International Journal of Recirculating Aquaculture

Using the Pond as a Biofilter: Review of Theory and Practice

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ABSTRACT

Intensive aquaculture systems are being used to efficiently produce fish and shrimp. However, an intrinsic problem of these systems is the rapid accumulation of feed residues, organic matter and toxic inorganic nitrogen species. This cannot be avoided, since fish assimilate only 20-30% of feed nutrients. The rest is excreted and typically accumulates in the water. Often, the culture water is recycled through a series of special devices (mostly biofilters of different types), investing energy and maintenance to degrade the residues. The result is that in addition to the expense of purchasing feed, significant additional expenses are devoted to degrade and remove two thirds of it. There is a vital need to change this cycle. One example of an alternative approach is active suspension pond (ASP) systems, where the water treatment is based upon developing and controlling heterotrophic bacteria within the culture component. Feed nutrients are recycled, doubling the utilization of protein and raising feed utilization. Other alternatives, mostly based upon the operation of a water treatment / feed recycling component besides the culture unit are also relevant. Active suspension ponds are being practiced and their numbers have increased dramatically during the last 10 years, most notably with shrimp culture. The purpose of this paper is to raise discussion on alternative routes to the classical recycling approach.

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The Role of 'Aquaponics' in Recirculating Aquaculture Systems

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ABSTRACT

Recirculating aquaculture systems (RAS) are designed to recondition "used" fish water so that it can be recycled back into the fish-rearing tank(s). These systems have become popular because of the ability to control water parameters, their high-density rearing capabilities, and their potential for water conservation. Because of the accumulation of nutrients in these systems, they offer an underutilized resource for persons willing to transform an existing RAS into one that integrates plants. A secondary crop of plants can add to the system's profit, with little overhead cost. The reduction of certain nutrients by the plants can also benefit the system by reducing or eliminating expensive filtration components. These integrated systems have gained recognition by researchers and commercial users alike, and have stimulated the interest of many because of their resource-efficient and "eco-friendly" status.

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Performance Characteristics or Rotating Biological Contactors within Two Commercial Recirculating Aquaculture Systems

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ABSTRACT

Biological filtration is a critical determinant in the process train design of a recirculating aquaculture system. In addition to the mechanical and biological efficiency of the biofilter itself, this process must be co-developed with the various interrelated technologies involved in water quality control. This study describes the performance of rotating biological contactors as an integral part of two commercial closed recirculating fish production systems. Data is presented from replicated systems employing paddlewheel-driven rotating biological contactors.

The RBC is a robust fixed-film bioreactor demonstrating excellent operational attributes in recirculating aquaculture systems. The efficiency of the RBC as biofilter is defined according to its mechanical and biological performance characteristics. In addition to highly efficient nitrification of ammonia under heavy feeding conditions (1.21 g/m2/day), the RBC has significant influence on control of secondary water quality and hydraulic considerations affecting the overall design and performance of the system. RBCs off-gas carbon dioxide, providing a level of pH control, a significant benefit in closed recirculating systems. Additional data is presented for carbon dioxide sparging efficiency, and the capacity for versatile hydraulic loading and low-head operation.

This paper also provides a practical comparison of RBC design and performance considerations with other biofilter options, including the effects of design on the mechanical reliability, energy requirements, and spatial efficiency of this biofiltration system.

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Total Gas Saturation Considerations for Recirculating Aquatic Systems

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ABSTRACT

Zebrafish (*Danio rerio*) are now widely used in aquatic research facilities for genetic and vertebrate development studies. Most of these facilities utilize recirculating systems for zebrafish production. Dependable production of high quality fish is of vital concern in these recirculation systems as these fish are valuable and in many cases irreplaceable in terms of their significance to the research being conducted.

Water quality is of utmost concern in zebrafish systems. One critical parameter that has received attention in these facilities is that of total gas pressure. Under abnormal conditions, the partial pressures of dissolved gases in the water can be greater than saturation. When this is the case, there is a potential for problems with gas bubble trauma and an increasing chance for secondary microbial infections. This paper discusses total gas supersaturation theory, problems associated with supersaturation, methods of monitoring total gas pressure, and ways that gas bubble problems can be prevented in recirculating aquatic systems.

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Intensive Zero-Exchange Shrimp Production Systems - Incorporation of Filtration Technologies to Improve Survival and Growth

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ABSTRACT

Cost effective application of superintensive, biosecure, marine production systems in the US will depend upon proactive management of culture water quality. More efficient production practices and effective management of waste materials from the shrimp aquaculture industry can allow for higher productivity, improved growth and survival, and pave the way for eventual application away from coastal areas. These improved production strategies are key factors contributing to profitability and environmental sustainability. Development of cost-effective management strategies includes application of mechanical and biological filtration devices to remove solids and nitrogenous products from culture systems. Accumulation of these waste products can limit system productivity and negatively impact cultured animals, increasing the potential for stress, disease and mortality. Technologies developed to remove solids and maintain concentrations of nitrogenous waste products within acceptable limits include different types of filters used alone or in combination with a variety of media types. All of these technologies have achieved varying degrees of success. While use of expandable granular biofilters is not new, improvements have been made in the design and composition of the filtration media. This, in conjunction with an appropriate backwash regimen encourages attachment and growth of nitrifying bacteria to accomplish clarification and nitrification in a single unit. The purpose of this study was to evaluate the effects of biological and mechanical filtration on production and selected water quality criteria in zero-exchange, biosecure, superintensive shrimp production systems.

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Aquaculture and Fisheries Biotechnology: Genetic Approaches

By: R.A. Dunham
CABI Publishing, CAB International, Wallingford, Oxfordshire OX10 8DR, UK. (2004) xi + 372 pp. ISBN 0-85199-596-9. $US 75.00.

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Review

Rex Dunham presents *Aquaculture and Fisheries Biotechnology: Genetic Approaches*. His aim, as stated in the preface, is to explain to students, farmers, fisheries biologists and scientists how theory relates to reality and to provide a strong review of the current status of key biotechnology topics, illustrating concepts with key research results. He aims to be objective regarding controversial topics, presenting various viewpoints and then discussing differing perspectives in the context of the available data. The book has 19 chapters, with a supporting glossary, extensive references to the technical literature, and an index.

The general strength of this book is the thorough review of applications of aquatic biotechnology to aquaculture, and it will serve as a useful reference to a range of professionals. Its general weakness regards applications to population genetics and fishery management. For teachers, combining a book focusing on selective breeding with this volume focusing on biotechnology would support a state-of-knowledge course on genetics in aquaculture.

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