Glencoe, Ontario Wastewater Treatment Plant Post Lagoon Nitrification And Effluent Polishing System Features SAGR® Process

By Merle Kroeker, P. Eng, Project Development Engineer, Nelson Environmental Inc., and Ken Musyoka, BSc. ChemEng, Chemical Engineering, Nelson Environmental Inc.

Introduction

Small communities in the United States and Canada are challenged with the need to upgrade aging wastewater treatment facilities to meet increasingly stringent effluent quality limits. Included in these limits is an intensified focus on nutrient removal including ammonia reduction. With limited budgets always a factor and technology playing catch up with the demand, until recently, the upgrade options were extremely limited. This is particularly true in cold climate areas where no proven cost effective tertiary treatment technologies following oxidation ponds or aerated lagoons were available to meet the required low ammonia levels.

Many treatment lagoons are able to partially nitrify during the warmer summer months when water temperatures rise above 15° C. This is due to enhanced biochemical reaction rates at higher temperatures, which leads to some nitrification within the lagoon. Nitrifying activity significantly slows down in winter as lagoon water temperature decreases and drops below 4° C. Reaction rates and subsequent ammonia removals are near zero at these low temperatures.

SAGR® (Submerged Attached Growth Reactor) Developed to Address the Need

Addressing the need to treat effectively year-round along with increased demand on WWTP facilities, Nelson Environmental Inc.'s (NEI) developed the OPTAER™ wastewater treatment system utilizing the SAGR® (Submerged Attached Growth Reactor) process. The system provides post lagoon ammonia removal and effluent polishing without abandoning existing lagoon infrastructure. This innovative approach is enabling small communities to retain their existing lagoons and thus eliminating the need to install costly mechanical treatment plants, while still being able to meet low ammonia requirements.

With the SAGR process, nitrification or polishing can be accomplished following any secondary treatment including aerated or facultative lagoons. The performance parameters and sizing for the SAGR process are based on extensive testing performed on post-lagoon demonstration SAGR's in Lloydminster, Saskatchewan and in Steinbach, Manitoba.

The SAGR can be constructed within existing lagoon basins, or as an additional treatment module following a lagoon. The system is able to consistently meet ammonia effluent levels of <1.0 mg/L in summer, and <2.0 mg/L in winter due to maintaining a large population of nitrifying biomass with influent water temperatures as low as 32.9° F (0.5° C). Regardless of the water temperature, the biomass provides ammonia removal to below regulatory requirements. (See Fig. 1). As an added bonus, the SAGR also provides BOD_5 and TSS polishing. Effluent BOD_5/TSS quality has been shown to be less than 5/10 mg/L year round. (See Fig. 2).

