Oriental Aquamarine Biotech India (P) Limited Coimbatore

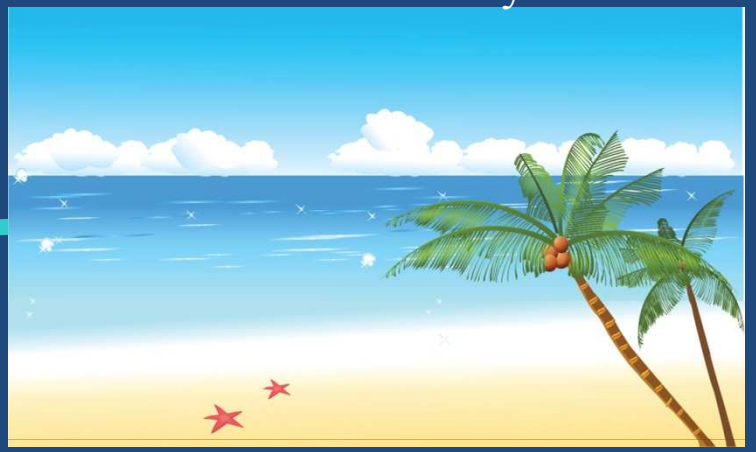
Nitrifying Bioreactor Technology for the Establishment of Biosecure Recirculating Aquaculture Systems

Aquaculture

Conventional Systems

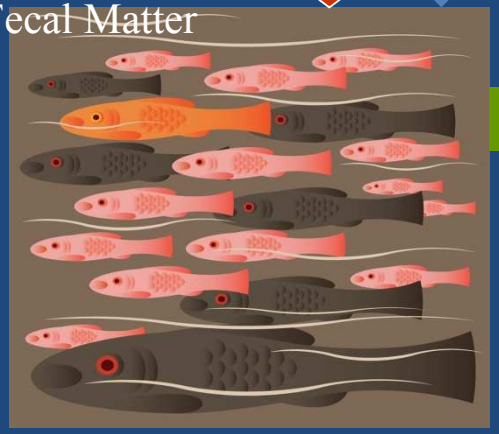
Aquaculture Tanks

Ocean/Waterbody



Ammonia &
Nitrites

Excess Feed
Fecal Matter



Conventional systems – problems
Needs large quantities of water

Conventional systems -problem

Reduced survival rate

Conventional systems-problems

Causes water pollution

Oriental Aquamarine Biotech India Private Ltd - Coimbatore

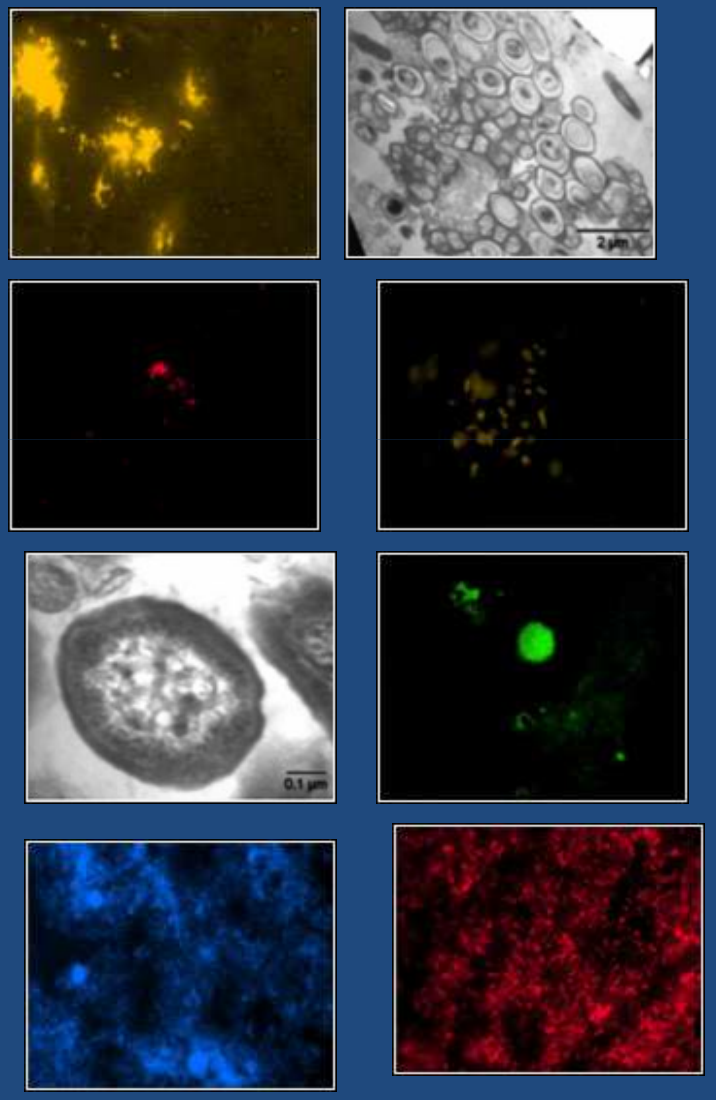
- Technology developed by National Centre for Aquatic Animal Health, Cochin University of Science and Technology, Kerala, India

