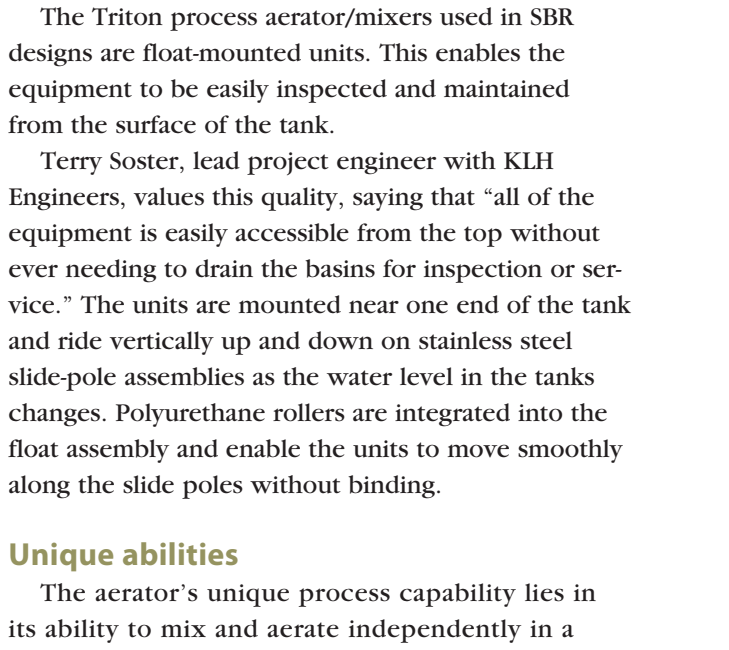
PRODUCTEMPHASIS

A Perfect Pair: SBR Designs & Advanced Aeration Technology

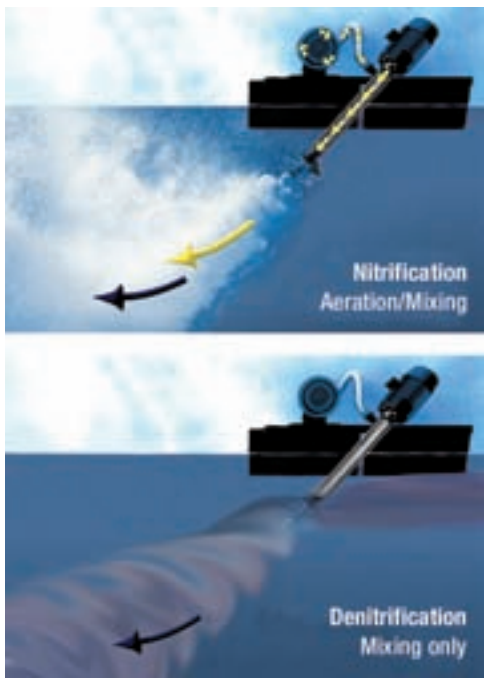
By Shawn Brown & Mike Presutti

Conventional sequencing batch reactors (SBRs) that utilize diffused-air networks have existed in the U.S. for about three decades now. The reliability of controls and instrumentation has significantly improved in the last 10 to 15 years, and as a result, SBR plant designs are becoming more widely accepted. The attractiveness of their compact layout and ease of operation has also helped increase their popularity.

Advanced aeration and mixing technologies for SBR designs reduce capital investment and improve process flexibility



The Triton dual-function aerator/mixer provides process flexibility to nitrify and denitrify as well as facilitate biological phosphorus removal by changing controls to allow for anoxic mixing steps during the cycles.



SBR savings

Perry Township in Fayette County, Pa., is one of the first SBR plants to be designed around a layout that utilizes a surface-mounted process aerator/mixer. This aerator is a significant improvement over the traditional diffused-air network designs. The new layout offers substantial capital investment savings, operational savings and improved process flexibility.

The facilities plan developed for Perry Township recommended a continuous flow reactor design utilizing diffused air. The original design engineer for the project looked at a variety of manufacturers and eventually selected an SBR system proposed by Wagner Fluid Systems out of Winfield, Pa.,—a process equipment supplier with an established history of successful SBR designs.

Wagner had recently partnered with Aeration Industries in Chaska, Minn. Together the two companies developed a new design that integrated Aeration's Aire-O2 Triton process aerator/mixer into Wagner's SBR system design. Once the design was complete, KLH Engineers, Inc. was awarded the contract to provide construction services on the project. Located in Pittsburgh, KLH Engineers is an environmental consulting firm focused strictly on the municipal wastewater sector. KLH has a long history of SBR design, having installed one of the first batch reactors in the U.S. in 1983.

