Sidestream Treatment - Centrate and RAS Reaeration Basins

Wastewater utilities across the country are facing more stringent effluent nutrient limits. Modifying existing facilities to comply with these standards often calls for innovative process upgrades that minimize the impact on rate payers. Sidestream treatment is a cost-effective method to reduce high concentrations of ammonia generated through anaerobically digested biosolids. This is important because centrate (or filtrate) sidestreams represent 20 to 40 percent of a plant’s total ammonia load. The CaRRB (Centrate and RAS Reaeration Basin) process is used to nitrify centrate ammonia prior to return to the mainstream secondary treatment process.

Unlike other “separate sludge” sidestream processes, CaRRB is seeded using the nitrifiers in the mainstream process through RAS return. This eliminates the need for sidestream clarifiers and pumping systems.

In addition to nitrification of sidestream ammonia loads, the CaRRB process provides four other significant benefits:

- Bioaugmentation of nitrifiers to the mainstream aeration basins.
- Generation of nitrate in CaRRB that is fed to mainstream anoxic zones for denitrification, reducing the mixed liquor return pumping requirements and associated capital and operating costs.
- Creating an inventory of high MLSS (mixed liquor suspended solids) in the CaRRB basins allowing for lower mainstream aeration basin MLSS and a reduced solids load on the secondary clarifiers.
- Providing biomass storage that can reduce the impacts of washout during high peak flow storm events.

CaRRB is cost effective because it provides equivalent nitrification capacity in a smaller footprint as compared to aeration basins. CaRRB can reduce the cost of expansion of mainstream secondary treatment facilities while helping meet more stringent nitrogen removal performance requirements.

Case Study:
Metro Wastewater Reclamation District
Denver, Colorado
Robert W. Hite Treatment Facility
North Secondary Improvements Project

The Metro Wastewater Reclamation District (MWRD) in Denver, Colorado, operates the 220-mgd Robert W. Hite Treatment Facility (RWHTF), which includes two separate primary and secondary complexes. The north secondary complex (NSEC) uses a BNR air activated sludge process in nitrification-denitrification mode, and the south secondary complex (SSEC) currently uses a high-purity oxygen activated sludge process that is being converted to a BNR air activated sludge plant. Both complexes share common solids handling facilities.

Presently, all of the nitrogen-rich centrate from the solids dewatering process is returned to the NSEC. The effluent criteria for discharge include monthly limits for ammonia and a weekly maximum limit for NOx (nitrate plus nitrite).

In 2004, MWRD began planning improvements at the RWHTF to comply with more stringent limits for ammonia, NOx, and phosphorus. The initial strategy...
included two new aeration basins and secondary clarifiers to supplement the existing 12 aeration basins and secondary clarifiers. As an alternative approach, Carollo evaluated the concept of centrate sidestream treatment with RAS in reaeration basins. The concept envisioned the construction of common CaRRB basins instead of two new aeration basins and secondary clarifiers. Construction of CaRRB was completed in June 2009, and the process was started up shortly thereafter.

The CaRRB approach afforded several important advantages over the original improvements strategy, including increased capacity and performance at a lower cost, reduction in required mixed liquor return pumping, and improved denitrification. CaRRB performance has exceeded expectations and confirmed the significant benefits offered by this process. The 106-mgd MWRD NSEC CaRRB application is the largest full-scale application of this technology worldwide. Based on this success, CaRRB will also be incorporated into the new SSEC BNR facility.

**Cost-effective Capacity**

Because solids in CaRRB are inventoried at RAS concentrations (significantly higher than the MLSS concentrations in the aeration basins), the same solids retention time (SRT) can be maintained at a lower bioreactor volume using the CaRRB approach. This results in lower solids concentrations entering the secondary clarifiers, subsequently increasing clarification capacity. The result is that the CaRRB approach yields a higher capacity at a lower cost. The original NSEC improvements strategy would have required two aeration basins with a combined volume of 4.1 million gallons and two 130-foot diameter secondary clarifiers. The CaRRB approach yielded approximately 20 percent more capacity than the original strategy with the construction of only 2.7 million gallons of centrate reaeration basins and without any new secondary clarifiers. This increased capacity resulted in a reduction in anticipated capital cost of approximately $17 million when compared to the original strategy.

**Reduction in Required Mixed Liquor Return**

CaRRB also allowed a reduction in the required mixed liquor return (MLR) pumping rate. Due to nitrification of centrate occurring in CaRRB, a significant amount of nitrate is generated and returned to the anoxic zones in the mainstream aeration basins, offsetting some of the MLR pumping requirement. At MWRD, the CaRRB process generates approximately 6,000 to 8,000 ppd of nitrate as N, that is fed to mainstream anoxic zones. This is equivalent to 70 to 100 mgd of MLR, or a reduction of 6 to 8 mgd per aeration basin. This reduction in MLR pumping allows installation of smaller pumps and provides an energy cost savings of approximately $80,000 per year.

**Improved Nitrification**

The CaRRB process yields a steady seeding of nitrifiers from the centrate reaeration basins to the mainstream aeration basins. The bioaugmentation effect appears to allow nitrification at slightly lower aerobic SRTs. The CaRRB process was designed to provide 50 percent centrate ammonia reduction when operated at design loadings. The degree of nitrification is limited by the operating pH and alkalinity available in the RAS. With adequate pH control, ammonia reduction in CaRRB can be higher than 50 percent.