- Technology commercialized by Oriental Aquamarine Biotech India Private Limited, Coimbatore, Tamil Nadu

The Solution – Bacterial Consortium

- A consortium of nitrifying bacteria have been identified which break down the ammonia and nitrites

- Consortium grows as biofilm on beads packed and remove Nitrites & Ammonia inside a bioreactor



The solution-Nitrifying Bioreactor

- PBBR

- SBSBR

Nitrifying Bioreactor

Stringed Bed Suspended Bio Reactor (SBSBR)
-500 liters/day

Packed Bed Bio Reactor (PBBR)
-60,000 liters/day

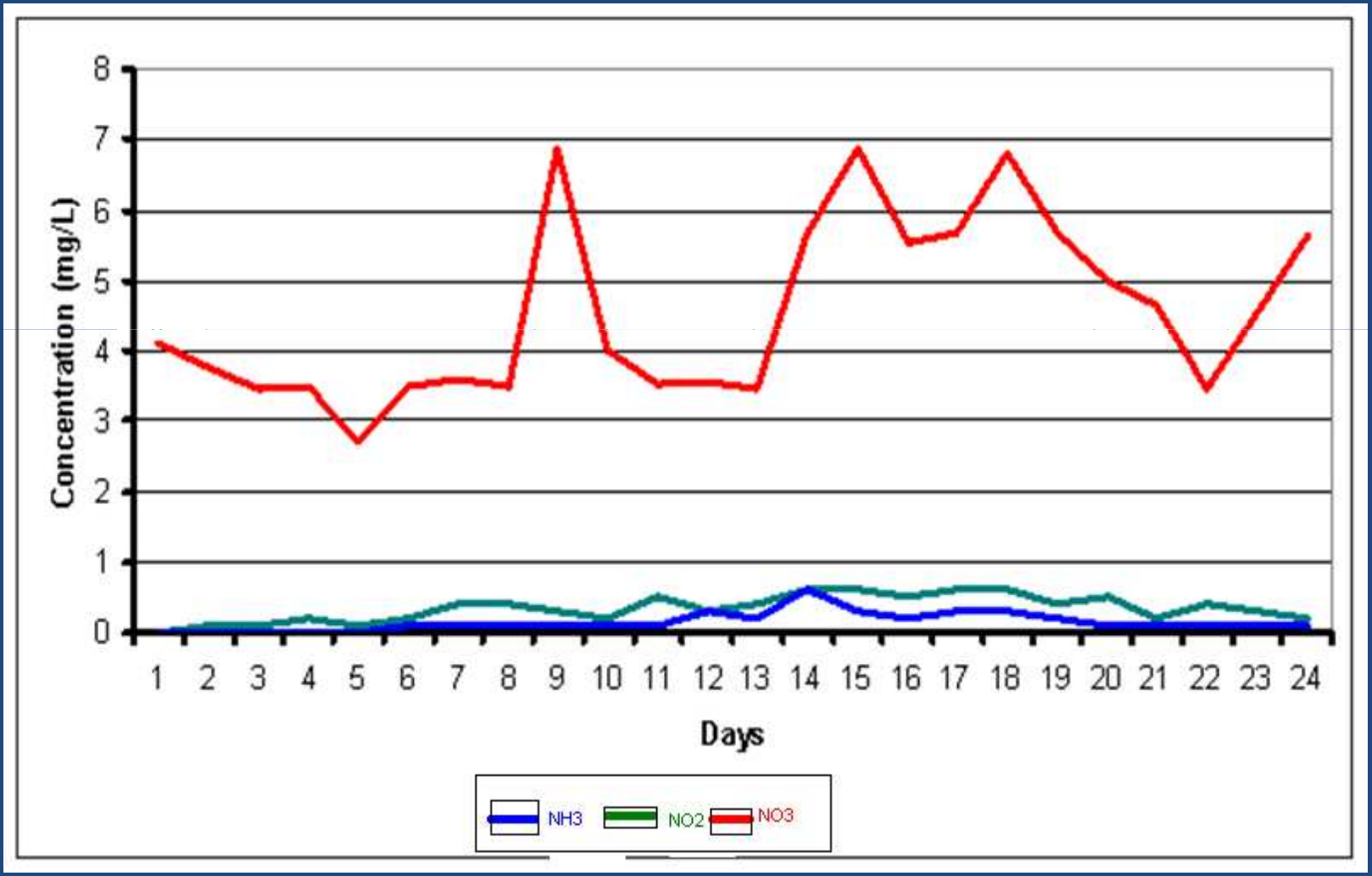
Water quality parameters in the larval rearing system and treated water stabilized as under :

