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DEVELOPMENT OF A FLOW-DRIVEN, SELF-ROTATING TANK DEPOSIT REMOVER FOR GROUPER NURSERIES

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ABSTRACT

Tank hygiene is an essential aspect for successful fingerling production but can involve substantial workload to maintain. The purpose of this research is to develop and test a new version of a flow-driven, self-rotating tank deposit remover to automatically and quickly remove the deposit for grouper nurseries. The deposit remover has a suction tube lying on the bottom of the tank. Water flowing through the suction tube drives a propeller to rotate the tube while sucking up the solids on the bottom. Previous versions of the deposit remover suffer from incomplete solid removal and a long operating time. An integrated nozzle/scraper assembly is introduced to improve the water inlet of the suction tube. A new gear box is designed to reduce the footprint by one-half and to align the input and output shafts for better balance. Modifications are made to the pivoting pipe elbow to achieve a uniform spacing between the suction tube and tank bottom and to eliminate solid accumulation surrounding the pipe. Optimum configurations of the propeller and the scraper are determined by experiment. The results show that the new deposit remover could remove more than 93% of size 0 and 3 feeds in one turn and could remove all the size 0 feed in 4.3 min and size 3 feed in 2.6 min at a flow rate of 1.77 L/sec. The removal speed is five times faster than the previous version making it a practical tool for the automatic bottom cleaning of grouper nursery tanks.

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I. INTRODUCTION

Grouper production is currently the most important marine fish production in Taiwan's aquaculture (Fisheries Agency, 2016). At nineteen thousand tons per year and a value of 5.3 billion NT, it ranks number two in the world grouper production. The grouper production in Taiwan is divided into brood stock, hatchery, nursery, and grow out stages with many small farms each focusing on one stage forming a unique infrastructure of grouper production (Yang, 2017). The production of juvenile groupers from the larvae to the fingerling stage is a critical period of grouper production because of viral diseases (Kokawa et al., 2008; Ma et al., 2012). Mass mortality has prompted many farmers to use indoor recirculating aquaculture systems (RAS) to grow the fingerlings (Lee, 2012). However, in the indoor high density production environment, cannibalism becomes a problem (Hseu, 2004). To mitigate cannibalism, the grouper fingerlings are commonly cultured in small floating cages in the culture tanks to separate the fish by size (Sheen et al., 2014). These floating cages would interfere with the circular flow pattern in the tank to eliminate secondary flow, so that the solid deposits could not move to the center drain of the tank and instead would scatter over the bottom of the tank. The accumulation of deposits encourages bacterial and protozoa proliferation causing fish diseases and reduced survival rate (Chen, 2011).

Cripps and Bergheim (2000) reported that quick removal of the particulate material could effectively reduce organic matters. To maintain tank hygiene for successful fingerling production, daily cleaning to remove the settled solids is necessary (Müller-Belecke et al., 2015) but would cost much labor and water resource in grouper nursery production. The development of automatic cage-bottom solid collectors and self-rotating deposit removers in this laboratory provides a solution to this problem (Yanz, 2010; Chen, 2011). It has been demonstrated that effective removal of the settled solids in the tanks by the automatic devices could reduce not only ammonia concentration but also bacterial count, thereby improving the survival of the fingerlings (Chen, 2011).

The development of the self-rotating deposit remover in this lab has lasted for more than eight years and has gone through many versions (Chen, 2011; Lin, 2013; Chen, 2015). It is envi-