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AOX/COD Removal in an ASB

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ABSTRACT

AOX and COD samples were taken at the inlet and outfall of the Georgia-Pacific Brunswick ASB. Twenty-four hour composites were processed in three different ways: (i) as is, (ii) coarse-filtered, and (iii) filtered again through a 500 Da cut-off filter. The double:coarse filtered ratio decreased sharply for COD, but not for AOX, suggesting that only 15% of AOX is biodegraded in the water column. This value was confirmed by comparing the outfall data with results from samples taken from the front end of the pond.

Studies on the fate of AOX in secondary treatment systems have suggested degradation under both aerobic (1,2) and anaerobic (3,4) conditions, settling (3,4), and chemical degradation (5). While it is certainly possible that all of these mechanisms play a role in AOX removal, quantitating the contribution of each process is important toward optimizing AOX removal. In a study with radioactive tracers, Williams and Banerjee (6) showed that only about 15% of AOX was removed biologically from the water column at the aeration stabilization basin (ASB) at Georgia-Pacific's Brunswick, GA, mill, which reports an overall removal of 45-50%. We now confirm this value in a completely independent approach, and demonstrate that AOX is principally removed either very early in the ASB, or even prior to entry into the ASB.

Description of the Georgia-Pacific Brunswick mill

The mill pulps both hardwood and softwood in 19 digesters, 8 for hardwood and 11 for pine. The capacity is 48 tons A.D. chips for the 11 small digesters, and 78 tons A.D. chips for the eight large digesters. Three bleach lines are run; two process pine, and one swings between hardwood and pine. Total production is about 2150 tons/day. The sequence used is D-Eop-D-Ep-D. A Dorr-Oliver primary clarifier with a holding capacity of 12.3 million gallons is operated at a rate of 20-24 million gallons/day. Secondary treatment occurs in a 12-acre presettling basin, a 137-acre aeration lagoon, and a 6-acre settling lagoon, for a total retention of 6 days. The aeration lagoon has 61 surface aerators. Total flow to the river is about 35 mgd.

AOX and COD analyses

AOX and COD data were acquired at the inlet and outfall of the ASB, and, on two occasions, at locations at the front end of the ASB. Twenty-four hour composite samples were collected and processed in three different ways: (i) as is, (ii) coarse-filtered (CF) through a 0.8 μ fiberglass filter, and (iii) filtered again through a 500 Da cut-off filter (DF: double-filtered). COD was determined at the mill; AOX was run at Triangle Laboratories at Research Triangle Park, NC.

Results and Discussion

The COD profiles are provided in Figure 1. The black bars are for the whole samples; the hatched bars represent the CF material; and the clear bars stand for the DF samples. The DF samples represent the potentially biodegradable fraction, since compounds larger than 500 Da cannot easily penetrate the microorganism. As expected, the variability decreases from the inlet to the outfall because of mixing in the pond. Approximately 20% of the inlet COD is particulate (unfiltered minus CF); this drops to 6% at the outfall, presumably because of settling. The CF and DF COD average to 1196 ppm and 570 ppm, respectively. The difference, 626 ppm, represents non-biodegradable COD. This value compares well to the average outfall CF COD of 600 ppm. Hence, approximately 43% of the inlet dissolved COD is biodegradable; the remainder traverses the pond relatively unhindered. The ratio of

DF:CF COD decreases across the pond as shown in Figure 2 as the biodegradable fraction is removed.

The AOX profiles illustrated in Figure 3 are very different from those for COD. Only 11% of the inlet AOX is of high molecular weight (>500 Da). The ratio of DF:CF AOX decreases to a much smaller extent across the pond as shown in Figure 4, demonstrating that the DF fraction decreases only slightly faster than the CF. The decrease would have been much sharper for the DF material if biodegradation was a major removal mechanism. The small decrease in the inlet:outfall ratio in Figure 4 translates to about 15% biodegradation in the water column, which is the value reported independently by Williams and Banerjee (6).