NH_4^+	< 0.1 ppm
NO_2^-	< 0.5 ppm
NO_3	10 – 100 ppm
Vibrio	$< 2 * 10^2$ / ml
Luminescent Vibrio	Nil
pH	7.5 – 8.5

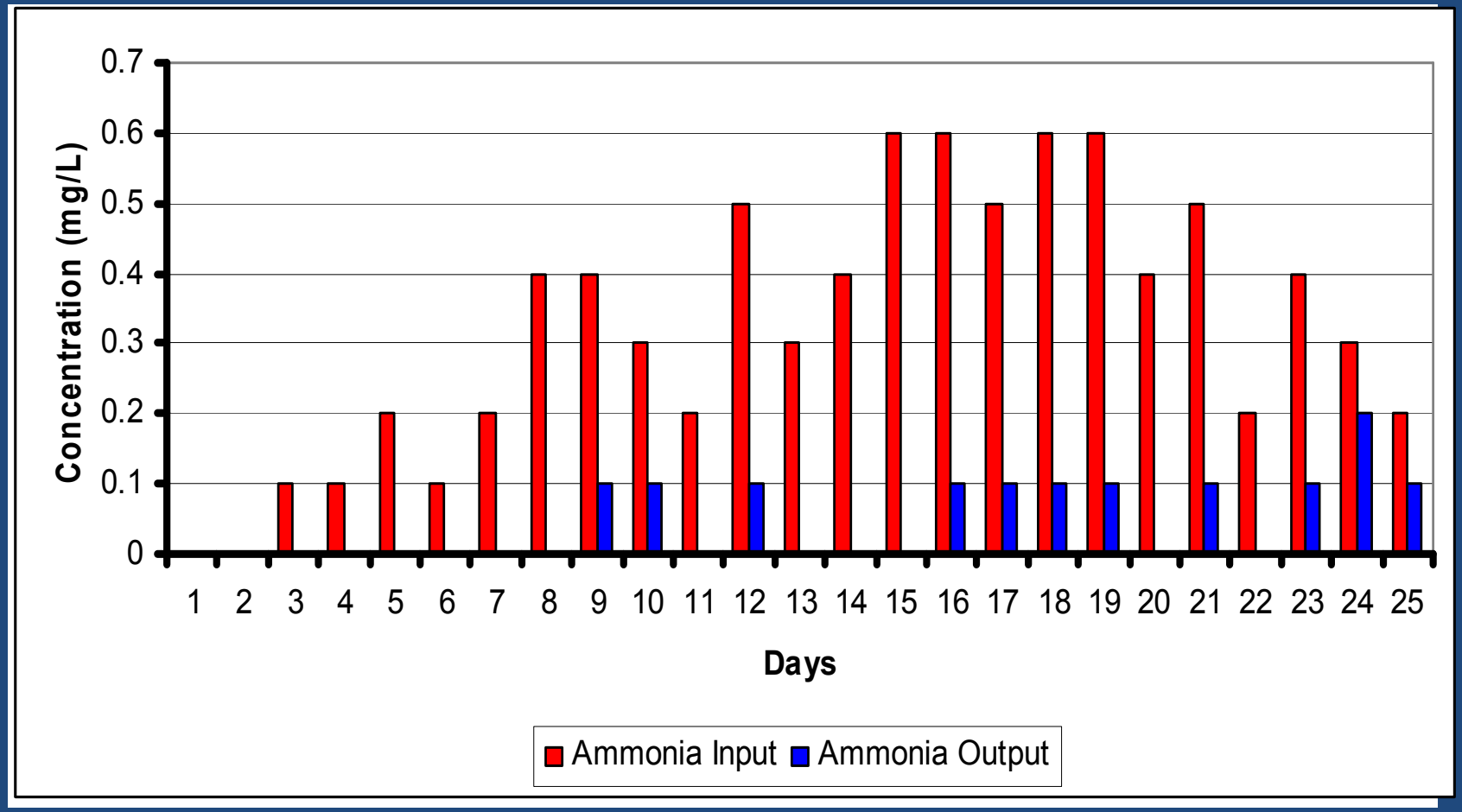
No water exchange

Reef Quality Water.

