Shovel Ready for Nitrate Reduction

Goodland, KS

Owner:
- City of Goodland, KS

Engineer:
- EBH Engineering

Contacts:
- Ron Rappard, Water Treatment Specialist

Completed:
- 2011

The City of Goodland, Kansas is one of the last stops in Western Kansas before entering Colorado. The nine wells in Goodland had seen their nitrate levels growing over time and the City decided to evaluate technologies available for removal of the nitrates. The nitrates in the wells varied from 4-5 mg/L to over 13 mg/L, while the Maximum Contaminant Level for nitrates is 10 mg/L.

When grant funds were made available through the American Recovery and Reinvestment Act (ARRA), Goodland's engineer, EBH out of Pratt, Kansas decided to see if they could meet the rather tight design guideline time frame to have plans and specifications done and submitted to the Kansas Department of Health and the Environment (KDHE) in just a few months. The resulting $5.7 million project was the state's largest ARRA water treatment project. The nitrate treatment system made up about 10 percent of the total project cost.

The City's engineer considered both Reverse Osmosis and Ion Exchange (IX) for the 1,650 gpm blended effluent nitrate removal design. They decided the 20-25% waste volume of RO was not acceptable and after visiting a conventional IX plant and a Layne Christensen Water Technology High Rate/Low Waste IX plant, they decided to use the Layne design concept due to its very small waste volume (< 0.6%) and low salt usage. KDHE required the City to dispose of the waste brine into a double lined stabilization pond. These are expensive and the low waste feature by Layne allowed for the smallest brine pond possible which saved the project hundreds of thousands of dollars compared to conventional IX treatment.

A pilot study was required by KDHE to verify the low waste volume and the system's high Liquid Loading Rate (LLR) of 20-22 gpm/sq ft. This LLR is about 3 times higher than the 6-8 gpm/sq ft LLR suggested by 10 States and also used by KDHE in their regulations. The pilot study was successfully completed in January of 2010 by Layne indicating about 0.5% waste volume could be achieved on a consistent basis and that the LLR of 20 gpm/sq ft met the

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projected nitrate removal with an approximate 11 hour filter run before breakthrough of the nitrates into the effluent.

A Performance Specification to achieve < 0.6% waste volume was put out to bid and 5 organizations responded with their best design approach. Layne was lowest price, met the specification requirements and could list about 13 High Rate/Low Waste installations in the US for reference.

Nitrate treatment plants typically treat part of the influent and bypass a portion of untreated influent which is then blended with the treated effluent. This results in a blended effluent that meets the design requirement of < 8 mg/L. The Layne process considers breakthrough to occur, causing regeneration of a vessel, when the effluent nitrates from the treatment skid approach 2-3 mg/L. This approach allows for a more consistent blending of untreated water with the treatment skid effluent to achieve a final effluent nitrate value of < 7-8 mg/L going into the system for distribution to the City residents.

The final design by EBH preferred the treatment skid approach used by Layne. Five 4-ft. diameter pressure vessels were pre-assembled onto a treatment skid resulting in a system about 24 ft. long by 6 ft. wide. All of the piping and valves were assembled on the skid including wiring of the electric valves and instruments to a Junction Box on the skid which was connected to the remote free standing Main Control Panel (MCP). The treatment skid is set into place by a crane and after pipe connections are made, resin installed and connections made to the MCP, the installation of the treatment skid is complete.

The Layne High Rate/Low Waste system recovers and recycles part of the rinse water and the only waste is the nitrate/sulfate laden brine going to the waste tank of just over 1200 gallons per regeneration of a vessel. The vessels/tanks included in the Low Waste system, other than the treatment skid vessels and pre-filters, include the Waste, Recycle and Brine tanks. Each of these tanks has associated pump skids with flow meters provided by Layne as part of the System design. By using this System approach to equipment provision, the City only has one phone call to Layne regarding control and operation.

System results to date have achieved a consistent nitrate blended effluent of < 8mg/L and depending on which of the 9 wells are being used, the results can be < 6 mg/L. The overall waste percentage has stayed around 0.3% which is about half the required 0.6% given in the design specifications. The plant operator can determine the amount of bypass allowed by using either an effluent nitrate analyzer to control the bypass volume or by the operator setting a percentage of bypass volume. The nitrate analyzer is set up to evaluate the influent, blended effluent and treatment skid effluent nitrate values which are recorded in the SCADA system supplied. During high demand in the summer the plant has been able to supply up to 2,500 gpm of blended effluent while meeting the < 8 mg/L nitrate requirement.

The City and engineer made their building big enough to allow for two additional treatment skids, if needed at a later date, due to increased nitrates in their wells which seems to be occurring every year.