Total Nitrogen Compliance News™

Vol. 1, No. 1 September, 2007

Reported independently by Total Nitrogen Compliance News, div. Indumark®, New York, NY

Special Deep-Bed Biofiltration System Keys Continued Nitrate-Nitrogen Compliance For WWTP/WRF, Despite Ongoing Rapid Service Expansion

Adjusts for Seasonal Slowdowns in Bio-Activity

Special, deep-bed biofiltration system is credited with key contribution to utility's continued compliance with state total nitrogen limits, despite ongoing rapid growth in service demand.

Table #1:
Nitrates and BOD

	Filter Entry	Filter Effluent
Nitrates	4-7mg/l	<1 mg/l
BOD	5-8 mg/l	3 mg/l

Combined air/water, sustained, sub-fluidized backwash cleans the media, with backwash water consumption as low as 2% of the forward flow.

Smithfield, NC — Management at the 7 mgd wastewater treatment plant (WWTP) and water reclamation facility (WRF) here credits a special, deep-bed biofiltration system as the key contribution to the utility's continued compliance with state regulations for total nitrogen discharge limits, in spite of ongoing rapid growth in its service demand.

In 2006, the plant's total nitrogen discharge to the Neuse River Basin was only 23,000 lbs., against an annual mass limit of 67,467 lbs. A $22/lb fine is mandated for exceeding that limit.

The special deep-bed biofiltration system, which started up in 2003, is the Leopold® elimi-NITE® Denitrification System, manufactured by F.B. Leopold Company of Zelienople, PA. The system's filtration capacity, which was increased as part of the plant's expansion to 7 mgd, is to be increased again later this year as part of a further plant expansion to 9.5 mgd.

"When nitrogen limits first started in the 1990's, we were able to comply through addition of aeration basins during plant expansions," recalled Dan Wall, wastewater facility manager for Central Johnston County. "Then, to achieve a 30% reduction in total nitrogen that was going to be needed by 2003, we made an anoxic zone out of one of the basins, and operated a recirculating pump from there to the remaining aeration basins. That reduced our nitrate effluent from 13-15 mg/l to 6-8 mg/l."

"But with more growth expected in our service demand," he continued, "we knew we needed further reduction, and turned to filtration. We selected Leopold, after investigating competitive claims about problems with their underdrain integrity. We visited their factory, saw how they were made, were guaranteed there wouldn't be any problems, and we haven't had any."

"They worked with us on and off for over a year with sampling and testing. Then throughout 2006, our third full year of operation, we had an average weekly total nitrogen reading of 1.96 mg/l, which actually exceeded the supposed technology limit of 2.5 mg/l."

In filter operation, methanol is added to the filter influent to provide an organic substrate for a denitrifying microbiological culture in the filter media. The nitrified stream is metabolized by the culture, eventually changing it to nitrogen gas that becomes embedded in the filter bed.

Nitrogen bubbles are trapped by the media and filter downward flow, and accumulate in the media. A short "bump" backwash

cycle of about 1 min. then releases the bubbles to the atmosphere.

A complete backwash cycle to clean the media occurs every 48-60 hrs., depending on solids loading.

"When we run the filters in non-dentrification mode, we have gone as long as 250 hrs. before the complete backwash cycle is needed," Wall noted.

Wall added that Leopold had worked with him to rewrite some operational programs.

"For example, now we can adjust the methanol addition during the winter, when the biological activity in the beds slows down," he said. "They wired it into the PLC to change the direct ratio of methanol to nitrates."

"Also, when there was too much dissolved oxygen in the filter---as much as 6-7 mg/l coming in---we at first couldn't reduce it because of the way the plant was built. But they were able to add a step, with extra methanol provided at a given rate, to drive D.O. down toward 0.3 mg/l, effectively making the lower half of the filter anoxic."

Dissolved oxygen (DO) is typically 4 to 6 mg/l entering the filter channel. With the addition of methanol there, it is reduced to about 1mg/l prior to discharge to the filters, and then to less than 0.3mg/l in the filter bed.

The plant has a daily limit for DO discharge to the Neuse River of 6 mg/l or higher. This is achieved with use of a cascade aerator prior to discharge, which provides for typical readings of 6.5 to 8 or 9 mg/l.

Methanol is stored in an 8000-gal. tank, with 4,000 gal. bulk shipments typically arriving every 45-50 days. A filter influent flow meter and nitrate analyzer was installed to allow for calculation of methanol feed based on flow and nitrate variations in the filter influent channel.

Currently, plant influent ammonia nitrogen averages 30 mg/l. Permit effluent is <1 mg/l during April through October, and <2 mg/l during November through March. Average plant effluent throughout the year is <0.5 mg/l.

Plant influent total nitrogen ranges from 35-40 mg/l. The average effluent reading for 2006 was 1.96 mg/l, for a total nitrogen discharge in 2006 of only 23,000 lbs., against an annual mass limit of 67,467 lbs.

Nitrate levels entering the filtration system range from 4-7 mg/l, and are <1 mg/l in the filter effluent.

BOD enters the filters at 5-8 mg/l, and exits at about 3 mg/l. The plant effluent permit limit from April to October is 5 mg/l. The plant average during that period is about 3 mg/l, and is <5 mg/l from November to March, when the permit limit is 10 mg/l.

pH, mandated to be >6 and <9, is typically at 6.8-7.

Reclaimed water from the plant is stored in an underground storage tank, and then pumped seven miles to an elevated storage tank. The water from this tank is re-used by spraying it on a 447-acre golf course. It is also re-used as watering for coastal Bermuda hay; watering for trees on a property owned by Johnston County that is deployed for solid waste disposal (landfill); and as dust control on the landfill roads.

Thomas M. Getting, P.E., DEE, Leopold's project engineer for the Smithfield installation, and the company's filtration product manager, noted key features of the system.

"It handles wide swings in solids loading, while providing for long filter runs," he said. "A combined air/water, sustained, sub-fluidized backwash cleans the media, with backwash water consumption as low as 2% of the forward flow."

Getting added that the company's filter designs are not restricted to one type of filter layout or maximum allowable width due to underdrain design limitations. System designs can be customized for a variety of site conditions, including existing filter basins. An alternative Flat Bottom Flume® design is described as reducing capital, civil and installation costs while maintaining superior filter performance.

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Filter operation includes addition of methanol to filter influent to provide organic substrate for a denitrifying microbiological culture in the filter media. Methanol is stored in an 8000-gal. tank.