SAVING ENERGY THROUGH THE USE OF A VACUUM BASED SODIUM HYPOCHLORITE CHLORINATION SYSTEM

By Steve Golden

All over the world, power-generating plants that use river water for cooling are being required to evaluate potential replacements for the plant's chlorine gas disinfectant system. The chlorine system is used to prevent the formation of microorganisms in river water that is pumped through the thousands of 1-inch cooling tubes contained in each plant's steam condensers. The solution is often a liquid chlorination system and a pumpless vacuum injection system as the one described below –

At many power plants, cool river water flows through the heat exchanger tubes and the exterior surfaces of the tubes absorb heat from the high-purity process steam flowing out of generating turbines. As the steam cools, it condenses back into high-purity, de-mineralized water that is recycled through the steam-generation and power-generation process.

Proper chlorination of cooling water translates directly into process efficiency. Without it, microorganisms present in cooling water begin to accumulate rapidly on the inner surfaces of the condenser tubes. They excrete a sticky organic material that can coat the pipe, trapping inorganic matter such as dirt or sand particles to form slime. Slime formation can reduce the efficiency of heat transfer and steam condensation in as little as 10 days, with potentially costly consequences.

When condensation efficiency is reduced, the result is an increase in backpressure from the turbines. The increase in backpressure doesn't seem like much, maybe 0.1 inHg or a fraction of one psi, but any loss of condenser vacuum means that more BTUs of fuel are needed to achieve the same output. If you consider that a 0.1 inHg loss in condenser vacuum equals about 25 BTUs, operating with that pressure differential in the turbines could cost an additional $250,000 in fuel input annually.

New Regulations Drive Decision-Making

For industries and utilities worldwide, chlorination is imperative for efficient and cost-effective use of water as a coolant. However, concerns about the safety of chlorine gas have led to new regulations on its storage and use, leading to a demand for alternative liquid chlorinating agents, such as sodium hypochlorite (NaOCl) solution.

An aqueous solution, NaOCl is less hazardous and easier to store and handle than chlorine gas, though it requires a greater overall storage space. Commercial-grade NaOCl is sometimes mistakenly compared to household bleach, which it is not. It is corrosive and caustic, which requires careful handling and storage, but if the special requirements of this compound are factored into the early stages of the design process, effective NaOCl treatment systems can be built at capital costs that can be up to 50% lower than alternatives.

Evaluating NaOCl delivery systems

Basically, there are two types of sodium hypochlorite dosing systems: pump-driven and vacuum-driven systems. Regardless of the system chosen, either will involve the sizing and installation of several new elements:

- A double-walled, polypropylene storage tank, with a capacity of about 6,000 gallons, capable of holding a supply of NaOCl solution sufficient for several weeks' use.

- Corrosion-resistant plastic piping to contain the "neat" 12-15% NaOCl solution from the storage tank, as well as the dilute NaOCl-water mix that would be injected into the inlets of the cooling water pumps.

- A NaOCl "doser" – either a metering pump or a vacuum feeder that would precisely dose the NaOCl solution into the carrier water.

- A monitoring strategy to ensure proper chlorination while validating compliance requirements.

A pump-driven system can deliver very accurate dosing, but it's got to be located in close proximity to the storage tank. A pump-driven system will require placing the NaOCl storage tank inside the operating facility. There's no way to do that without causing huge potential problems with spills and odors or with loading or unloading the liquid.

Under pump pressure, the system is susceptible to serious leaks due to pressurizing of the NaOCl solution. Even a small leak, under pressure, could grow quickly, due to the pressure requirement of a pump-driven system.

A vacuum dosing approach is much more practical, cost efficient and safe. An induction mixer, or injector, exposed to a water flow produces a vacuum through a venturi, drawing NaOCl solution through a feed control system. Total flow of the material is governed by the position of a variable flow valve, while a vacuum regulator controls the open and closed cycles of the injector. In the event of a downstream failure, the vacuum regulator will automatically stop the venturi-based vacuum, and halt the flow of NaOCl solution – an important safety feature.

A major advantage of the vacuum system is that it is operating completely under a vacuum. Basically, it only receives head pressure from the NaOCl storage tank on the suction side of the injector. Also because it is under vacuum, if something breaks, there isn't going to be the kind of leakage problem you would have with a pressurized system.

By following a few design rules, it is possible to put a lot of the process outside! Placing the storage, water feed, and injector outside eliminates any risk of exposure to "neat" sodium hypochlorite liquid within the plant. Only a dilute solution will flow through the operating units to the circulating pumps. The lines will be purged with fresh water after each treatment.

A Vacuum Based Retrofit Decision Will Significantly Lower Operational Costs

Major cost savings can be realized during such a retrofit. Although PVC pipe is never preferred in high-traffic areas, it can be salvaged in many applications. Many facilities have always used plastic-lined metal pipe, which can usually be reused. The downstream system can usually be reused when the pure water is mixed with the NaOCl just before the injector.

The slight head pressure provided by the NaOCl storage tank, combined with the vacuum created through the venturi effect of the injector, is capable of pulling the NaOCl relatively long distances to the point of use. A precise dose of neat NaOCl is provided by the automatic vacuum feeder that is positioned between the storage tank and the injector. Once mixed with the carrier water the solution is carried out to the point of use.

A storage tank, usually located outside the facility, holds “neat” 12-15% liquid sodium hypochlorite. The precise dosage of NaOCl is dispensed through the automatic feed control system. At the induction point, the NaOCl mixes with the carrier water, forming a solution that is piped hundreds of feet to the suction side of large circulating pumps. The solution chlorinates the cooling water used in stream condensing units, preventing the formation of bacterial slime and optimizing heat transfer efficiency. At the end of each chlorination cycle, the system is purged with fresh water, clearing out any residual solution until the next dosage is required.

The dosing system used to inject and control NaOCl feed is a Reliant Water Technologies Model 4100 vacuum electronic flow sensor type chemical feed system. The Model 4100 dosing system, with an accuracy of +/-2% of full feed flow and a turndown ratio of 100:1, provides users with a more cost effective and safer alternative to gas chlorination systems and chemical metering pumps. In hundreds of installations throughout the U.S., there have been no maintenance issues reported.

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