micromhos ($\mu\text{S}/\text{cm}$).”

Ayalla says the station’s upstairs control room would frequently receive alarms and operators would go downstairs to the sample panel and find everything in spec. In addition, he says the station eventually realized

the poor data logging capabilities of the conductivity monitors would interfere with plans to upgrade the facility's computer-based boiler control system. The upgrade includes the incorporation of all on-line water treatment data to allow for further enhanced process control and more sophisticated trending.

"With our existing meters, if the operators wanted to find out what the current conductivity was at various points in the circuit, they would have to go downstairs and look at each monitor on the sample panel. But once we upgraded our computer-based boiler control, operators could be in the control room and have access to all the water analysis data. It wouldn't do any good to have a data log that was getting bad information."

On-Line Monitoring Upgrade

State-of-the-art instrumentation can provide more consistent results and improve confidence in key measurements, especially when it is used for making critical process control decisions and carrying out on-line data logging for real-time and historical trending. To that end, the Comanche Station replaced its existing conductivity monitors with Hach sc100 Universal Controllers equipped with conductivity sensors.

The new monitoring units each have a built-in data logger that collects measurements at user-selectable intervals (1 to 15 minutes), along with calibration and verification points, alarm history, and instrument setup changes for up to six months. The Hach sensors, specifically designed to monitor boiler water and condensate conductivity in return lines, are equipped with temperature compensators to provide quick response to changes in temperature.

The monitors are designed to receive data from up to two sensors each, and the two sensors need not be for the same parameter (conductivity, pH/ORP, dissolved oxygen, or turbidity). Each of the Comanche Station's steam-water circuits uses four controllers to monitor seven conductivity points.

In addition to 4-20mA output, the conductivity monitoring units installed at the station have S485/MOBUS protocols, providing the capability for automated process control, although operators elect to use manual control (based on on-line data-supported grab sample analysis every four hours) for all its steam-water circuit water chemistry control functions. However, the Comanche Station is considering the adoption of automated hydrazine feed using its two existing Hach hydrazine analyzers for on-line control.

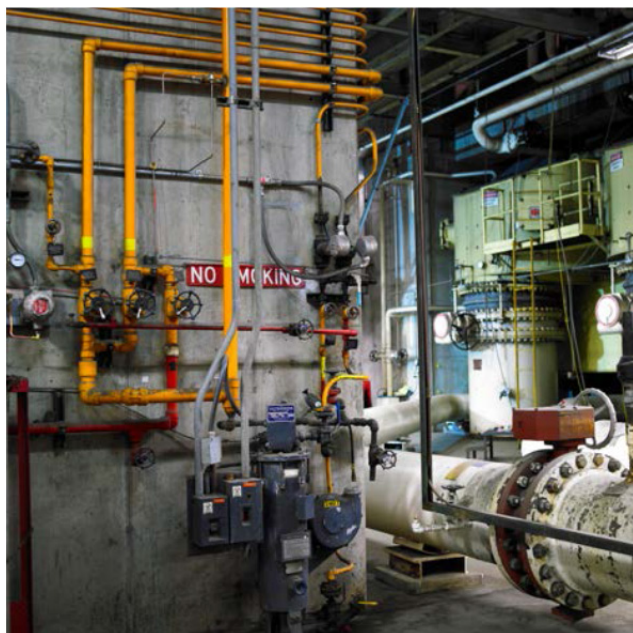


Ayalla says that the addition of state-of-the-art data logging and the ability to get real-time data monitoring will have a positive impact on troubleshooting by allowing a more proactive response.

"Because on-line monitoring of conductivity, pH and other parameters provide a real-time and historical picture of water quality at different points in our steam water circuit, our operators can more quickly discover trends that could indicate the root cause of transient conditions. And at the very least they no longer have to go downstairs and look at the individual monitors to find out the current readings."

"In addition to the advanced electronics of the new conductivity monitors, I like not being tied up into having one monitor for each probe," says Ayalla. He jokes that the only problem he's experienced with them has been cosmetic.

“I provided specs for two new water sample panels before we decided to upgrade to these new monitors. We used to have seven conductivity meters in our old panels and now there are only four, so both our new panels have three empty holes and I’ve got to go patch them up. Or maybe we could just add redox there or something – we’ve got the room.”



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