Samples for AOX analysis were collected on two occasions at two additional sites (aerators 23 and 28) located at the front end of the pond. The results are compared to inlet and outfall AOX in Table 1. Clearly, most of the decrease takes place before the AOX reaches the two aerators, which indicates that most of the reduction occurs in the pre-settling zone and/or early in the pond. The decrease in CF AOX from the two pond locations to the outfall is 13%, only slightly lower than the 15% value inferred earlier. Thus, three independent lines of evidence: the Williams and Banerjee radiotracer study (6), the DF:CF AOX ratios, and the decrease in AOX from locations early in the lagoon to the outfall all support an approximately 15% AOX biodegradation in the water column of the Brunswick ASB.

Comparison of inlet and early-pond AOX reveals a decrease of more than 40%. Only a small fraction of this can be attributed to biodegradation, since the DF:CF ratio is relatively constant. Volatilization probably accounts for a small fraction of the loss, but most of the organochlorine generated is relatively involatile. The two possible remaining mechanisms are chemical degradation and settling, and evidence to distinguish between the two is presently unavailable. It is interesting that while the whole:CF COD decreases from 1.28 at the inlet to 1.06 at the outfall as particulates settle out, the opposite is true for AOX where the whole:CF ratio increases slightly from 1.06 to

	whole	CF	DF	DF/CF
inlet	9.33	8.85	7.85	0.89
aerator 23	5.36	5.09	3.99	0.77
aerator 28	5.53	4.98	3.77	0.76
outfall	4.74	4.27	3.41	0.80

1.11. Larrea et al. (7) have observed that 18% of Kraft lignin condenses to particulate material during aeration. If condensation also occurred for AOX, then the increase in the ratio could be explained.

Finally, our results are to be compared with the results of Aprahamian and Stevens (8) who compared influent and effluent AOX and TOC in a 70% ClO₂ substituted mill both before and after filtration through a 1000 Da membrane. Their TOC reductions of 76% (whole) and 45% (filtered) across the pond compares well to our corresponding COD values of 79% and 48%, respectively. However, their decrease in AOX (63% filtered, 40% whole) differed from ours (57% filtered, 50% whole). Possibly, this could represent the difference between partial and complete ClO₂ substitution.

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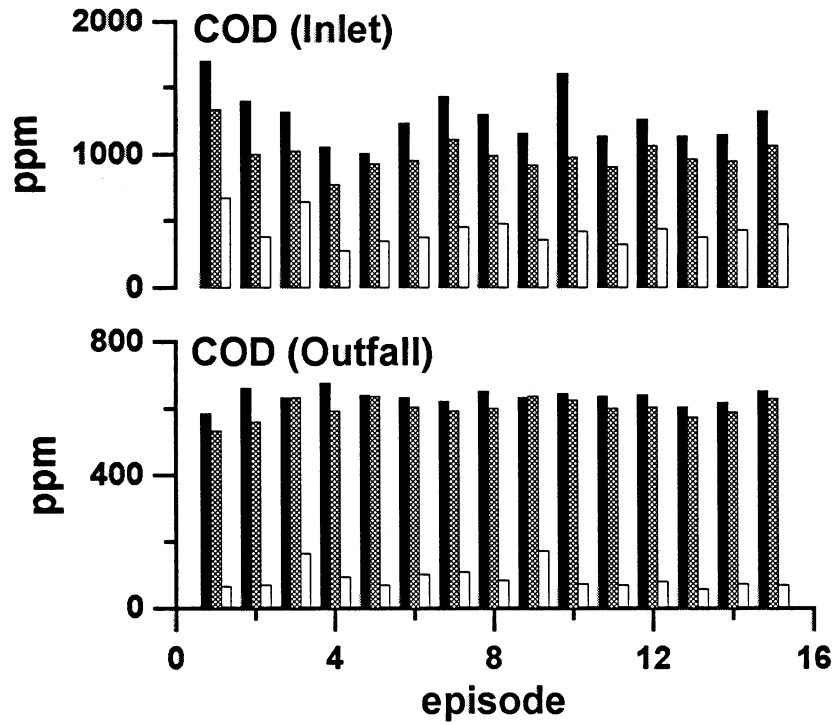