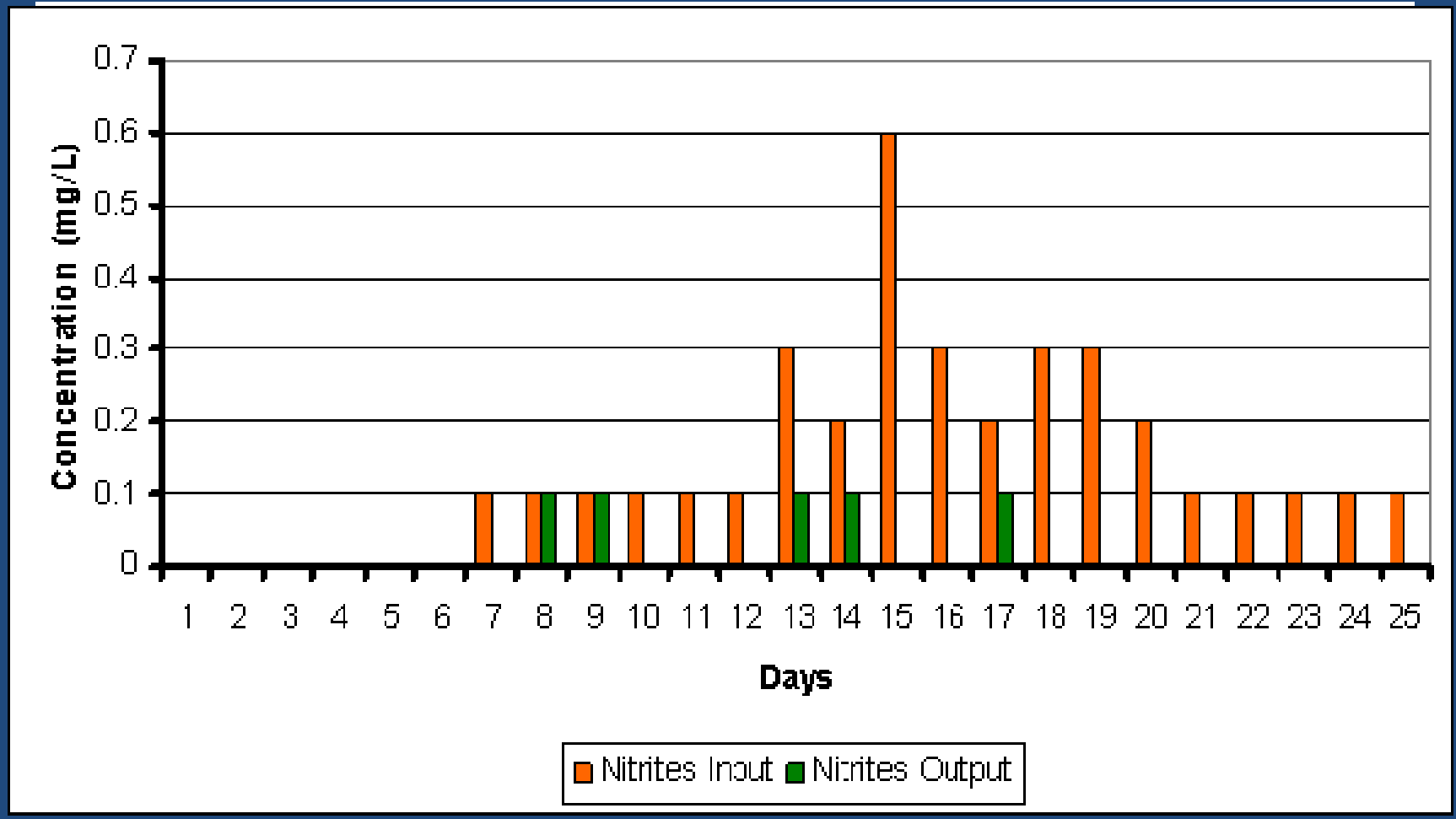
PROGRESS OF NITRIFICATION IN PBBR INTEGRATED *PENAEUS MONODON* MATURATION SYSTEM



