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Metering Pumps Aid in Power Generation's Shift to Natural Gas

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How metering pumps save water in newer plants.

Today, 90 percent of electricity generated in the United States comes from coal, nuclear or natural gas plants. Thermoelectric power plants boil water by burning a fossil fuel or through a nuclear reaction to create steam that spins turbines. Once steam passes through a turbine, it has to be cooled back into water before it can be reused to produce more electricity. Colder and cleaner water cools steam more effectively and allows more efficient electricity generation.

Fifty years ago, inefficient once-through cooling systems were used to take water from rivers, lakes or oceans and circulate it through pipes to absorb heat from the steam in condensers. Once used, the water was discharged back to its local source. Today, there are still a few legacy plants in the U.S. that use this process, but almost all of them are in line for renovation as part of repowering efforts.

Image 1. Water treatment applications are administered by injecting chemicals with metering pumps. (Images courtesy of Pulsafeeder)

Most power plants built in the U.S. after 1980 rely on closed-loop recirculating cooling processes. These systems use cooling towers to expose water to ambient air. Water that evaporates is replaced, but most of the water is sent back to the plant's condenser to be used again multiple times.

A third, even more efficient cooling approach, called dry-cooling, uses air instead of water to cool steam in turbines. Most plants that use this system run on natural gas. Despite the name, dry-cooling systems still require water for system maintenance, cleaning and boiler blowdown.

How Much Water Do Power Plants Need?

Coal-fired plants, relying on once-through cooling processes, need about 30,000 gallons of water for every megawatt of electricity produced. But plants with recirculating systems can make the same megawatt of electricity with just 5 percent as much water (about 1,200 gallons per megawatt). Nuclear plants, regardless of their cooling systems, require twice as much water as coal-fired plants.

This unquenchable appetite for water, combined with the goal of reducing harmful carbon dioxide (CO_2) emissions, is driving momentum toward natural gas-powered plants that leverage dry-cooling processes. This is why almost all of the new power plants being built in China, India, Africa and other parts of the developing world are standardizing on natural gas combined-cycle (NGCC) techniques.

NGCC systems can increase a plant's efficiency by up to 40 percent over coal-fired plants. Natural gas feed stocks are abundant, less expensive and easier to transport via pipelines. In Europe, where more than 40 percent of electricity is generated by coal, and China, which has an even higher percentage, large coal-fired plants struggle to ratchet down production, causing wasteful surpluses that often need to be exported to neighboring

Image 2. The appetite for water and the goal of reducing CO2 emissions is driving momentum toward natural gas-powered plants that leverage dry-cooling processes.

markets at lower prices. But natural gas-fired plants give operators greater control over feedstock inputs, which provides flexibility to meet demand.

How Natural Gas Power Plants Operate

A NGCC power plant uses a gas combustion turbine to generate electricity, and it also uses waste heat to make steam, which then generates additional electricity in a steam turbine. Because the first stage (the gas combustion turbine) has no steam to condense, it does not require cooling. As a result, the combined process requires 25 percent as much water to generate the same electricity as a coal-fired plant.

Even though natural gas plants use less water, they still need to treat water, because there is a direct correlation between the quality of the water and the efficiency of the plant. The quality and the turbidity of a plant's incoming water can vary depending on storms or man-made interactions. A number of pretreatment activities must be performed, such as removing sludge and sedimentation, dissolving suspended organic material, adjusting pH levels and disinfecting water by killing disease-causing microorganisms.

The following applications are administered by injecting chemicals with metering pumps:

Disinfection is accomplished by dosing specific quantities of high-concentration sodium hypochlorite (bleach). When sodium hypochlorite comes in contact with bacteria, it oxidizes molecules in the cells of the germs and kills them. Even though this simple but harsh chemical has been used for more than a

Image 3. Nuclear plants require twice as much water as coal-fired plants to produce electricity.

hundred years, it is prone to causing problems by "off-gassing." So the pumps used to deliver it must be able to pass the gas bubbles through without locking or clogging the pump.

pH adjustment. Power plants operate best when the pH of the water is as close to neutral (7) as possible. Specific volumes of acids are administered to alkaline feedwater (pH higher than 7) to adjust the pH, while similar volumes of caustics are dosed to acidic feedwater (pH lower than 7) to raise its alkalinity.

Boiler feedwater must be treated to avoid scale and corrosion that could damage or impede the boiler's performance. Boilers and other plant equipment are protected by metering pumps that dose precise volumes of corrosion inhibitors.

At the end of a plant cycle, the process water must be treated prior to disposal. Many plants use flocculation basins, where additional chemicals are dosed via metering pumps to aggregate precipitated particles, making them easier to filter out. Additional rounds of disinfection and pH adjustment are typically rendered by the plant's wastewater facility before water is discharged into the environment.

Because most plants run 24/7, water treatment must be done in a manner that prevents unplanned downtime. As such, the metering pumps used must be highly reliable and able to run continuously, and a simple approach to maintenance is key.

Reliable Pump Operation

Plant operators need a durable pump technology that is able to dose a precise volume of a water treatment chemical while maintaining a high level of operational reliability. This is one reason why hydraulic diaphragm metering pumps are preferred for a majority of water treatment applications in power plants. The pump's ability to survive system upset conditions helps keep the overall plant infrastructure operating reliably, all while dosing the exact amount of chemical needed to keep operations running efficiently.

Space in any plant is valuable, so operators prefer pumps with small footprints. Today, trends continue to shift away from horizontally laid infrastructure, because vertical configurations are more spatially available, less susceptible to flooding and easier to work on.

From an economical perspective, the power industry around the globe is gaining efficiencies by moving away from coal and shifting to more economical inputs like natural gas.

On the environmental front, most can recognize the wisdom in striving to achieve the Paris Agreement's 2-degrees Celsius target — even with different approaches to get there.

While renewable technologies, which currently provide less than 10 percent of the world's electricity, continue to mature, there are practical, proven and immediate steps that can be taken today to provide cleaner energy that is better for the environment, while also increasing efficiency and improving the bottom line for plant operators.

The global shift from coal to natural gas for power generation is one such win-win scenario. Natural gas brings a stable and practical approach to generating power. This shift also brings substantial water savings via more efficient cooling processes. The pump manufacturers that recognize the path ahead for cooling and water treatment requirements in the power generation industry are responding with newer and more nimble hydraulic diaphragm metering pumps.

About the Author
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