Nutrient Removal Training in the Chesapeake Bay Watershed

by Tim Miller

For wastewater treatment plants (WWTP) discharging into the Chesapeake Bay watershed, day to day plant operations are changing. Discharge permits have included nutrient monitoring since 2005. Permits have been or are being modified to include facility specific nutrient action levels and nutrient removal optimization. To help the regulated community work toward meeting these changes, the New York State Department of Environmental Conservation (NYSDEC) targeted wastewater operator training as an important outreach effort. NYSDEC's Facility Operations Assistance Section and local New York Water Environment Association (NYWEA) chapters identified specific training needs and interests for operators within the Chesapeake Bay watershed.

From this effort, three targeted training areas were identified to help local operators deal with the new nutrient removal goals: phosphorus removal, nitrogen removal and filament control. The training focus for all three programs was not on theory or design, but rather on methods operators can use to initiate and optimize nutrient removal using their current facility.

Joe Brilling, NYSDEC

Operators attend a recent Chenango, NY workshop, co-sponsored by NYS Department of Environmental Conservation (NYSDEC) and the New York Water Environment Association (NYWEA).

Three separate training programs were recently offered for wastewater operators in Chenango, NY:

- ***Phosphorus Precipitation and Clarifier Optimization*** – 45 operators attended
- ***Nitrogen Removal*** – 34 operators attended
- ***Filament Identification and Control*** – 35 operators attended

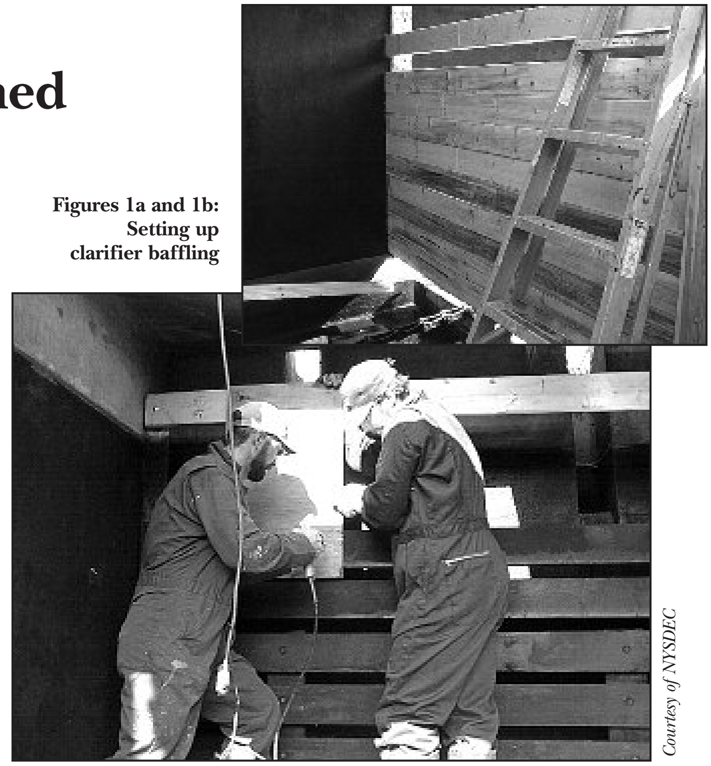
Phosphorus Workshop

The phosphorus workshop focused on chemical addition for phosphorus removal. The common aluminum and iron metal salts used for phosphorus removal were discussed, along with the advantages and disadvantages of each. In addition, operators worked with chemical addition worksheets to calculate starting chemical dosages, taking into account the normal biological uptake. The worksheet allows the operator to compare dosage and costs for each chemical.

Every 10 mg/L of suspended solids leaving the plant contains about 0.23 mg/L of phosphorus. By improving solids capture, treatment plants can reduce the amount of phosphorus being discharged. The workshop offered steps to help maintain stable plant operation, process adjustments to treat the wet weather high flow conditions common to all treatment plants and offered several low cost modifications to improve clarifier hydraulics through baffling ***(Figures 1a and 1b)***. The mid-tank baffle structure slows the velocity currents within the clarifier, providing a better settling condition within the clarifier.

