Integrated Waste Management: A Conceptual Design for the Confined Swine Industry

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The phenomenal growth of the confined livestock industry in the United States has allegedly contributed to odor problems, surface and groundwater pollution, nutrient enrichment of the Chesapeake Bay and the Gulf of Mexico, and the proliferation of the toxic dinoflagellate *Pfiesteria piscicida*. Furthermore, recent studies indicate significant volatilization of ammonia to the atmosphere from confined livestock operations (Aneja et al 1999). As a result of these escalating problems (perceived and real), integrators and operators of large confined livestock facilities will be required to develop and submit waste management plans.

A conceptual design for a proposed demonstration at a commercial swine facility has been developed by TVA scientists and a commercial technology firm, BioConcepts Inc., N. Carolina. In addition, EPA and TVA scientists are collaborating on treatability studies to further refine design and operating protocols for wetlands-based treatment systems for treating high strength animal wastes. The aforementioned design is based on preliminary results from a TVA pilot-scale waste management system for treating high strength wastewater from a recirculating tilapia aquaculture system (Figure 1). Fish manure and wasted feed are continuously removed from the recirculating system by a 60 micron screen filter (Hydrotech HD 501 Microscreen Drum Filter, Water Management Inc.), and stored as a liquid slurry. The slurry (10-14% solids, v:v) is batch loaded every four hours to either an intermittent sand filter, or to the influent manifold of a dual reciprocating subsurface-flow wetland system (TVA patented technology). Underdrain water from the sand filter is also treated in the reciprocating system. The dual reciprocating system has a calculated hydraulic retention time and is loaded with high strength wastewater at a rate equivalent to 512 lbs. BOD5/acre/day.

The integrated system has been operational since March 1999; weekly sampling of water quality was initiated in April. High percentage removal rates for BOD_5 and nutrients have been stable (Table 1), despite indications that the first reciprocating cell is beginning to plug with organic solids. Of special interest is the efficacy with which the second reciprocating system is removing residual phosphorus. We surmise that phosphorus is being removed via both biological nutrient removal and precipitation of low-solubility calcium phosphate compounds (notice reduction of total alkalinity due to off-gassing of CO_2).

Work is continuing with respect to using intermittent sand filters to remove and compost the organic solids. This should significantly extend the life of the reciprocating wetlands and allow for designs with shorter HRT's. Based on these preliminary results, it is anticipated that the system can provide significant and sustainable reductions in odor, biochemical oxygen demand (BOD5), nitrogen and phosphorus. High value ornamental crops, including trees, shrubs and cut flowers can be produced in the reciprocating wetland cells to help offset capital and operating expenses.

The treatment system being proposed here can be applied to the confined swine industry, and is based on the serial integration of flushing gutters, gravity clarifiers, intermittent sand filters for fine solids removal, and the patented reciprocating sub-surface flow constructed wetlands. The reciprocating technology (Behrends et al. 1996), has been licensed to BioConcepts Inc., Oriental, N. Carolina to practice the technology in North Carolina in the fields of municipal and animal waste management (email: info@bioconceptsinc.com).

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Table 1. Average influent and effluent parameter values for an experimental two-stage reciprocating system for treating high strength wastewater from an intensive tilapia aquaculture system. Loading rate equivalent to 512 lbs. BOD5/acre/day.

Parameter[1]	**n**	**Influent (#2)**	**Effluent ReCip 1**	**Effluent ReCip 2**	**Change(%)(Inf / ReCip 2)**
BOD_5 (mg/L)	5	827	23	7	99
Total N (mg/L)	5	53	3.6	3.8	93
Total P (mg/L)	5	45	23.5	9	80
D.O. (mg/L)	27	0.6	0.7	4.4	863
ORP (millivolts)[1]	18	-359	-365	+135	-
pH (unitless)	27	6.5	6.8	7.4	12
Temp (^oC)	27	24.4	24.4	24.7	-
Alkalinity(mg/L as $CaCO_3$)	8	168	345	287	41
Specific cond. (umhos/cm)	16	651	810	702	7.3

- Mean values are based on 5-8 weekly observations or 16-27 daily observations.
- Calomel reference electrode; add 244 to convert to H2 reference electrode.

References

Aneja, V.P., J.P Chauhan, and J. Walker. 1999. Ammonia Emission and Deposition. In: Havenstein, G.B (Editor), 1999 NC State University Animal waste Managment Symposium. Pp. 80-84.

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