Ion exchange upgrade boosts Gainesville’s makeup water system performance

Experience shows that the choice for upgrading its system produces high quality water, economically, with a minimum of operator attention at the Kelly power plant.

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New water treatment equipment was commissioned at Kelly Generating Station in 1993 and took over the load from an existing conventional ion exchange water treatment system. The old equipment, installed in the early 1960s, included a two bed (strong acid cation exchanger / strong base anion exchanger) primary system followed by a mixed bed polisher. Two trains allowed continuous water production during regenerations.

The old system was designed to treat relatively low total dissolved solids (TDS) water from a local spring. In the mid 1970s, the Kelly plant changed to its current water source, Gainesville city water. This water is drawn from the Florida aquifer and is lime softened. The city water has a TDS of 202 milligrams per liter (mg/L), a total hardness of 125 mg/L as CaCO₃ and 20 mg/L silica.

The TDS of the new water source is about twice the previous level so the capacity of the old water treatment equipment reduced by about half. When water consumption was high, a train would require regeneration every 36 to 48 hours.

Though the regeneration sequence was semi-automated, an operator was needed full time during the three to four hours that it took to complete a regeneration. It often was necessary to regenerate a train at night or on weekends and this resulted in a significant amount of overtime for the operators.

In general, the old system could produce adequate water quality, with resistivity typically 0.5 to 1 megohm.cm and silica levels less than 0.01 mg/L, or 10 ppb, in the mixed bed effluent.

However, the nature of the Kelly plant’s operation meant that the plant cycled up and down frequently, and the old water treatment system had difficulty coping with the erratic water demand. The age of the existing water treatment equipment and the amount of operator attention it required prompted Gainesville Regional Utilities (GRU) to search for new water treatment equipment.

Criteria for equipment selection
First, new equipment had to be cost effective and capable of producing enough water that was suitable for use in the boilers. It also had to operate with far less attention than the existing system. Complete automation was essential.

Further, the equipment had to be small enough to be installed in the main building at the Kelly plant so that the power
70 percent less sulfuric acid basis, and one system, a Recoflo demineralizer, seemed to have some advantages over some other systems that were proposed. This demineralizer used 80 percent to 90 percent less resin, consumed up to 70 percent less sulfuric acid and 40 percent to 65 percent less caustic, and produced 20 percent to 65 percent less water.

A total of 35 technical points were displayed on a spreadsheet and operating costs were calculated. Though the Recoflo demineralizer had the highest initial capital cost, the annualized cost over 20 years was the lowest because of the lower chemical consumptions and waste flows. This system also was the best fit with the selection criteria shown in the table—automated, small and environmentally sound.

The new system consists of a single two-bed ion exchange demineralizer and peripheral equipment. Raw water is passed through a carbon column and a multi-media filter before being fed to the demineralizer. Treated water is held in two 15,000-gallon storage tanks, which originally were part of the old water treatment system.

The demineralized water used for regeneration is held in two small tanks (the water in one is heated for use by the anion exchanger), and the regenerant wastes are collected in an equalization tank prior to overflowing to the drain. Concentrated acid and caustic used for regeneration are stored in day tanks adjacent to the ion exchanger and are filled automatically from outside bulk storage tanks.

The new ion exchanger supplied is different from the previous exchanger. It uses an ion exchange process that combines countercurrent regeneration, small particle size ion exchange resin, low exchanger loadings and fully packed resin beds. This results in a smaller, more efficient system, (Figure 1). In addition, resin beds usually are 36 to 60 inches deep. The resin beds on GRU's equipment are only six inches deep. Further, the benefits of countercurrent regeneration, where regenerant chemicals are passed through the bed in the opposite direction to the on-stream or service flows, have been well documented.

Operation of the system is completely automatic. Total cycle time of the demineralizer is less than 20 minutes. Regeneration and rinsing of both beds takes approximately two minutes and is followed by an internal recirculation to quality which takes about three minutes. Concentrated regenerant chemicals are automatically diluted in-line for use.

