A package plant approach to decentralized wastewater treatment

By Nathan Antonneau, John Irwin, and Brett Woods

Decentralized wastewater management is defined as the collection, treatment and reuse of wastewater at or near the point of waste generation. Decentralized wastewater treatment has been utilized for many years, with a number of different treatment technologies, most notably septic systems.

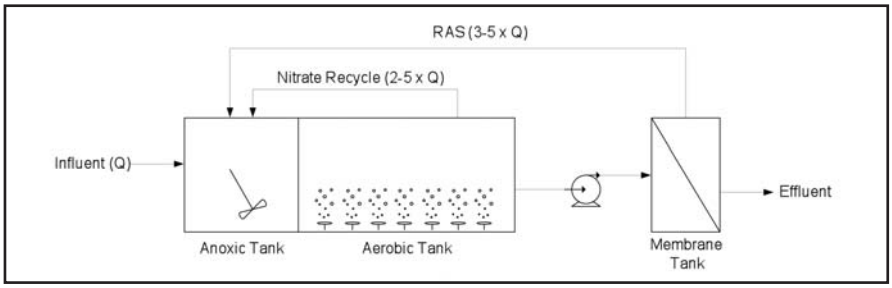
In cases where septic treatment is not adequate to meet the treatment objectives, engineers will often incorporate secondary and tertiary treatment into the process design. Attached growth, activated sludge or hybrid systems can all be used, in combination with tertiary filtration and disinfection, to achieve even the tightest effluent limits.

One technology that has proven very successful for decentralized systems in recent years is the membrane bioreactor (MBR). The technology incorporates settling, activated sludge and filtration, into a compact process configuration. Membrane filtration is the distinguishing element of an MBR process. Many different types and configurations of proprietary membranes exist, with most membrane manufacturers, and several system integrators, offering package or modular systems.

A package plant is a system that is fully assembled (wiring/plumbing) with the ability to start up and wet-test all equipment, including electrical works, in the factory. Due to shipping constraints, portions of the package plant may require re-assembly at the installation site. These systems have a service range from a single residence to small communities or commercial establishments.

Pros and cons of package systems

There are several advantages to using package MBR systems over conventional treatment systems, including reduced engineering and construction labour, as well as reduced installation and commissioning time. Package MBR systems have a very small footprint and are capable of being assembled to meet tight project schedules. They also consistently produce effluent that can meet very stringent effluent limits and almost any reuse standards. In addition, package MBR systems require less operator attention and are easier to monitor remotely due to instrumentation and controls.



Process flow diagram of conventional Modified Ludzack Ettinger (MLE) process for packaged MBR systems.

The main disadvantages of package MBR systems include their higher capital cost and energy demand. The membranes also require periodic chemical cleaning, and the hydraulic limitations of the membranes may necessitate more system equalization.

Siemens Water Technologies is both a membrane manufacturer and package MBR system integrator. The company's Xpress™ package MBR system is manufactured in four sizes. The smallest unit has a treatment capacity of approximately 100,000 L/day, and the largest has a treatment capacity of nearly 400,000 L/day.

The package plant includes fine screening, suspended growth biological treatment, and membrane filtration. Ultraviolet disinfection can easily be added to these systems for complete treatment. Each of the package plants undergoes up to two weeks of factory testing to ensure all mechanical and electrical works operate as designed, prior to shipment.

Case history: Grey Eagle Casino

The Grey Eagle Casino was a new commercial venture by the Tsuu T'ina Nation, in partnership with Sonco Gaming (Alberta) Ltd. This casino and future hotel/entertainment project is located on Tsuu T'ina lands in southwest Calgary.

The location had no water and sewer services, and had tight standards for discharging the wastewater that ultimately goes into Pine Creek. Any discharge at this location required advanced treatment, including a highly filtered effluent, with nitrogen removal to levels below 10 mg/L total nitrogen, and phosphorus removal to levels less than 0.5 mg/L.

In addition to advanced treatment, the site layout required a compact system that would allow both the wastewater treatment and water treatment systems to be housed in the same building. The close proximity of the equipment to the casino made stringent odour control necessary. A very tight project schedule, as well as the short supply of construction labour during a period of heavy oilfield development, created a preference for a simple, prefabricated system that could be installed quickly and inexpensively.

After looking at several options, Sonco Gaming's engineer selected the Xpress MBR package plant. With an estimated average flow rate of 200,000 L/day, this plant addressed all of the casino's specified needs. The advanced treatment unit easily met the casino's stringent effluent requirements. The system was designed with a completely enclosed biological reactor and covered membrane tanks. A simple carbon adsorption odour control system ensured nuisance-free operation.

The compressed schedule meant that the building for the water and wastewater equipment had to be constructed well before equipment delivery. When the MBR skid arrived, it was conveniently lifted through removable roof

panels, set in place, and quickly installed.

The complete wastewater system includes an in-ground equalization and sludge storage basin, lift pumps, and MBR package system (fine-screen, anoxic and aerobic biological treatment reactors, and a two-cell membrane system followed by disinfection). Effluent is discharged to a subsurface disposal system and ultimately drains into Pine Creek. The system has been meeting all discharge requirements since it became operational in October 2007.

Case history: Lower Kuskokwim School District

The Lower Kuskokwim School District (LKSD), headquartered in Bethel in southwestern Alaska, is one of the state's largest rural school districts, serving a 58,900-sq-km area, roughly the size of the state of West Virginia. With only 3,800 students, the LKSD operates several small, very remote sites. Many of the wastewater treatment systems are on-site decentralized systems.

Recently, the LKSD began to implement district-wide upgrades to its schools' wastewater treatment systems. Package treatment plants were recommended for three of the more remote schools that were evaluated. A compact system was specified because the water and wastewater systems had limited space available. The LKSD also has a district-wide SCADA system that monitors many critical elements of its schools' operations, including the wastewater treatment systems.

The LKSD worked closely with its engineer and determined that a 100,000 L/day Xpress MBR package plant would best meet the district's needs. The solution met all critical design elements: small footprint, remote monitoring capability, and packaged system approach. Since the three schools were very remote, the contractor elected to pre-construct a building around the Xpress system to simplify installation.

The unit was shipped from the factory in Thomasville, Georgia, to Billings, Montana, for full assembly. The building was then deconstructed for shipping to Seattle, where the Xpress unit and building components were loaded onto a barge and shipped to the school sites, which were all accessible by waterway. The Xpress unit and building were off-loaded from the barge and reconstructed at the site. So far, one plant has been commissioned and the other two are scheduled for commissioning this winter.

Installation at Grey Eagle Casino in Calgary.

Decentralized systems have been used for many years to meet a variety of project requirements. MBR systems offer many advantages over more conventional wastewater treatment systems, and packaged MBR systems are a proven alternative for decentralized treatment.

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