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Solids removal in a recirculating aquaculture system where the majority of flow bypasses the microscreen filter

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Abstract

Solids capture in a sedimentation basin in the lower portion of an external standpipe was compared with solids capture by the drum filter (DF) in a commercial recycle aquaculture system (RAS) with dual-drain culture tanks equipped with sidewall and bottom-center drains. The system had a unique combination of features: sidewall drain effluent, 79% of total from the culture tank, that by-passed the drum filter; center drain effluent of each tank discharged into an external standpipe that functioned as a simple sedimentation basin; daily freshwater inflow was only 1.6% of total system volume, and the waste effluent from the culture building discharged to a septic tank with a perforated tile line that terminated in a pond. The high-pressure backwash spray of the drum filter operated 36% of the time and contributed 40.6% of septic tank inflow. The external standpipe contained three lengths of pipe (a triple standpipe, TSP). It was flushed manually by pulling one of the three standpipes for 10 s once per day. At the start and end of two 27 d intervals, samples of effluent from the DF and TSP were captured from the septic inlet that was exposed immediately following draining of the septic tank. Flushing the TSP (0.34 m^3) contributed 59.4% of total inflow to the septic tank and contributed solids that had accumulated in the quiescent zone below the shortest of the three standpipes. TSP accounted for 83.2% biochemical oxygen demand (BOD), 71.4% TN, 82.1% total phosphorus (TP), 66.1% suspended solids (SS), 64.1% total dissolved solids (TDS) and 86.5% total suspended solids (TSS) of the total volume of effluent water quality parameters discharging to the septic tank. Only 21% of recirculating flow went through the microscreen of the drum filter. The case

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study demonstrated the value of an inline sedimentation basin to remove heavy solids and reduce loading of the drum filter.

Keywords: Recirculating system; Triple standpipe; Drum filter; Largemouth bass; Hybrid striped bass; Rainbow trout; Walleye

1. Introduction

Rapid removal of solid wastes (i.e., particulates from waste feed and feces and biofilter floc) is the most critical unit process in a recirculating aquaculture system (RAS). Organic particulates may compromise gill function and nourish facultative fish pathogens, as well as contribute to biochemical oxygen demand (BOD), and provide substrate for growth of heterotrophic microorganisms in the biofilter that displace the nitrifying bacteria (*Nitrosomonas* and *Nitrobacter*) essential for conversion of ammonia to nitrate.

In a culture system with circular culture tanks, the tanks are first in the sequence of components for capture of solids. Given an appropriate tank diameter to depth ratio, an effective flow injection mechanism and adequate rotational velocity of flow, the primary rotating flow creates a secondary radial-flow that rapidly transports settleable solids to the center drain. Thus, a major positive feature of circular tanks is that they are self-cleaning and rapidly concentrate and remove settleable solids (Timmons et al., 1998).

When the total flow from the culture tank exits through the central drain, solids removal (e.g., bead or microscreen filter) must be scaled for the total effluent, which is contrary to the recommendation that ‘‘water flows should be managed to concentrate solids in a small portion of the total flow for the system’’ (Timmons et al., 2002). Dual-drain tanks have been designed to separate the effluent water that is low in solids from a smaller flow that is high in solids; the majority of flow to be removed through an elevated drain located either at the center of the tank (two-center outlets) or at the tank sidewall (sidewall and center outlets). Lunde et al. (1997) patented a dual-drain tank with two center outlets; it has an annular plate fixed above the bottom-center drain to capture solids in a small flow and a second drain just above the bottom-center drain for withdrawing a larger volume of water relatively low in solids (Losordo et al., 2000). The Cornell-type dual-drain tank has a bottom-center drain to capture solids and a sidewall drain that carries the majority of flow with low solids content (Summerfelt, 1995; Summerfelt et al., 2000).

In systems with dual-drain tanks, a smaller volume of flow that contains concentrated solids will go to the drum filter (DF); however, because solid waste removal by filtration is a major capital cost, and it also demands electrical energy and water for intermittent use of the high-pressure backwash pump, it is desirable to remove a large portion of the solids from the bottom-center drain of a dual-drain tank in advance of the filter. The AquaOptima AS culture system employed an inline swirl separator to reduce the solids load to the drum filter, which reduced the frequency for back-flushing the drum filter (Losordo et al., 2000).