Waste Management of Sediment Laden Effluent Streams Generated by Intensive Recirculating Aquaculture Systems

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INTRODUCTION

Intensive recirculating systems are receiving serious consideration as replacements or complements to extensive (pond) production systems. Environmental concerns, water resource shortages, and production problems associated with pond systems have pressured the industry into considering the new technologically complex recirculating approach. Widespread adoption of recirculating systems has been inhibited by economic realities as the science of recirculation is refined. However, a number of commercial tilapia, channel catfish (Ictalurus punctatus), and hybrid striped bass (Morone saxatilis), intensive growout systems of large capacity have been built. Demonstration of the economic viability of large (million pound capacity) production systems can be anticipated within a few years.

One of the claims of the recirculating proponents, i.e. that recirculating systems eliminate environmental impact, has been appropriately challenged by extensive system supporters who have raised the issue of the handling of sediment laden wastewaters produced by virtually all recirculating systems. This paper addresses itself to the magnitude of this problem and overviews technological approaches for its resolution.

BACKGROUND

Virtually all recirculating systems developed for finfish production discharge system waters at a slow rate to avoid problems with mineral build-up. Except in areas where nutrient enrichment of receiving waters is a concern, these waters pose little environmental threat as the internal water quality (total ammonia nitrogen <1 mg-N/l; biochemical oxygen demand < 10 mg/l) must be high to assure production. However, all recirculating systems control total suspended solids levels (Chen and Malone, 1991) by employing capture processes, such as clarifiers, sand filters, or screens, which are periodically cleaned resulting in a low volume effluent rich in solids.

The fate of the biochemical oxygen demand (BOD) was examined utilizing information from Wheaton (1977) and Wimberly (1990). The analysis (Figure 1) shows

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that 3/4 of the potential demand is expressed in the system through the metabolic activities of the fish and by the bacteria attacking the wastes circulating in the system. Twenty-five percent of the BOD leaves the system in the form of captured solids or as biofloc originally generated in the biofilter. This sludge discharge represents the main environmental threat posed by recirculating system.

The magnitude of the problem can be estimated for a hypothetical 2 million gallon production system with a peak holding capacity of approximately 1 millon pounds of fish. Assuming stocking is staggered to assure continuous production, the facility would hold about 500,000 pounds of fish at any time. Fed at 2 percent of body weight, the system would generate a sludge discharge of about 75,000 gallons/day with a TSS level of 7,000 mg/l and a BOD strength in the order of 1,000 mg/l. This discharge is comparable to the raw sewage discharge from a small community of 3,000 - 6,000 people.

Fortunately, the partially stabilized nature of the waste is conducive to treatment. Several recognized treatment combinations can be employed to complete stabilization of the sludge, allowing final recycling through land application. Figure 2 illustrates a treatment approach consisting of a clarifier, a sludge digestion unit, and a tertiary polishing unit capable of treating both the exchange waters and the backwash (or washdown) waters from the system. Table 1 summarizes the approximate sizing for our hypothetical million pound production facility (Metcalf and Eddy, 1979; Poon et al., 1986; EPA, 1988; Reed, 1991). The authors find the secondary clarifier, aerobic sludge digestion lagoon, and sand filter combination particularly attractive because of its reasonable cost and moderate land requirements.

CONCLUSIONS

From this examination, it can be concluded that the sludge line discharges can indeed pose a significant threat to natural receiving streams if left untreated. Viable treatment options for addressing this problem are available. However, precise design criteria for treatment of sludges generated by aquaculture facilities do not exist. Demonstration-scale studies should be undertaken to prevent gross sizing errors with major production facilities.

REFERENCES

1. Chen, S., R. F. Malone. 1991. Suspended Solids Control in Recirculating Aquacultural Systems. In proceedings of Aquaculture Symposium: Engineering Aspects of Intensive Aquaculture, in press.

2. Environmental Protection Agency (EPA). 1975 Process Design Manual for Suspended Solids Removal, U. S. EPA Technology Transfer Publication.

FIGURE 1
FATE OF BOD ASSOCIATED WITH FEED

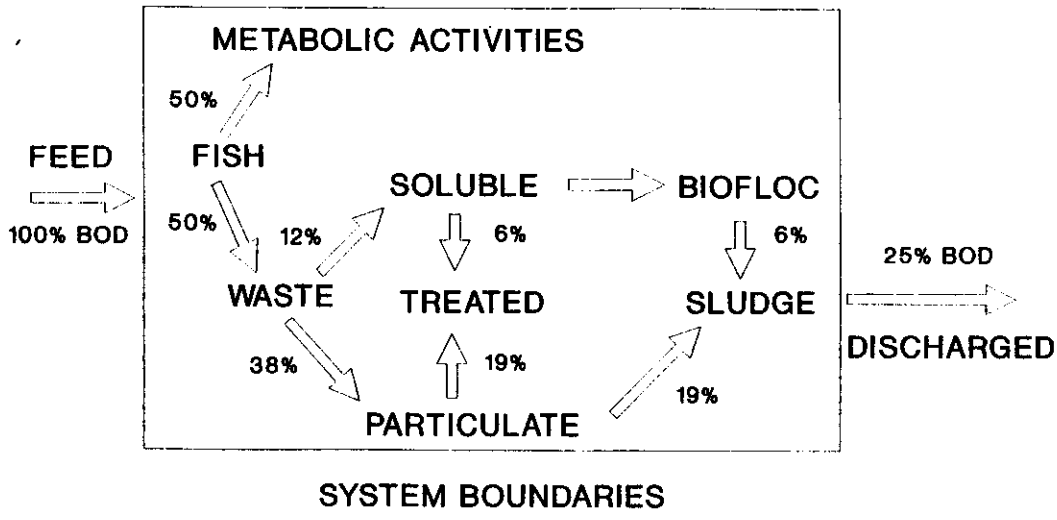

FIGURE 2
PROPOSED SLUDGE TREATMENT SYSTEM