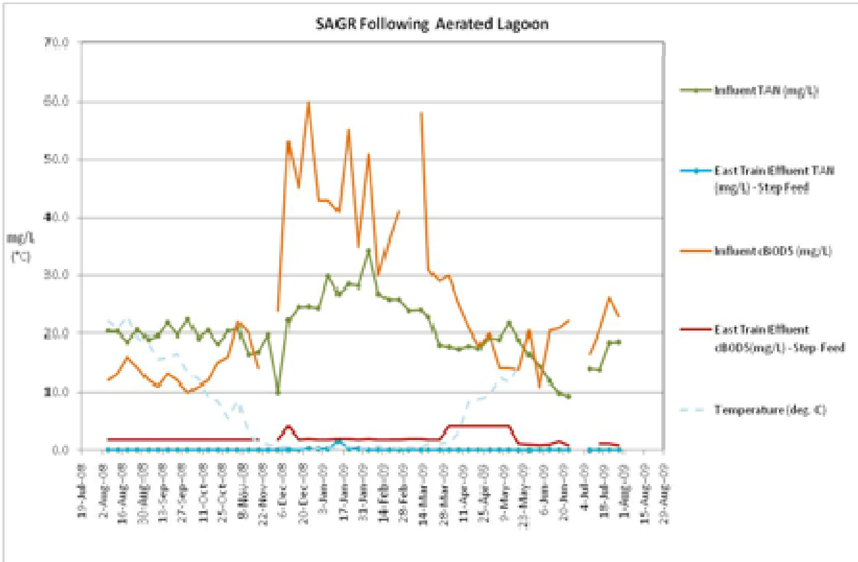

Figure 1. SAGR® influent and effluent cBOD$_5$ and TAN concentrations

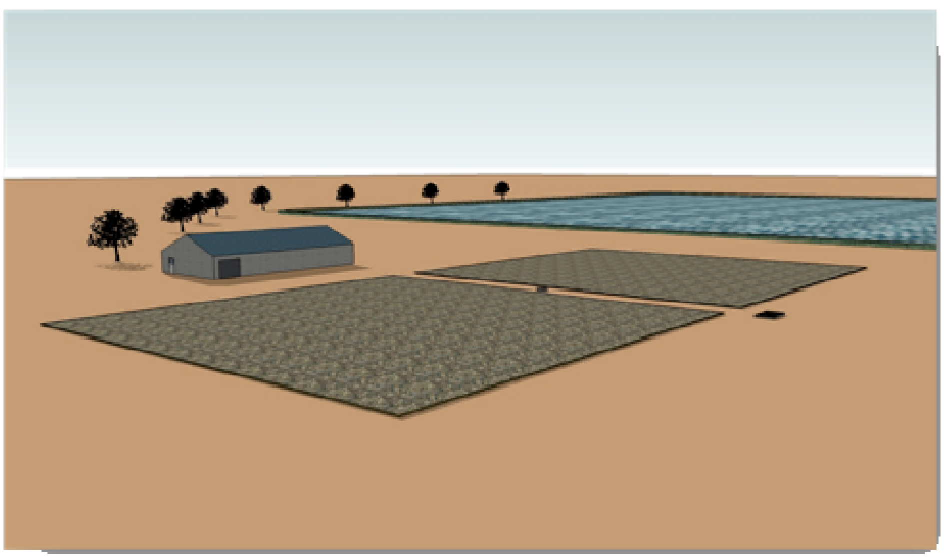

Figure 2. Glencoe WWTP process layout rendering

Case Study: Glencoe, Ontario WWTP

The Challenge

The Municipality of Southwest Middlesex's Glencoe, Ontario lagoon based WWTP facility was operating at maximum capacity. The previous system in Glencoe comprised of two facultative lagoons, which based on data collected in 2005, needed an upgrade to cope with current and future demands. To attain the capacity increase without constructing additional lagoons, the process was converted from seasonal to continuous discharge, which required that the effluent quality meet permit requirements year round.

The existing system, constructed in the mid-1970s, had reached its useful design life and was operating at its maximum capacity of 946 m^3/day. The two facultative lagoons (West and East cells) operated in parallel with spring and fall discharges into the nearby Newbiggen Creek. As a seasonal discharge facility, the WWTP had ample retention time and appropriate conditions to treat raw wastewater to an average of 6.15/12.6-mg/L $cBOD_5$/TSS. The system was however unable to provide cold temperature nitrification and did not have the capacity for projected future flow and load demands. In addition, it was unable to handle septage and biosolids from surrounding communities.

The Solution

Commissioned in March of 2011, work started at the Glencoe WWTP in April 2010 to upgrade the wastewater treatment facility using NEI's OPTAER wastewater treatment process. The upgraded system design includes utilizing one of the existing lagoons for secondary treatment followed by a SAGR process for ammonia removal and effluent polishing. At 1746 m^3/day, the upgraded system has nearly twice the maximum hydraulic capacity of its predecessor and utilizes approximately half the footprint. This capacity is anticipated to meet future demands based on a 30-year design life and will serve a projected population of 3,568 residents.

The overall process design was a collaborative effort between NEI and Genivar (Southwest Middlesex's consulting engineering firm). The plan was to decommission the east cell leaving it for use as a storage facility or to bypass the aerated cell. The west cell is subdivided into three sections using two geomembrane floating baffle curtains. The objective of the baffle curtains is to divert flow and maximize the hydraulic retention time while preventing short-circuiting and minimizing costs.