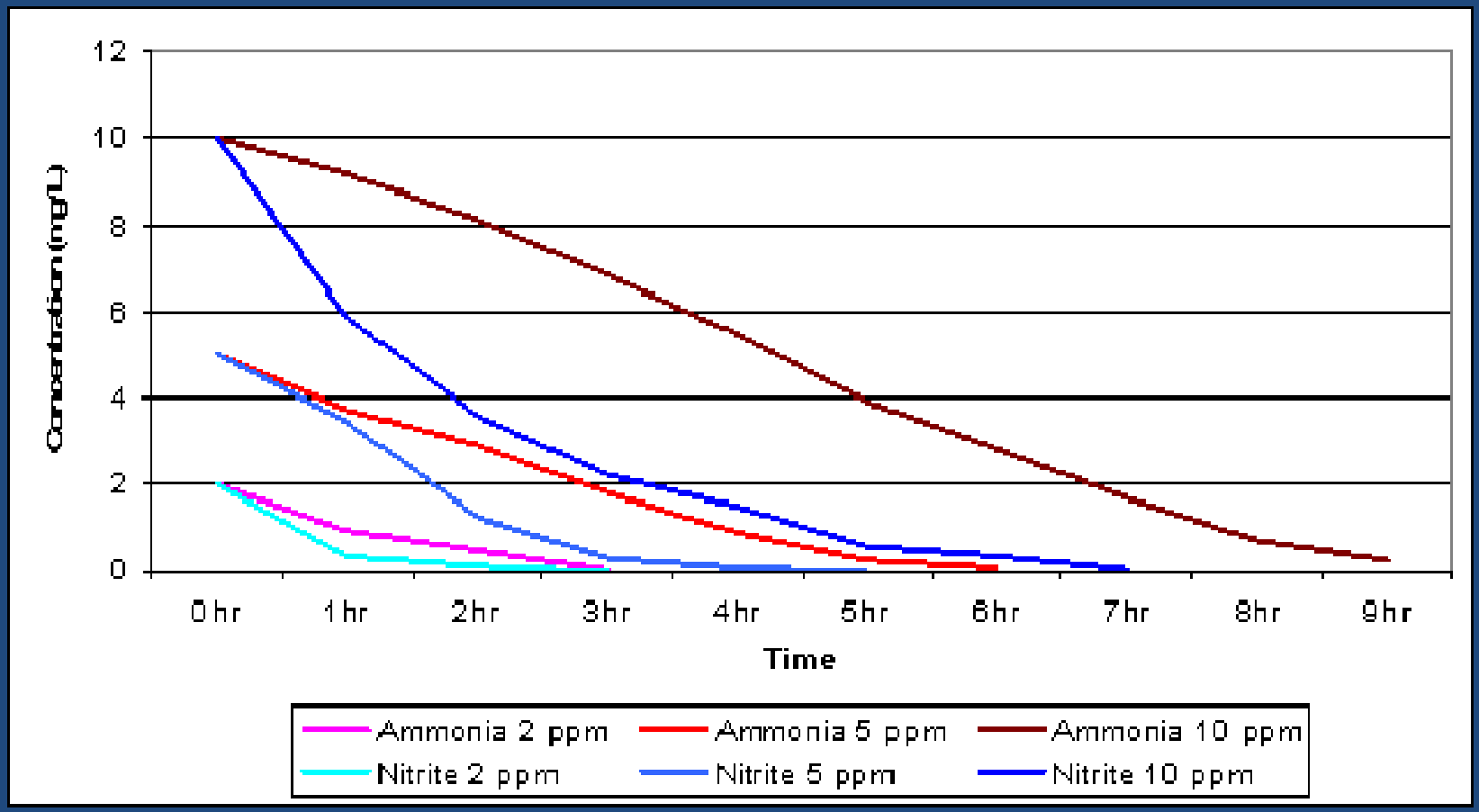
NITRIFICATION EFFICIENCY



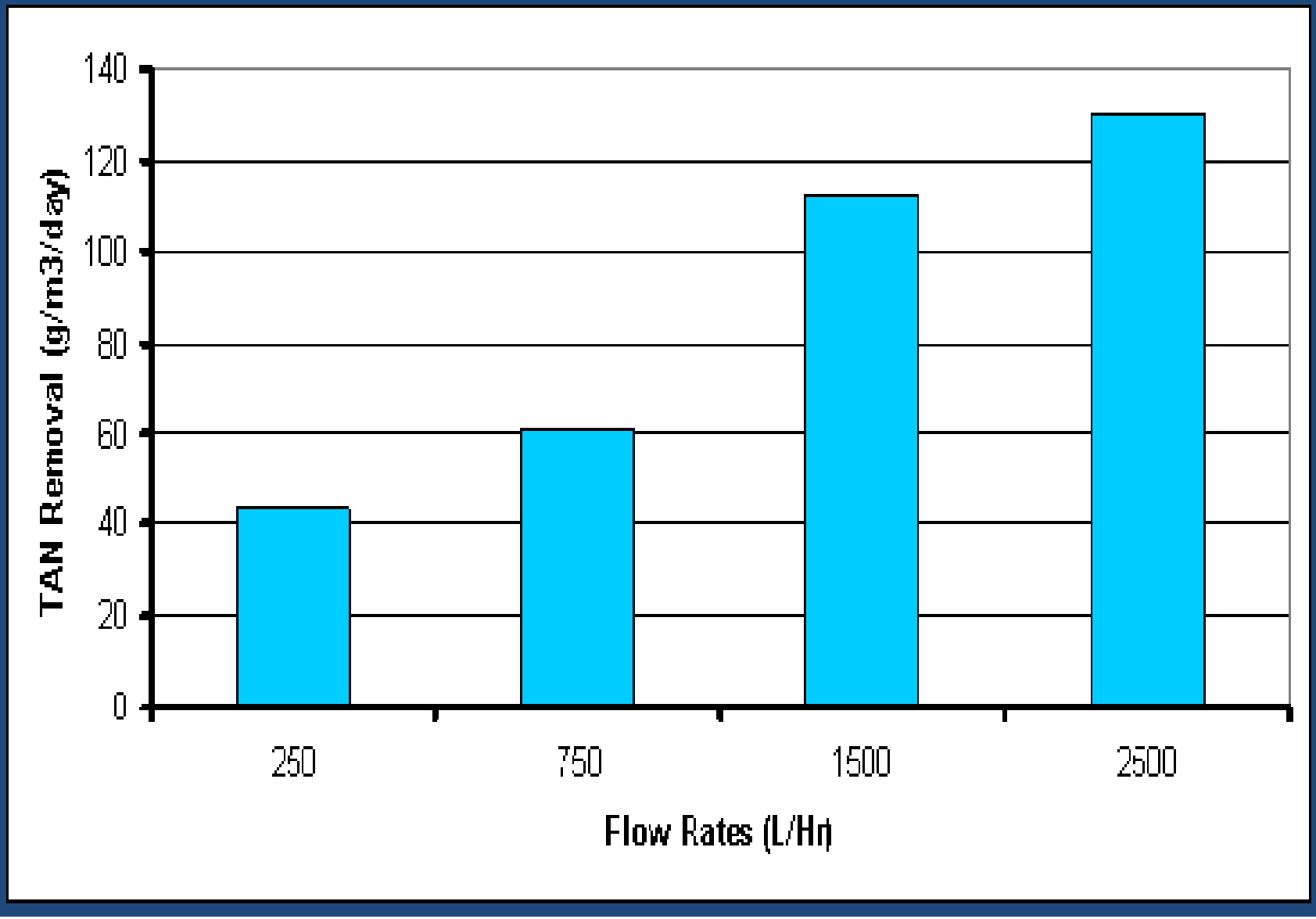
