Environmental Business Specialists, LLC

EBS Consulting Site Visit Report
Paper Mill – Eastern United States
August 26, 2005

Introduction

On several occasions, I have spoken with the mill environmental engineer regarding nitrification issues with the activated sludge system and we recently conducted a laboratory evaluation on the system relative to nitrification. The purpose of this visit was to familiarize myself with the system to facilitate communication in the future and to determine how EBS may be of service to the mill. Dorothy DeCarli, EBS Consultant, accompanied me.

Current Situation

When I spoke with the mill about one month ago, the problem facing the mill was high effluent ammonia values due to difficulty in maintaining nitrification. Through a combination of corrective steps (feeding molasses, adding commercial nitrifiers, adding municipal sludge, adding hydrogen peroxide to the foul condensate, increasing the Basin pHs, adding liquid oxygen to Basin A2, and lowering the MLSS) and cooler temperatures, ammonia removal has improved and effluent ammonia levels are back below 2.0 mg/l. The prevailing thought is the increasing in WAS and RAS rates and the cooler temperatures had the greatest impact on recovery. While conventional wisdom says that lowering the sludge age (MLSS) hurts nitrification, there is also a strong possibility that keeping solids in the system, particularly the secondary clarifier, was resulting in sludge digestion and ammonia release. Regarding the effect of temperature, our lab work at this mill and another client shows that nitrification can occur at temperatures up to 110 F, but some efficiency is lost. I would also add that the increased pH may have been a significant contributor to recovery. My experience is that a higher pH (7.8 – 8.2) is required to re-establish nitrification than is required to maintain it (7.2 – 7.6).

Now that ammonia is back under control, another problem has arisen – effluent BOD. It appears that increasing RAS and lowering MLSS has contributed to increased effluent BOD levels. It also appears that Basin A2 is performing worse than A1, despite the liquid oxygen addition. Another consultant, Bob Stein, has been assisting the mill in evaluating the system and the impact of the oxygen addition. I will defer to him on this area. I spent most of my time on site evaluating the microbiology via microscopic examination and oxygen uptake testing. The goal was to determine if the BOD increase was related to a performance imbalance between the basins, insufficient aeration, flow or loading imbalance, or toxicity/inhibition.

I also reviewed the "Fishbone of Driving Forces" for the system with the mill. Using this approach allows us to isolate each of the drivers recognizing, however, that there is a great interrelationship among these facets of the system.

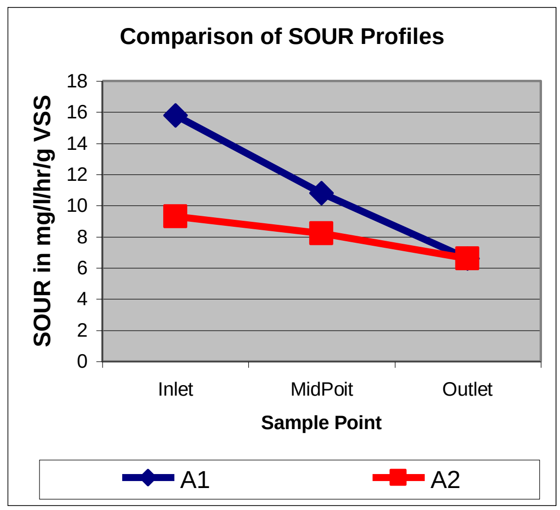
Results

Dissolved Oxygen Uptake Rate (DOUR) Profile

DOUR is a tool not routinely employed at this mill, but can be very useful in evaluating the health, viability, and effectiveness of aeration basin microbiology. The test is effectively a short term BOD test in which the higher the result the more biological activity in the sample. When the DOUR is divided by the grams of biomass (MLSS/1000 * % volatiles) the result is the Specific Oxygen Uptake Rate, which approximates the amount of work being down by each gram of biomass at that sample location. For a semi plug flow basin such as this one would expect there to be a drop in the SOUR across the basins as the BOD is consumed by the bacteria. One would also expect the SOUR profiles between the two basins to be similar.

The results of the DOUR/SOUR profiles conducted today are shown below.

	Basin A2 MLSS = 2810 mg/l VSS = 1.826 g/l	Basin A1 MLSS = 3270 mg/l VSS = 2.125g/l
Inlet End	DOUR = 17 mg/l/hr SOUR = 9.3 mg/l/hr/g VSS DO = 3.3 mg/l	DOUR = 33.6 mg/l/hr SOUR = 15.8 mg/l/hr/g VSS DO = 1.0 mg/l
MidPoint	DOUR = 15 mg/l/hr SOUR = 8.2 mg/l/hr/g VSS	DOUR = 23 mg/l/hr SOUR = 10.8 mg/l/hr/g VSS
Outlet	DOUR = 12 mg/l/hr SOUR = 6.6 mg/l/hr/g VSS DO = 4.3 mg/l	DOUR = 14 mg/l/hr SOUR = 6.6 mg/l/hr/g VSS DO = 3.3 mg/l



These results indicate a significant imbalance between the two basins. This could be related to some toxicity in Basin 2A. However, the foul condensate flow is evenly distributed, so there is minimal chance of that. Additionally, the RAS is mixed before it is put back in the basins, so any toxicity would impact both basins to some extent. There was a significant amount of septic solids stirred up when the aerator grid was restarted in A2 after the oxygen system was shut off, which may have had a temporary adverse impact on that basin. A more likely possibility is that there is a disproportionate amount of Lagoon flow going to A2, which would lower the influent BOD concentration by diluting the foul condensate. This would also shorten the hydraulic retention time. This may explain why the BODs are higher in A2 than A1. It would also explain the differences in SOUR profiles. Since the lagoon flow is not metered to the basin and the RAS is adjusted to equalize MLSS, it is possible that an imbalance could occur without anyone realizing it. While we can’t be certain this is the case, the data indicate that it is a situation worth considering, and addressing it is low risk.

