Advanced Aeration and Mixing Technology for SBR Designs

By Shawn Brown and Mike Presutti

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

Sequencing batch reactors(SBRs) utilising diffused air networks have existed for about three decades. The reliability of controls and instrumentation has significantly improved in the last 10 to 15 years. As a result, SBR plant designs are now widely accepted. The attractiveness of their compact layout and ease of operation has also helped increase their popularity.

The Perry Township in Fayette County, Pennsylvania, is one of the first SBR plants to be designed around a layout that utilises 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 the Perry Township recommended a continuous flow reactor design utilising diffused air. The original designs engineer for the project looked at a variety of manufacturers and eventually selected a SBR system proposed by Wagner Fluid systems out of Winfield, Pennsylvania.

Wagner had recently partnered with Aeration Industries in Chaska, Minnesota, USA. Together the two companies developed a new design that integrated Aeration's Aire-O_2 triton process aerator/mixer into Wagner's SBR systems designs. Once the designs were complete, KLH Engineers Inc was awarded the contact 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 US in 1983.

Aeration in action

The design of the Perry Township SBR is based on an average daily flow of 100,000gpd of municipal wastewater. Influent design loadings are of 240mg/L biochemical oxygen demand(BOD5) and 30mg/L ammonia. The plant layout consists of three concrete tanks: two batch reactor tanks measuring 13 x 35 x20ft and a sludge holding tank measuring 9 x 25 x 20ft. Instead of using diffused air, the plant engineers installed one 10hp triton aerator/mixer in each of the reactors, which are designed to remove 200lb per day of BOD and 25lb per day of ammonia.

In addition, a 5hp triton unit was installed in the 30,000gal 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 are moved vertically by a gear-driven jack screw to produce controlled and high-quality flow of effluent during the decant phase. The four-sided design allows for reduction in the overall size of

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

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.

According to Terry Soster, Lead Project Engineer with KLH Engineers, the equipment is easily accessible from the top without the need 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 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 900rpm (60Hz) motor that 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 longer bubble hang times. This, in turn maximises oxygen transfer efficiency.

Saving money

Compared to conventional SBR designs utilising diffused air, this system, including both mixing and aeration in one unit directly installed in the tank, provides substantial saving 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 blower and blower buildings or enclosures is eliminated. The results are a 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 valuable space that would have been used for blowers, but could now be used for storage that was unavailable in the original plant designs.

The Perry Township plant is currently only required to treat BOD, but it 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 is the only portion of the aerator 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. In all there are six cycles per day.

Triton aerator/mixers at Green CETP, Vatva, Ahmedabad, using 12 x 60HP triton aerator/mixers, is one of the biggest installations in India

Future concerns

As the discharge permit requirements become more stringent throughout the US, biological nutrient removal has become a necessity for most plants. In Pennsylvania, there is a regulatory initiative to have state wide phosphorus removal limits for all plants discharging into the streams.

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 of 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 the plant operating experience. The ability to have mixed, non-aerated cycles will enable modifying operational cycles to meet future requirements with the current plant design.

Another available option to optimise nitrification and denitrification cycles is to be integrate the aerator/mixer with an oxidation reduction potential(ORP) analyser to accurately control the process. By using ORP analyers, 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 maximises 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

The new SBR design 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.

About the Author

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