NITRIFICATION EFFICIENCY



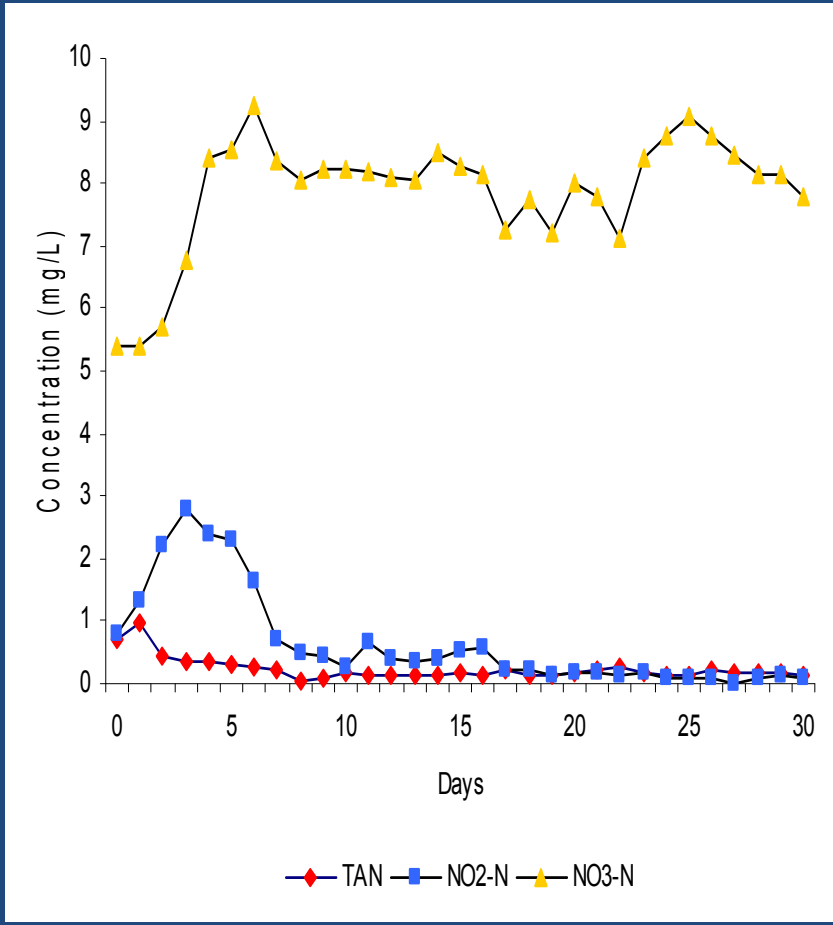
Substrate reduction at varied concentration