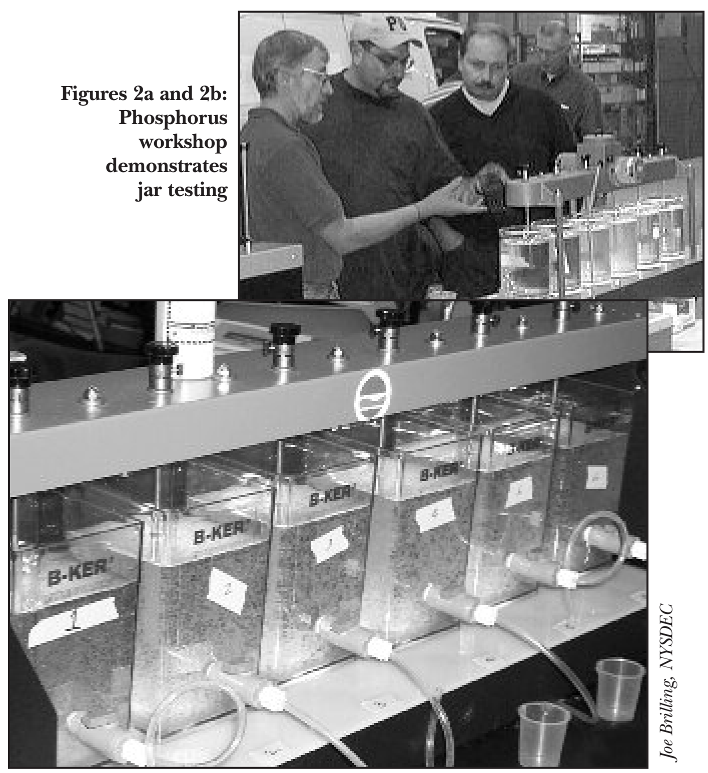
The highlight of the phosphorus workshop was the jar test demonstration ***(Figures 2a and 2b)***. Visually seeing fine particles come together into larger, settleable flocs and the effects of an under-dose

Figures 1a and 1b: Setting up clarifier baffling



Courtesy of NYSDEC

Figures 2a and 2b: Phosphorus workshop demonstrates jar testing



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and overdose condition reinforce the need for matching the chemical feed to the changing incoming loading. The jar test also demonstrates that more sludge is generated in the process, requiring additional sludge wasting and sludge handling. Using information from the workshop, some of the operators in attendance have completed short term, full scale chemical addition testing and have demonstrated they can meet the 2 mg/L total phosphorus optimization goal.

Nitrogen Removal

The nitrogen removal workshop focused on the nitrification and denitrification processes. To achieve consistent nitrification, the workshop focused on making sure the three key parameters are met:

1. Adequate aerobic mean cell residence time (MCRT)
2. Adequate dissolved oxygen
3. Adequate pH/alkalinity

The workshop provided a spreadsheet to help operators calculate the minimum MCRT needed given the conditions at their treatment plant. In addition, the workshop introduced some of the simple test kits that can be used to monitor and evaluate the nitrification process in a real time basis.

The second part of the workshop covered nitrogen removal through the biological reduction of nitrate to nitrogen gas (denitrification). One point of emphasis is even plants without nitrogen removal requirements may be able to save money and improve overall operation by establishing denitrification. The denitrification process returns part of the oxygen and alkalinity used up during the nitrification process. This reduces the overall aeration requirements and can reduce the alkalinity addition needed to buffer the system. By lowering the nitrate levels leaving the aeration tank, the operator also reduces the amount of denitrification and floating solids concerns that plague the secondary clarifier operation.

The workshop's practical focus was on modifying the treatment system to encourage some denitrification to occur. Operators in New York have done this by creating anoxic (low dissolved oxygen) zones using reduced diffusers and wall construction ***(Figure 3)***. Other plants have cycled the aeration to create intermittent aerobic and anoxic conditions needed for denitrification to occur.