Microscopic Examination

Overall, the biomass appears healthy with a moderate level of filamentous bacteria causing elevated SVI's in the 250 – 400 range. There were few higher life forms, probably related to the elevated temperatures which remain around 104 F. At these temperatures, the more advanced indicators (stalked ciliates and rotifers) tend to disappear. It should be noted that while the filaments would not be classified as abundant or excessive, most of the filaments are within the floc, which impedes settling and is particularly troublesome, since chlorination is less effective on filaments not extending outside the floc. The supernatant was quite clear, indicating minimal dispersed bacteria or pin floc. A few nitrifier colonies were observed.

Summary of Drivers

1. **pH/Toxicity**
    a. The foul condensate stream contains extremely high levels of methanol, which our lab work has shown to be severely inhibitive at concentrations above 500 mg/l on unacclimated biomass.
    b. While toxicity **may** be an issue at times, particularly with nitrifiers, the uptake rates and generally good BOD removal indicate viable bacteria.
    c. There is some suspicion among the operators that the peroxide is causing problems with the bugs, since there are no higher life forms. Based on the dosage and feed point, I do not believe the peroxide is affecting the biomass. The loss of indicators is probably temperature related and the relation to peroxide addition is coincidental.
    d. pH control appears acceptable.
2. **Food**
    a. Overall BOD loading appears acceptable, though there have been a few high days.
    b. There may be a loading imbalance as discussed above.
3. **Oxygen**
    a. The addition of liquid oxygen did not appear to help. Some data suggest there may have been a loss of treatment volume in A2 due to the first grid being shut off and the reduced mixing in that area of the basin.
    b. Elevated DOs in A2 is correlates to the higher BOD in that basin.
    c. The high DO levels in the effluent of each basin indicate that there is sufficient oxygen for BOD removal.
    d. Input from Sanitaire indicates the system should handle 10,800 – 15,000 pounds per day of BOD, which is rarely exceeded.
4. **Mixing and Flow Patterns**
    a. See discussion of flow distribution.
5. **Temperature**
    a. In general, optimum temperature is 65 – 95 F. Around 105 F, higher life forms disappear and clarity sometimes suffers.
    b. Nitrification is also adversely impacted by high temperatures.

6. **Time**
    a. Good BOD removal requires time. The increased RAS rates which improved ammonia removal may be adversely affecting BOD removal. Also, a flow distribution problem would aggravate the problem in the basin getting more flow (A2).
7. **Nutrients**
    a. This does not appear to be an issue for phosphorus and certainly not for ammonia.
8. **Biomass**
    a. In general the biomass appears healthy, though the unusual SOUR profile in A2 **could** be related to some unusual situation.
    b. Increasing MLSS is a standard cure for improving BOD removal. In this case, recent history dictates that increases in gains in BOD removal be weighed against any increase in ammonia. This is critical because every mg/l of ammonia in the effluent will more likely add 4.2 mg/l of nitrogenous BOD to any "regular" BOD in the sample.

Suggested Action Items

1. Gradually reduce RAS from clarifiers watching for any increase in ammonia in effluent.
2. Adjust gate valves to increase flow to A1. Utilize DOUR test to see if balance is improved. What we would like to see is the Inlet SOURs become similar without the effluent SOURs going up. If your operators are going to run DOUR, I will be happy to coach them. My cell number is (985) 674-1737.
3. Add the 50 lbs of commercial bacteria on hand (25 lbs today and 25 lbs on Saturday)
4. Consider adding sludge from the city as long as it does not contain excessive filaments. Use clarifier underflow to get the most "bugs per gallon." Do not use digester sludge since it tends to be high in ammonia. See comment below about commercial bugs versus city bugs.

Additional Comments

1. We discussed running nitrate on aeration basin supernatant rather than the clarifier effluent. Due to the great potential for denitrification in the clarifiers, the aeration basin supernatant will give you a much better indication of nitrification.
2. EBS has resiprometry capabilities that may be of use to the mill for either looking at current potential issues with foul condensate or in assisting in determining the feasibility of pretreating of foul condensate in the out of service stabilization tanks.
3. Paul Klopping and I will be conducting our annual Pulp and Paper Activated Sludge course at our new lab and training center in Mandeville, LA on November 9 – 11. Information is available on the EBS website at www.ebsbiowizard.com.
4. Trucked in sludge typically has a viability of $1x10^6$ to $1x10^7$ cfu/g or between $1.5x10^{13}$ and $1.5x10^{14}$ "bugs per truck. A 25 pound bucket of typical five billion count commercial bugs contains $5.7x10^{13}$ bugs, so it works out that a bucket of bugs is about equal to an average truck of sludge. Depending on convenience, trucking cost, and municipal sludge quality, commercial bacteria may be appropriate if you decide to add bugs.

Summary of Driving Forces