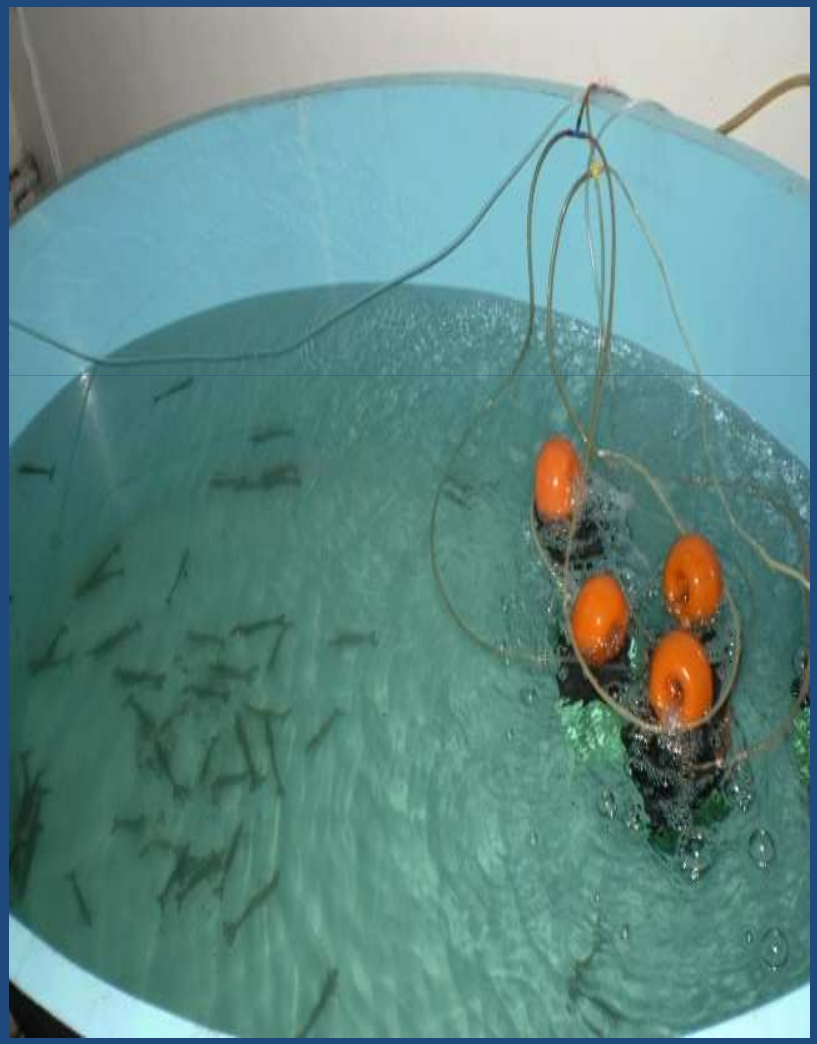


VOLUMETRIC TAN REMOVAL RATES BY THE REACTOR WITH FLOW RATE

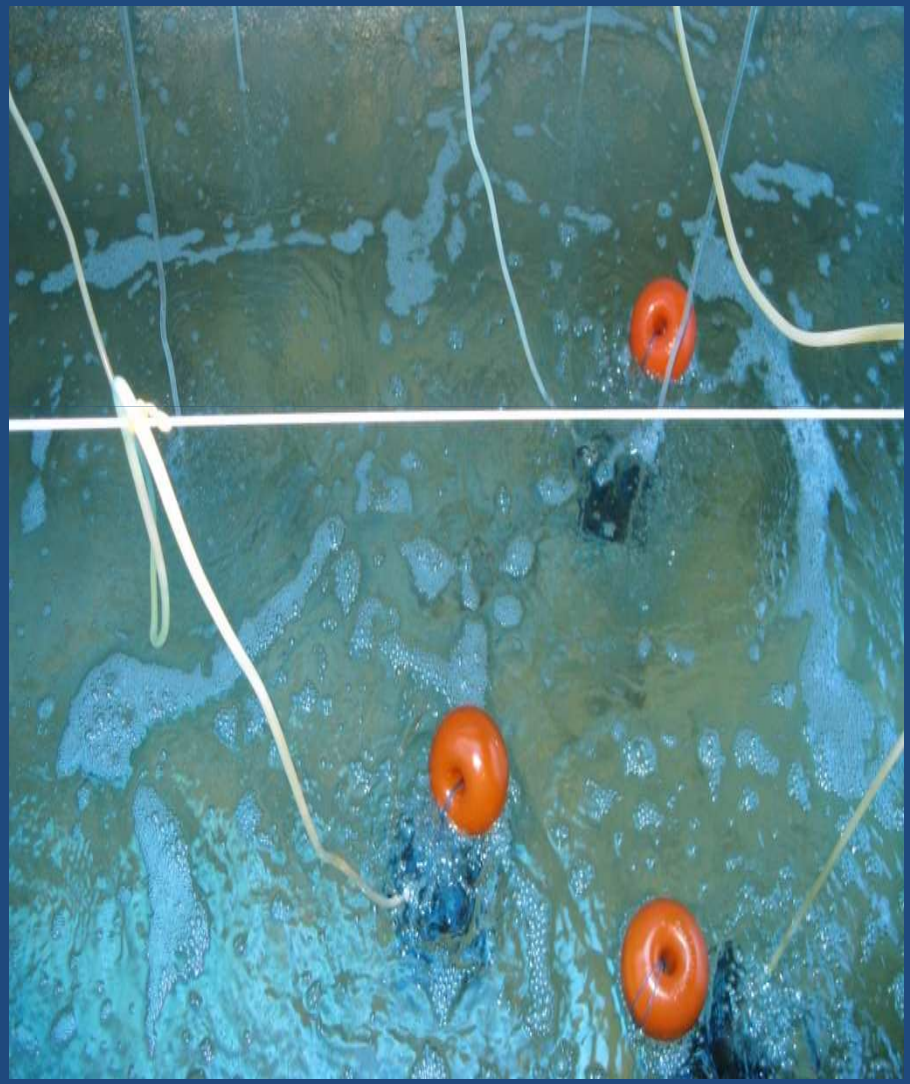


TAN, NO2-N and NO3-N experimental systems integrated