Installation and commissioning

Some existing equipment, including the treated water storage tanks and a carbon filter, was incorporated into the new system. It also was necessary to find a suitable location for it in the main building. Ultimately, all of the equipment, with the exception of the treated water storage tanks, was installed on a 14.5 foot x 14.5 foot concrete pad bounded by three main support beams (Figure 2).

Commissioning was simplified by the fact that the ion exchange equipment had been fully loaded with resin, pre-tested and operated with chemicals in the manufacturer's plant prior to shipment. Thus, after the normal initial mechanical bugs were worked out, the system was turned on and began producing water as specified.

The service history on the equipment has been fairly uneventful to date. Aside from a failed electronic flow meter and a...
small regenerant storage tank replacement, little maintenance or repair work has been required.

In the first months of operation, the system has produced approximately 1.9 million gallons of boiler makeup water. The quality of this water has exceeded expectations and now closely matches or exceeds the purity of the water normally produced via the mixed bed demineralizer.

It should be noted that the old units were operating under a number of handicaps. Iron fouling caused by old piping was an ongoing problem. This and other factors meant that double regenerations were frequently required, increasing the chemical consumption.

The new demineralizer needs little day-to-day attention. And, although the old system has been maintained in an operational state for redundancy, it has not been needed since the new demineralizer was commissioned. After initial startup period, silica levels in the product water have consistently been less than five ppb. Resistivity of the product water produced in a typical cycle is shown in Figure 3.

Average resistivity of the product water produced by the new unit is approximately five megohm/cm. However, while the treated water is in the storage tanks, it picks up some carbon dioxide from the air, lowering its resistivity to the level shown in Table 1.

**Summary**
The new compact demineralizer has met or exceeded all expectations at Kelly generating station. It has economically and reliably produced high quality water, with a minimum of operator attention. Any power plant engineers seeking to increase water demineralization capacity at their plants should consider the latest technology available and state of the art equipment.

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**Table 1. Water chemistry of new vs. old demineralizers**

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**Table 2. Regenerant chemical usage and waste generated; new vs. old demineralizers**

**History of the John R. Kelly Power Generating Station**

The John R. Kelly Power Generating Station, owned and operated by the City of Gainesville, has been producing power since 1914.

Originally, the sole power supplier for the city, the Kelly plant grew as the community expanded but, by the late 1960s, additional power sources were needed. The Deerhaven Generating Station began commercial operation in the early 1970s, and the city negotiated a permanent tie into the state electric grid through the Florida Power Corp.

Since then the Kelly plant has served as Gainesville Regional Utilities’ secondary power generating facility. The Kelly plant provides power to the community during periods of peak demand, in emergencies or when regular maintenance is performed at the Deerhaven plant. In addition, Kelly provides power to the state grid when needed.

Oil and natural gas are the primary fuels used at Kelly. Two units still operate. Unit 7 produces 22 MW with an 860-pounds-per-square-inch (psi) boiler and Unit 8 produces 44 MW with a 1,260-psi boiler.
"The Nucla CFB upgrade closed the loop. We took advantage of our own experience to move from a demonstration to a commercially successful utility plant."

Tom Heller, Operations Superintendent, Tri-State Generation and Transmission

Nucla Station pioneered utility-scale circulating fluidized bed technology and for its efforts, the Colorado plant received an EPRI award for demonstrating innovative technology.

When Tri-State Generation and Transmission Association, Inc., Nucla's owner, decided to upgrade the plant, they selected Ahlstrom Pyropower for the engineering, construction and erection of the project.

In 1993, a brief three-month outage resulted in AHLLSTROM PYROFLOW® boiler modifications, generator rewinding and about 150 other projects to improve the station heat rate and overall efficiency.

Today Nucla produces clean, economic energy from locally-mined coal while protecting the environment.

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