The OPTAER fine bubble diffuser system is installed in the shallow partitioned cells to achieve elevated BOD_5 and TSS removal by providing mixing of the water column and a higher concentration of dissolved oxygen (DO). Odor control is an added benefit of aerating the cells. The diffuser is designed to ensure sufficient mixing and adequate DO supply within each treatment cell, which optimizes both aerobic biodegradation of organic loading and settling of the resultant flocculating biomass. The diffusers are suspended near the bottom of the cells and provide oxygen and mixing through the rising action of small air bubbles released in the water. With the aeration system, convection cells are created between the diffusers as the bubbles rise resulting in solids settling by the downward motion of the water caught in a circulation loop. When the solids reach the bottom of the lagoon, additional oxygen for biodegradation is provided through the diffusers near the cell bottom. This process results in minimal organic bottom sludge accumulation. Aerobic digestion takes place within the aerated cells at the sludge water interface.

Because of low sludge production in the system, retention time is maintained for long-term $cBOD_5$ removal.

To meet the stringent effluent requirements BOD_5, TSS and TAN (particularly the TAN limits), the SAGR tertiary treatment system was implemented following the upgraded three-cell secondary treatment lagoon. For phosphorus removal, disc filters with chemical addition (located in blower and filtration building) were installed at the back end of the process.

Effluent quality from the upgraded, continuous discharge Glencoe WWTP system is anticipated to meet and surpass permit requirements on a year round basis with a smaller footprint and added plant capacity. The added plant capacity also created room for surrounding communities including the hamlets of Appin and Melbourne to tie in to the system. In addition to the increase in capacity and effluent discharge quality, the overall footprint of the Glencoe facility is decreased leaving unused pond space of 5.67 hectares.

All components and accessories (except the baffles, disc filters and alum addition system) were designed and supplied by NEI. The MOE discharge requirements of this upgraded treatment facility are 13.7/13.7 mg/L BOD_5/TSS and 3 mg/L total ammonia. Target design effluent was proactively set at 7/7 mg/l BOD_5/TSS, and <1 mg/l total ammonia.

Preliminary Performance Results

Preliminary data from the Glencoe facility during the initial startup period indicates that the upgraded WWTP is already meeting effluent TAN requirements. The raw wastewater average influent TAN is 28.1 mg/L while effluent leaving the SAGR is 0.16 mg/L based on seven data points obtained in May and early June of 2011 and translate to a 99 percent TAN removal. The storage pond has not yet been decommissioned and is also discharging through the SAGR, which is increasing the hydraulic loading.

Figure 3. Completed SAGR process with insulating woodchips at grade

Conclusion

In the Glencoe WWTP case, the upgrade of the facility utilizing the SAGR process enabled the facility to more than meet environmental permit requirements, optimizing use of existing infrastructure while minimizing operating costs. This is due to the upgraded system's ability to efficiently address post-lagoon nitrification and ammonia removal even at very cold-water temperatures.

The upgraded Glencoe facility has nearly double the treatment capacity of the original lagoon design with a significantly smaller footprint and will meet future demands based on a 20-year design life. The SAGR effluent TAN data from two demonstration sites shows that the system is capable of meeting and exceeding permit requirements.

This Glencoe facility system is an excellent example of the flexibility and performance capabilities of the OPTAER lagoon-based wastewater treatment system in treating wastewater to some of the most stringent effluent requirements. The system provides an example of a cost effective and efficient solution for WWTP operators throughout North America who face the same regulatory challenges, but want to keep the low operation complexity and costs associated with their existing lagoon systems.

About the Authors:

***Merle Kroeker, P. Eng**, graduated from the University of Manitoba with a degree in Biosystems Engineering. He is a Project Development Engineer with Nelson Environmental Inc. His experience includes wastewater treatment system process design for lagoon systems across North America focusing on cold climate ammonia reduction. Merle can be reached at mkroeker@nelsonenvironmental.com*

***Ken Musyoka** holds a degree in Chemical Engineering from Lakehead University. He provides a supportive role in various aspects of lagoon based wastewater treatment including process and equipment troubleshooting and optimization for Nelson Environmental. His experience encompasses research, wastewater systems design and development, analytical chemistry, and quality control. Ken can be reached at kmusyoka@nelsonenvironmental.com*