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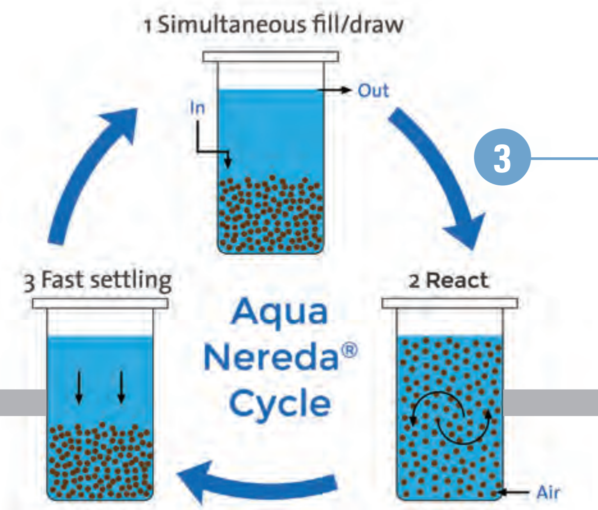
1. The first full-scale municipal Nereda aerobic granular sludge technology was installed in Epe, Netherlands. The technology is contained in the circular tanks.
2. A comparison shows the rapid settling of aerobic granular sludge (left) versus conventional activated sludge. Settling time in this example was five minutes.
3. A simple schematic of the Nereda process.



Defying the Conventional

AN INNOVATIVE SECONDARY TREATMENT TECHNOLOGY USES AEROBIC GRANULAR BIOMASS FOR EFFECTIVE NUTRIENT REMOVAL IN A COMPACT FOOTPRINT WITH LOW ENERGY CONSUMPTION

By Ted J. Rulseh

Companies continue to develop new approaches to basic wastewater treatment processes, always in search of more effective pollutant and nutrient removal with lower costs for energy and other inputs as well as in smaller packages.

Among the latest offerings is the AquaNereda Aerobic Granular Sludge technology, which in commercial application in Europe is under the name Nereda. Aqua-Aerobic Systems is the exclusive provider of Nereda technology developed by Royal HaskoningDHV in the U.S.

The technology consists of a three-phase batch process completed in a single tank. Durable granules composed entirely of biomass do the work of treatment, performing simultaneous nitrification and denitrification for nitrogen removal while also biologically removing phosphorus to low levels without chemical addition. It accomplishes this without mechanical mixing and with closely controlled introduction of air.

Brian Bates, product channel manager for the AquaNereda process, talked about the technology in an interview with *Treatment Plant Operator.*

tpo: Is this an alternative to conventional activated sludge?

Bates: Yes. The microbiology is very similar to that found in an activated sludge system. However, the biology is primarily found in granules. Rather than relying on a flocculated sludge, which is a loosely mixed microbial community, the granules are layered microbial communities. Within each granule, you have aerobic, anoxic and anaerobic zones. Basically, each granule is a miniature treatment plant. The granules are created automatically by the conditions created in the AquaNereda reactor.

tpo: Is this process preceded by primary treatment?

Bates: It doesn't have to be, but it can be — similar to conventional activated sludge. We have some applications that follow primary treatment, but most plants thus far are fed with raw influent. The process stream has grit removal and screening, just as it would in a conventional system. Sometimes, depending on the plant design, we need a buffer tank.

> "Within each granule, you have aerobic, anoxic and anaerobic zones. Basically, each granule is a miniature treatment plant."
> BRIAN BATES

tpo: After the preliminary steps, how does the process begin?

Bates: Everything is done in one tank. The first step is a simultaneous fill from the bottom of the tank and a draw from the top. The raw wastewater is a rich carbon source, and at the granules there is a high food-to-mass ratio. Phosphorus release occurs because of the anaerobic conditions there, and the clean effluent is displaced up through the top. No air is introduced in this step; the granules remain settled at the tank bottom.

tpo: What happens after this step?

Bates: The process moves to the react phase. The influent flow is shut off. Air is then added intermittently through fine-bubble diffusers, controlled based on dissolved oxygen, ammonia concentration, or both. Simultaneous nitrification and denitrification occur because of the different discrete zones within the granules.

tpo: At this point, are the granules held in suspension?

Bates: Yes. However, the level of mixing varies throughout the cycle. Sometimes, we achieve a complete mix of the granules, but this is not necessary throughout the entire reaction phase. The aim is to move the bulk liquid around the granules.

tpo: What happens after the react phase?

Bates: The process advances to the settle phase. The granules separate from the treated water. Rapid settling allows more time to be spent in the react phase, and that enables the use of small reactor volumes while achieving ultralow enhanced biological nutrient removal. During the settle phase, a small amount of sludge is wasted out of the system. After that, the process reverts to the first step.

tpo: What effluent conditions can this system produce?

Bates: We typically guarantee 10 mg/L for BOD and TSS. We can achieve as low as 3 mg/L total nitrogen and less than 1 mg/L total phosphorus with no chemical addition. With chemical addition, we can get phosphorus down to approximately 0.5 mg/L, and with tertiary filtration, we can go lower.

tpo: Is this process typically followed by tertiary filtration?

Bates: Not necessarily. The need for filters is based on the effluent requirements. If effluent TSS of less than 10 mg/L is needed, a filter would be required.

tpo: What is the nature of the granules used in this process?

Bates: The granules in aerobic granular sludge are truly a biomass — there is no carrier in them. Everything is formed by the biology we select to create extracellular polymeric substances. These EPSs act as the glue, creating extremely robust granules that can handle many adverse conditions in the system. There has never been a case of de-granulation in an operating facility.

tpo: What specific advantages does this process have over conventional activated sludge?

Bates: It has a 75 percent smaller footprint compared to a five-stage biological nutrient removal process. It roughly doubles the mixed liquor suspended solids, to about 8,000 mg/L. Due to the batch nature of the process, you save on final clarifiers. The energy savings are also significant: energy savings of 30 to 50 percent compared to conventional systems have been achieved.

tpo: Can this process be retrofitted to an existing plant?

Bates: It's great in retrofit applications. We can retrofit to essentially any basin geometry. Since all processes occur in a single tank, plants that have secondary clarifiers can have their aeration tanks retrofitted with the AquaNereda process and their clarifiers can be converted to other purposes, such as equalization basins or sludge basins. In the process, the MLSS is increased significantly, enabling more flow through the same system while saving on chemicals and energy. As an added bonus, nutrient removal is typically improved.

tpo: Is there a sweet spot in terms of system size?

Bates: We typically look for flows greater than 100,000 gpd. Above that, the sky is the limit. One plant in Ireland has a maximum flow of 314 mgd.

tpo: What is the status of installations of this technology?

Bates: There are around 40 installations worldwide that are in operation or under construction design with flows ranging from 100,000 gpd to over 300 mgd. In the United States, we have many plants under design with some in the detailed design stage. In addition, Aqua-Aerobic Systems is currently constructing an AquaNereda plant at the wastewater treatment plant in Rockford, Illinois, that will serve as a site for customers who would like to see the technology. It's also for research and development to help determine how far we can push this process and possibly come up with novel ways to use it. tpo