

# Time-Based Treatment Is A Game Changer For Activated Sludge, Granular Sludge, And Densified Sludge

Wastewater treatment plants (WWTPs) across North America continue to struggle in the face of evolving wastewater composition, increasing population, and rising energy costs. For decades, continuous-flow, multi-stage [biological nutrient removal](#) (BNR) activated sludge has been the go-to technology for secondary treatment. While effective, this process often requires significant infrastructure, considerable amounts of energy, and a large footprint to manage varying influent conditions.

As these challenges mount, WWTPs are turning to new types of suspended growths. Densified sludge and granular sludge have been proven as intensification technologies to enhance treatment including nutrient removal, with the benefit of a smaller footprint and power savings. For these technologies, control of the treatment environment is important; this can be efficiently achieved by using time-based batch processing. Even better, time-based batch processing allows WWTPs to gain the benefits of new suspended

growth technologies in a much smaller footprint. For wastewater utilities looking to expand or retrofit existing facilities, or build new greenfield plants, it is worth understanding different types of suspended growth and how they work with time-based batch processing.

## Improved Treatment With Densified And Granular Sludge

On the surface, the main difference between [activated sludge](#), densified sludge, and granular sludge is the particle

size, which is established using selective feed and waste processes (Figure 1). Activated sludge particles are typically smaller than 200  $\mu\text{m}$ , and mixed liquor suspended solids (MLSS) is typically 3,500 to 4,500  $\text{mg/l}$ . Densified sludge has more compact flocs composed of particles ranging between 200  $\mu\text{m}$  and 400  $\mu\text{m}$ . The denser particles settle more quickly, creating more concentrated mixed liquor (5,000 to 5,500  $\text{mg/l}$ ). This improves nutrient removal over traditional activated sludge.



**Figure 1.** Examples of different types of suspended growth technologies at work: AquaSBR® Sequencing Batch Reactor (activated sludge, left), Aqua TruDense™ True Densified Sequencing Batch Reactor (densified sludge, center), and AquaNereda® Aerobic Granular Sludge (granular sludge, right)

[Granular sludge](#) goes further, with particle sizes ranging from 400  $\mu\text{m}$  to over 3 mm. Each particle has discrete layers in which aerobic, anaerobic, and anoxic conditions are occurring, which increases treatment quality. The larger particles settle much faster than other types of suspended growth – about 5 minutes compared to 30 minutes for activated sludge, allowing the system to operate with an MLSS of 8,000 mg/l or higher.

### Importance Of Time-Based Treatment

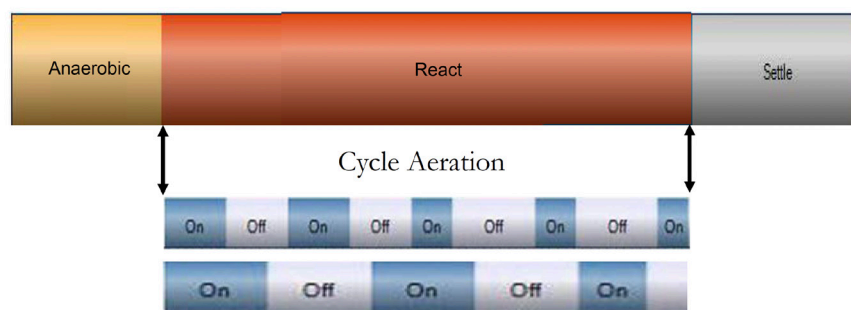
Regardless of the type of suspended growth used, continuous-flow, multi-stage BNR uses multiple tanks or zones for each stage in the nutrient removal process -- anaerobic, aerobic, and anoxic -- as well as secondary clarifiers and possibly primary clarifiers. This requires substantial real estate, extensive pipework, and a tremendous amount of pumping as wastewater is moved between zones.

Time-based batch processing treats a fixed volume of water in a single tank. After initial screening and grit removal, wastewater goes through essential treatment phases controlled by time: fill, react, and settling. During the reaction stage, anaerobic and aerobic processes are alternated by turning blowers on and off as needed, eliminating the need for separate tanks or zones (Figure 2).

The benefits of time-based batch processing are numerous:

**Smaller footprint.** In batch processing, a single tank can perform both aerobic and anaerobic processes. This cuts down on the number of tanks needed to process the same amount of influent. In addition, it does not require multiple flow paths to move wastewater between stages. Lastly, since fluid is not constantly moving from tank to tank or zone to zone, batch processing has much shorter hydraulic retention times and sludge retention times. Overall, when using time-based batch processing with activated sludge,

## Ability to Modify Aeration Times to Meet Required Effluent



**Figure 2.** The stages of time-based batch processing, including aerobic treatment, anoxic treatment, anaerobic treatment, and clarification all occur in a single tank, reducing the overall footprint and energy costs associated with pumping between treatment zones.

WWTPs can reduce the footprint needed for the process by 50%. Densified sludge's faster settling and increased MLSS concentration cuts down space requirements by an additional 20% to 25%. Granular sludge goes further, with about half the footprint of time-based batch processed activated sludge, which translates to roughly one-quarter of a full multi-stage BNR.

**Greater treatment stability.** With traditional multi-stage BNR, sudden increases in flow rate, including wet weather events, can wreak havoc on the ability to manage treatment outcomes. In time-based batch processing, the bulk of the reaction phase occurs after the tank is closed to new influent; new or excess influent is diverted to a second tank that begins the reaction cycle while the complete batch is being treated. This reduces variables that can impact treatment outcomes. The increased control makes it easier to manage suspended growths and effectively execute densified or granular sludge.

**Increased treatment flexibility.** Along with fewer unexpected variables, the process also offers greater flexibility to operators to make adjustments based on nutrient loading. For example, the exact time spent in aerobic and anaerobic stages, and the number of times alternated between each stage, can be

customized for each batch if needed.

**Reduced energy consumption.** In time-based batch processing, wastewater does not need to be pumped between tanks and zones to reach subsequent stages of treatment, which can save between 40% and 60% of energy costs compared to traditional multi-stage BNR.

**Improved scalability.** Since only a single tank is needed per batch, time-based batch processing can be scaled up more easily than continuous-flow MSBNR. This makes it ideal for growing populations where increased flows are expected in coming years and decades.

As WWTPs face increasingly complex treatment demands, growing populations, and rising energy costs, new suspended growth technologies can improve treatment outcomes and reduce energy and other costs. Aqua Aerobic Systems Inc. offers these technologies as AquaSBR® Sequencing Batch Reactor, Aqua TruDense™ True Densified Sequencing Batch Reactor, and AquaNereda® Aerobic Granular Sludge Technology, the only viable aerobic granular sludge solution on the market. Through these systems, WWTPs can take full advantage of such activated sludge and its alternatives while enjoying other benefits over traditional continuous-flow, multi-stage BNR. ■