

Abstract

Recirculating aquaculture system (RAS) is a land-based water treatment technology, which allows for farming aquatic organisms, such as fish, by reusing the water in the production (often less than 5%). These systems result from the need of more intensive practices, growing environmental constraints on water consumption and effluent quality, as well as the possibility to supply fish in places where it would be otherwise difficult. RAS technology is based on the use of filters, either mechanical or biological, and can, in principle, be used for any species grown in aquaculture. Due to the low recirculation rate, ammonia accumulates in the system and must be converted into nitrate using nitrification bioreactors. Although less toxic for fish, nitrate can also be further reduced into nitrogen gas by the use of denitrification biofilters which may create several issues, such as incomplete denitrification, resulting in toxic substances, such as nitrite and nitric oxide, or a waste of carbon source in excess. In this thesis an in-depth study of a RAS is provided and optimal operation conditions are determined by using a simulator developed in MATLAB[®]. Using this simulator, a global assessment of the plants nitrate controllability using acetic acid as manipulated variable is done and two different control methodologies are implemented: a classical PID control and a simple model-based linearizing control. A new PID tuning method based on the estimated amount of ammonia excreted by the fish and the SIMC tuning method is proposed, and the robustness of the linearizing controller is improved by cascade and adaptive control strategies. To test these methodologies before applying them to the industrial case-study, a smaller pilot scale plant was designed and built. Ammonium carbonate was added to simulate the presence of fish and facilitate the plants operation. The setup was capable of converting the required quantity of nitrate and nitrate conversion efficiency was estimated.