Optimizing Operations

By Lloyd W. Johnson

A decentralized Aqua-Aerobic membrane bioreactor (MBR) system is being field-tested at the Colorado School of Mines' Advanced Water Technology Center to treat one of the campus' housing community domestic wastewater sources (about 400 apartments). The objective is to optimize biological nutrient removal (BNR), membrane operation and process adjustment for constant and seasonal flow patterns to achieve reuse quality effluent and minimize energy consumption.

An SBR-MBR combined system achieves low energy consumption and facility sustainability

ARTICLE SUMMARY

Challenge: The objective is to optimize BNR, membrane operation and process adjustment for constant and seasonal flow patterns to achieve reuse quality effluent and minimize energy consumption.

Solution: A decentralized Aqua-Aerobic MBR system was installed.

Conclusion: The overall sustainability of the process for wastewater reuse will be increased, and operational settings and conditions will be more easily predicted.

Design & Installation

The system consists of a full-scale sequencing batch reactor (SBR), coupled with a full-scale MBR and a bench-scale conventional MBR (10 to 15 gal per hour) that operates as needed to compare performance between various treatment schemes. The SBR utilizes two alternating adjacent batch reactor trains with a flow capacity of 6 gal per minute (gpm) to 12 gpm. Each MBR is fitted with one Koch PURON 30-sq-meter hollow-fiber membrane module. The membrane has a single header design consisting of a self-supporting mounting frame, side baffles and permeate and air scour headers. The SBR-MBR system is equipped with a full complement of instrumentation joined with a SCADA system for online monitoring and control.

The goals for the onsite SBR-MBR system are to maintain continuous stable unit operation and to establish a baseline system performance by monitoring such parameters as influent and effluent organics, nitrogen, phosphorus and turbidity values. Reactor mixed liquor suspended solids (MLSS) and mixed liquor volatile suspended solids values, transmembrane pressure, chemical cleaning requirements and flux stability also are being evaluated.

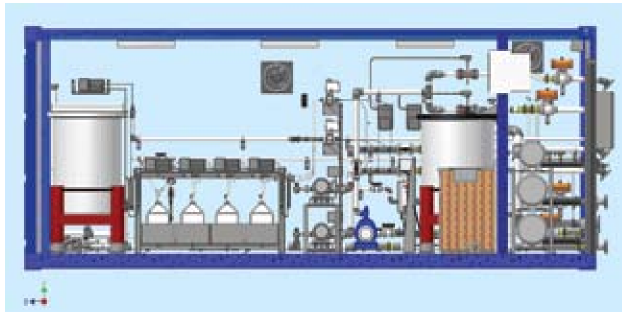
Operating Strategy

The operating strategy for the two-basin SBR portion of the plant consists of Basin 1 receiving flow for one hour while Basin 2 discharges. Each basin is equipped with timers to create desired aerated and nonaerated events. Hydraulic mixing is provided by a submerged pump fitted with two directional nozzles. The time-based SBR provides the ability to relax the membranes for permeate withdrawal if the influent flow is less than design. In addition, it can be sized to provide some equalization for flow events in excess of design average; the membrane flux rate is automatically adjusted for permeate peak flow if the influent flow is higher than the design average.

The decentralized system was seeded with SBR activated sludge on Feb. 9, 2009, with an initial MLSS concentration in each basin of approximately 1,000 mg/L. The system achieved a steady-state 8,000 mg/L design MLSS concentration on April 1, 2009, and superior removal efficiencies were met quickly.

Over the past year the SBR-MBR has been mechanically optimized and evaluated under a variety of operating and weather conditions. Thus far it has demonstrated average dissolved organic carbon and chemical oxygen demand (COD) percent removals of 91% and 95%, respectively. Total nitrogen removal averaged 95%, with permeate nitrogen predominantly as nitrate. Stable permeate total phosphorous concentrations were less than 0.6 mg/L. Bacterial yield has been below 0.09 (MLSS/COD per day) during normal operation, which is beneficial for decentralized treatment and reuse applications. Energy efficiency has averaged 26.2 kWh per 1,000 gal for production of high-quality water and will increase with use of the optimization model. Previous to optimization modeling, associated transmembrane pressures during normal operation were below 1 psi.

By optimizing the SBR-MBR facility to achieve specific water qualities at minimal energy consumption, the overall sustainability of the process for wastewater reuse will be increased, and operational settings and conditions more easily predicted. WWD



The SBR-MBR has been mechanically optimized and evaluated.

Aqua-Aerobic MBR system at Colorado School of Mines.

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