The workshop covered additional denitrification requirements such as maintaining adequate nitrate recycle to the anoxic zone and evaluating the carbon source coming into the anoxic zone. Wet weather impacts, such as reduced detention times, excessive dissolved oxygen within the anoxic zone and reduced incoming carbon, were also discussed.

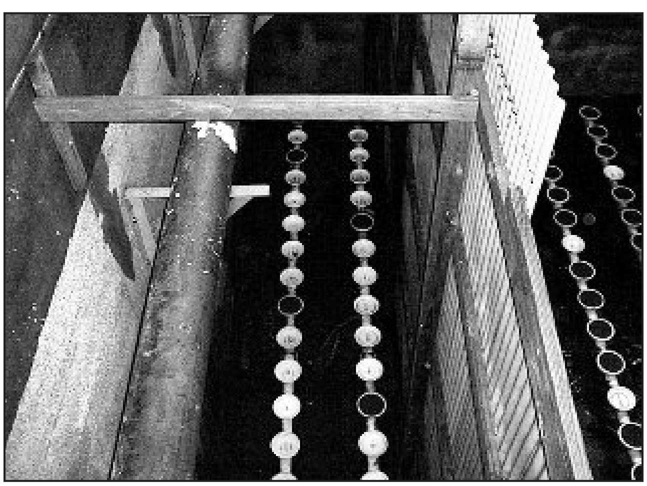
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Figure 3: Anoxic (low dissolved oxygen) zone

Filament ID and Control Workshop

Finally the filament identification and control workshop was geared to the activated sludge operators in the Chesapeake Bay watershed. Changing the treatment process to include nitrification and denitrification often result in changes to the activated sludge microbiology. An overgrowth of filamentous bacteria can impact plant operations and result in the loss of nutrient removal. Control methods New York operators have used, such as process adjustments, plant modifications and chemical addition, were covered.

Another filamentous bacteria problem related to nutrient removal is foaming. In severe cases, this foaming can result in solids loss and/or odor problems ***(Figure 4)***.


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Figure 4: Aeration tank foaming due to nocardioform overgrowth

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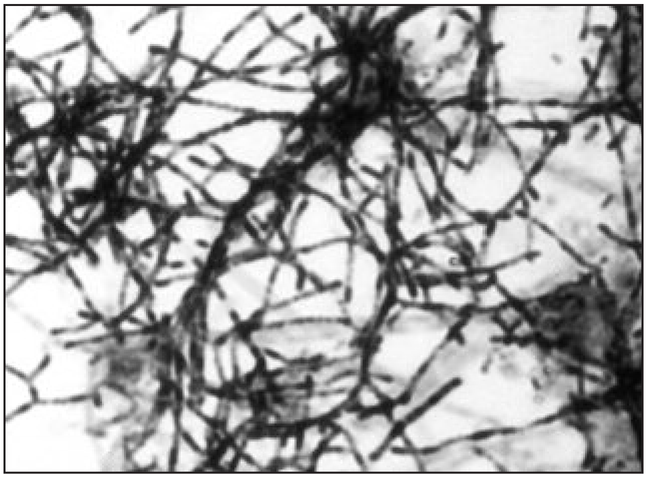

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Figure 5 (above): Micrograph of Nocardioform at 1000x magnification

The two main culprits for these foaming problems are nocardia or nocardioforms – a group of several bacterial genera that can cause foaming ***(Figure 5)*** – and Microthrix parvicella. Again, over the years, New York operators have developed many methods to control this growth. The methods covered in the workshop included a new foaming wasting method from the Andes WWTP using a shop vacuum to hose off nocardioform foam ***(Figure 6)***. Positive control of foaming allows the operator to run the plant for nutrient removal rather than foam control.

The workshops were designed to present simple, low cost, low energy consumption modifications that can help operations staff begin to develop some nutrient removal capability or identify the factors preventing nutrient removal. Testing and evaluating, before limits may be imposed, allow operators to learn from successes and failures and to identify the most cost effective approach to implementing nutrient removal.

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NYWEA

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Figure 6: Andes, NY Wastewater Treatment Plant's nocardiofoam removal