Figure 1: Whole (black), coarse-filtered (hatched), and double-filtered (clear) COD

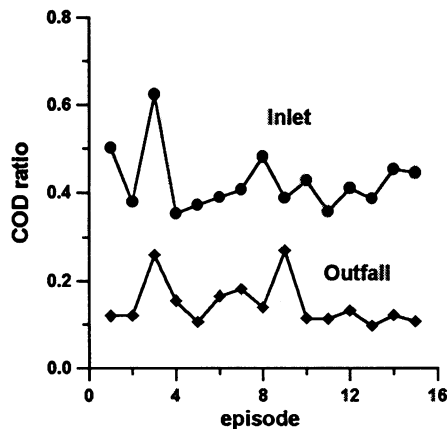


Figure 2: Ratio of DF:CF COD

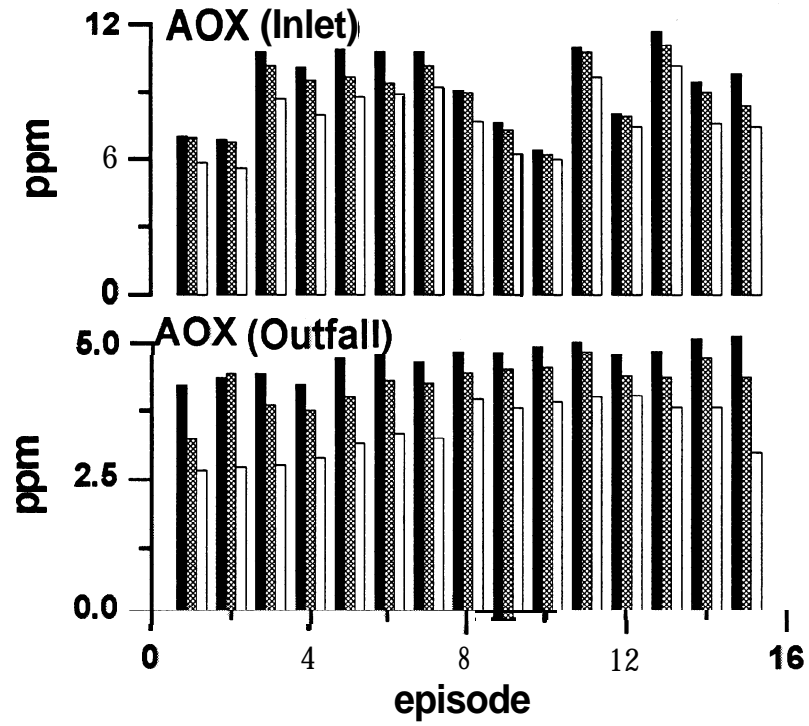


Figure 3: Whole (black), coarse-filtered (hatched), and double-filtered (clear) AOX

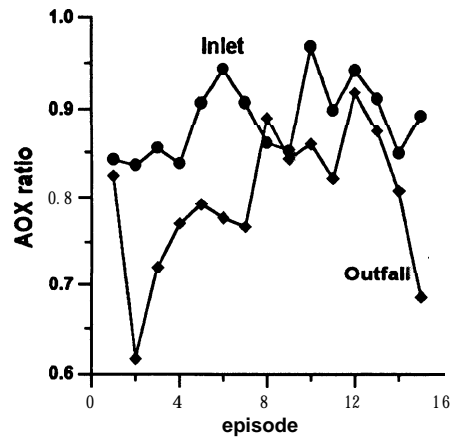


Figure 4: Ratio of DF:CF AOX

