NITRIFICATION AND THE IMPACT OF ORGANIC MATTER IN FIXED-FILM BIOFILTERS: APPLICATION TO RECIRCULATING AQUACULTURE SYSTEMS

Abstract

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Inhibition is significant within fixed-film nitrification process in wastewater treatment systems with high carbonaceous material due to the competition between heterotrophic and nitrifying bacteria for limited oxygen and space. The inhibition of organic matter to the nitrification process becomes more critical in recirculating aquaculture systems that contain a low concentration of ammonia and a high concentration of organic matter. Quantitative information on the effect of organic matter upon nitrification is insufficient. Additionally, application of results from pure culture systems to biofilter design can lead to inaccurate estimations. In this research, the effect of organic matter on nitrification biofilters was investigated experimentally with a lab-scale reactor series system and theoretically with a mathematical biofilm model. To extend this research to aquaculture system design and operation, the results from the lab-scale study were compared with pilot and commercial scale systems and biofilter design recommendations were provided for cold water aquaculture systems. The results from these studies showed that the biofilter nitrification rate decreased exponentially with increases in COD/N ratio although

the degree of inhibition on nitrification varied with different types of biofilters. Taking into account these results, a mathematical biofilm model was developed to demonstrate the inhibition due to addition of organic matter on nitrification and a simplified analytical solution was obtained for practical applications. A correction factor of 0.2~1.0 representing the effect of organic matter and a correction factor of 0.2~0.9 associated with the effect of system scale-up were recommended when the nitrification design equations resulted from a pure culture measurement were applied in the design of commercial scale biofilters.