Aeration in action

The design of the Perry Township SBR is based on an average daily flow of 100,000 gpd of municipal wastewater. Influent design loadings are 240 mg/L biochemical oxygen demand (BOD_5) and 30 mg/L ammonia. The plant layout consists of three concrete tanks: two batch reactor tanks measuring 13 x 35 x 20 ft and one sludge holding tank measuring 9 x 25 x 20 ft. Instead of using diffused air, plant engineers installed one 10-hp Triton aerator/mixer in each of the reactors, which are designed to remove 200 lb per day of BOD and 25 lb per day of ammonia.

In addition, one 5-hp Triton unit was installed in the 30,000-gal sludge holding tank to provide aeration and mixing. Each reactor also contains one of Wagner's unique decanters. The four-sided stainless steel decanters are fixed and baffled and are moved vertically by a wormgear-driven jack screw to produce a controlled and high-quality flow of effluent during the decant phase. The four-sided design allows for a reduction in the overall size of the decanter, thereby reducing cost and simplifying installation.

The Triton process aerator/mixers used in SBR designs are float-mounted units. This enables the equipment to be easily inspected and maintained from the surface of the tank.

Terry Soster, lead project engineer with KLH Engineers, values this quality, saying that "all of the equipment is easily accessible from the top without ever needing to drain the basins for inspection or service." The units are mounted near one end of the tank and ride vertically up and down on stainless steel slide-pole assemblies as the water level in the tanks changes. Polyurethane rollers are integrated into the float assembly and enable the units to move smoothly along the slide poles without binding.

Unique abilities

The aerator's unique process capability lies in its ability to mix and aerate independently in a single unit. The aerator is driven by a 900-rpm (60 Hz) motor, which significantly extends the life of the equipment. The motor drives a large mix propeller, which ensures that the tank contents are completely mixed.

The aerators are not self-aspirating. All of the air produced by the aerator is fed by an onboard regenerative blower that pushes the air down the dynamically balanced hollow shaft of the mixer and injects it into the water column, thus producing a large volume of fine bubble-diffused air. The air is driven deep into the tank by the power mix propeller, providing for efficient contact of the air with the wastewater and facilitating long bubble hang times. This, in turn, maximizes oxygen transfer efficiency.

This pre-start up photo shows how the unit is able to ride vertically up and down on stainless steel slide-pole assemblies as water levels in the tank change.

Saving money

Compared with conventional SBR designs utilizing diffused air, this system—which includes both mixing and aeration in one unit directly installed in the tank—provides substantial savings in capital investment, both from an equipment supply perspective and an installation perspective. The cost of diffuser networks, piping networks, supports, centrifugal or positive displacement blowers and blower buildings or enclosures is eliminated. The result is a much more compact plant that is quick to install and easy to operate and maintain.

"The use of the aerator devices has allowed the authority to free up valuable building space that would have been used for blowers and to use that space for much-needed storage that they did not have with the original plant design," Soster said.

The Perry Township plant is currently only required to treat BOD, but the plant has already integrated an anoxic mix cycle to facilitate phosphorus uptake into the plant's control sequence. Each SBR cycle includes 15 minutes of fill and anoxic mix where the mixer-only portion of the aerator is in operation, 120 minutes of fill and aeration where the full aerator/mixer is in operation, 45 minutes of settling with the aerator/mixer in standby, and 60 minutes of decant with the aerator/mixer in standby and the decanter in operation. Total, there are six cycles per day.

Future concerns

As discharge permit requirements become stricter throughout the U.S., biological nutrient removal will become a necessity for most, if not all, plants.

"In Pennsylvania, there is a regulatory initiative to have statewide phosphorus removal limits for all plants discharging to streams," Soster said.

The Triton unit allows the Perry Township plant to be easily upgraded in the future to enable the plant to nitrify, denitrify and facilitate biological phosphorus removal by simply changing the controls' programming to allow for anoxic mixing steps during the SBR cycles. This is accomplished by turning off the blower on the aerator/mixer and allowing the unit to mix only for a set period of time. No supplemental mixers are required. Control of the anoxic cycles can be accomplished by setting a timer in the control panel to control the anoxic step based on plant operating experience.

"The ability to have mixed, non-aerated cycles will allow us to simply modify operational cycles to meet future requirements with the current plant design," Soster said.

Another available option to optimize nitrification and denitrification cycles is to integrate the aerator/mixer with an oxidation reduction potential (ORP) analyzer to more accurately control the process. Using ORP, the plant's controls can monitor inflection points on the ORP curve that occur upon completion of nitrification and denitrification and determine precisely and automatically when to turn the blowers on and off. This approach maximizes the removal of total nitrogen from the process. Implementation of anoxic cycles also improves settling of the activated sludge by providing selective pressure against the growth of filamentous bacteria and naturally recovers alkalinity that is consumed during the nitrification process.

Summary

This new SBR design has provided Perry Township with a cost-effective plant that is easy to maintain and operate. The process flexibility afforded by the innovative system ensures that the plant will be able to meet its permit requirements in a proactive manner well into the future. WWD

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