WATER TREATMENT UNIT FOR A COGEN PLANT

Mohammad Usmani,
Project Engineer
BOB J. JOHNSON &ASSOCIATES

ABSTRACT

BP Solvay (BPS) decided to install Four COGEN units at their Deer Park, Texas plant. The existing water treatment facility consisted of water softeners and the quality of water was far below the requirement for the COGEN units. The source of the feed water was clarified Trinity River water and was high in suspended solids, total hardness, and silica. BPS needed to upgrade the water treatment system to meet water quality specifications for the COGEN units, and for their process needs. BJJA completed design & installation of water treatment system in 24 weeks after receipt of order.

Background

BPS required a system that would reliably produce an average of 400 gallons per minute, with peak supply of up to 800 gallons per minute or approximately 1.4 million gallons per day. Wastewater disposal was limited due to limited existing piping to carry the waste from the system and the high cost of wastewater treatment. Space availability for the new water treatment plant was limited due to existing equipment and piping.

A critical project requirement was the completion of the Reverse Osmosis project time to provide treated water for the scheduled startup of COGEN Units.

BPS bid requirements were based around their need to lease the equipment as an Operating Lease, which would mirror the Operating Lease they were using to build the COGEN plant. BPS also asked for a bid to outsource the operation and maintenance of the water treatment plant.

Multiple bidders bid the project under a standard RFQ. In January 2001, BPS selected Bob J. Johnson & Associates, Inc. of Houston (BJJA) as the successful bidder. BJJA was selected due to its process selection, wastewater reduction and recycle plans, and a commitment to complete the project in 24 weeks after award of contract. BJJA accepted this challenge and began the technical details and drawings of the unit for an expedited project execution and for the commercial process of formalizing the bid and finalizing the contract(s). The pressure vessels were required to be ASME code, and all equipment needed to be skid

Figure 1: The ASME coded Softener tanks and SS face piping.

mounted to reduce site erection time and material handling at site.

A metal building was designed to enclose all the equipment for freeze protection and sound dampening. Equipment was selected based on space requirements, life cycle cost

efficiency, and process compatibility. All process details, plans, drawings and equipment specifications were submitted to the client for review and approvals were obtained within three weeks.

The BJJA Project Manager worked closely with the client's Project Manager to obtain advance approval on long lead items and released these items for fabrication.

BPS also contracted with Bob J. Johnson & Associates to operate the plant and maintain the system under a Services and Maintenance Agreement separate from the 15-year Operating Lease for the equipment.

Process Details

BPS's existing water treatment system consisted of Water Softeners only. As a result the existing boilers operated with higher chemical treatment cost and with higher blowdown.

The clarified feed water to BPS had high suspended solids ranging from 26-30 ppm; Total Hardness was in the range of 90 to 143 ppm as $CaCO_3$ and a high quantity of sub-micron suspended particles.

BJJA combined filtration systems with proprietary chemical feed to reduce 98% of the incoming suspended solids before the water softeners. These filters are designed to operate automatically with minimum operator requirement. The softeners were designed with salt saving / high capacity resin to handle a maximum flow of 500 gpm through each vessel.

The SDI of feed water to membranes was reduced from a level "too high to calculate" to 5.0.

Figure 2: SS Filters were provided with a design capacity of 500 gpm each.

Figure 3: RO Unit, showing the SS feed header, membranes Housings and instruments installed

The membranes for the RO unit were carefully selected based on the feed water quality. The TFC membranes selected have ultra low inorganic and organic fouling tendencies, high silica rejection, and are resistant to biological fouling.

Caustic was injected into the permeate to reduce corrosion in the boiler feed water tank.

The operation was completely automated with PLC and communication port for the DCS system. The PLC was programmed user friendly with functions to modify the regeneration of softeners, and PID controllers for finer control abilities of critical functions. BJJA also provided a communication modem to monitor system's operation from their office.

Figure 4: PLC Panel has graphical screens

showing all the operating loops of unit.

A wastewater recycle process was developed to reduce the wastewater quantities resulting in a reuse capability of more than 1.2-MM gallons per year.

Conclusions

BJJA began the installation and construction of the plant in the last week of May 2001. The Water Treatment plant was accepted on August 6, 2001 after a successful performance test of five days of continuous operation. The target date for completion of the 800 gpm water treatment unit was achieved.

The quality of water produced exceeded the client's specifications, including silica. The silica in the treated water is in the range of 100-110 ppb now. The plant has operated without any interruption and the remote monitoring facilities has saved on-site time requirements for the operation and maintenance of unit.

Figure 5: Soft starter panels, soft starters were used to reduce starting load of 150 hp motors.

The preventive maintenance program for the equipment is effective and has prevented unforeseen breakdown of equipment. The membranes have only required cleaning once during the first 7 months of operation. Typical RO systems operating in the area with this feed water require cleaning at least once in 4-6 weeks. This system has saved BPS 30% of the real estate required for a competitive system, up to 65% of the wastewater discharge from conventional filtration, and increased water quality well beyond BPS's minimum requirements.

Figure 6: Chemical cleaning system was provided for the RO unit, FRP piping was used for interconnections of equipment.

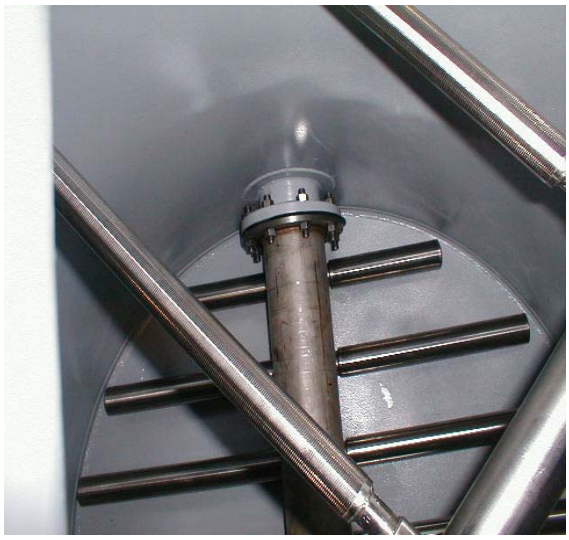

Figure7: The internal SS headers of softeners were designed to operate at maximum flow rate with a low pressure drop.

Figure 8: All instruments used are industry standard for safety, high precision and reliability of operation.

Figure 9: Three feed water pumps were provided with 100% redundancy for operation assurance. Equipment layout was developed to provide safe access for operations, reducing space requirements.

Figure 10: Chemical injection was designed for automated operation and spill containment.