with SBSBR rearing *Penaeus mondon*



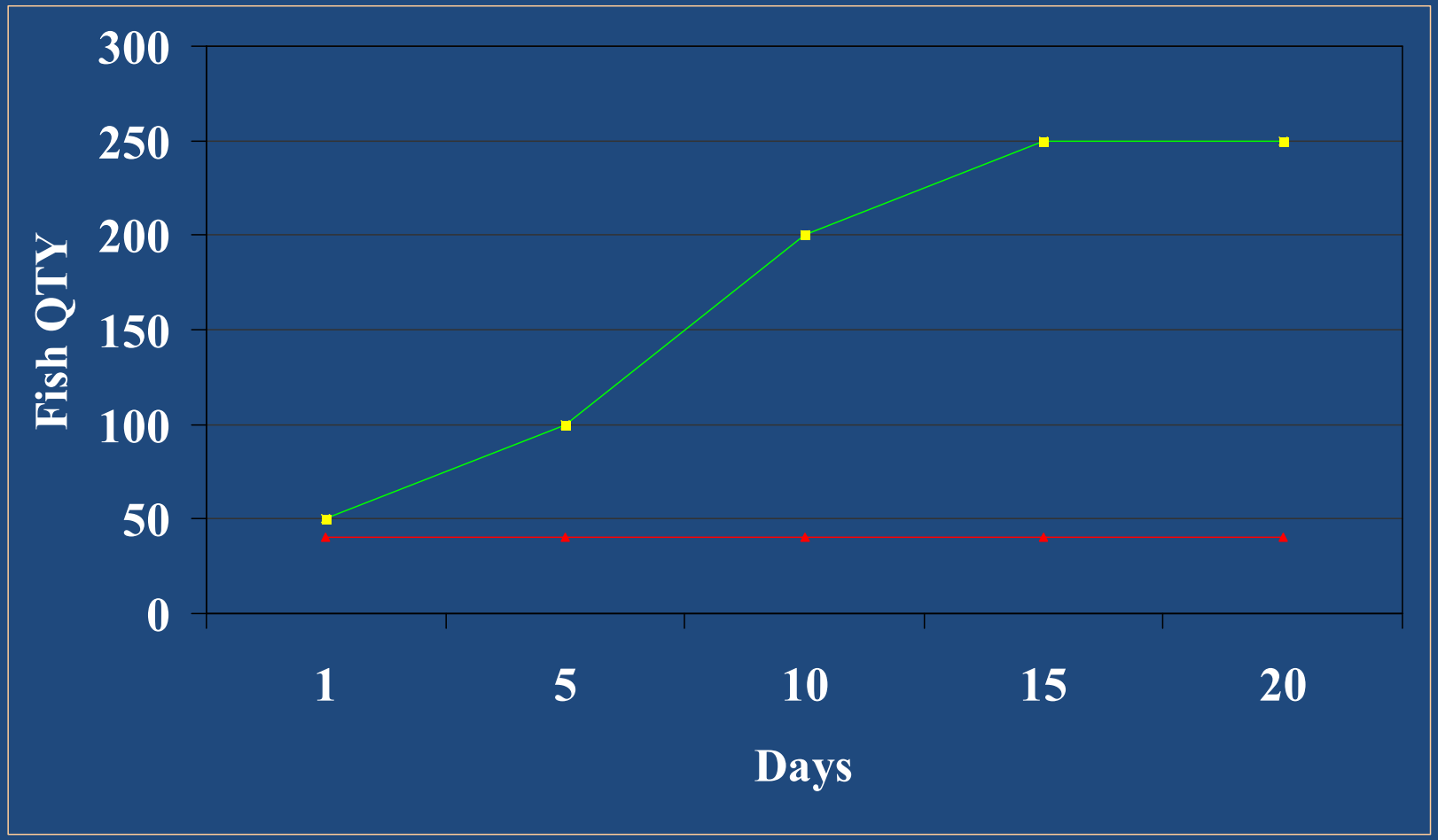


Stringed Bed Suspended Bioreactor Deployed in a Larval rearing system at Queens Hatchery, Kodungalloore



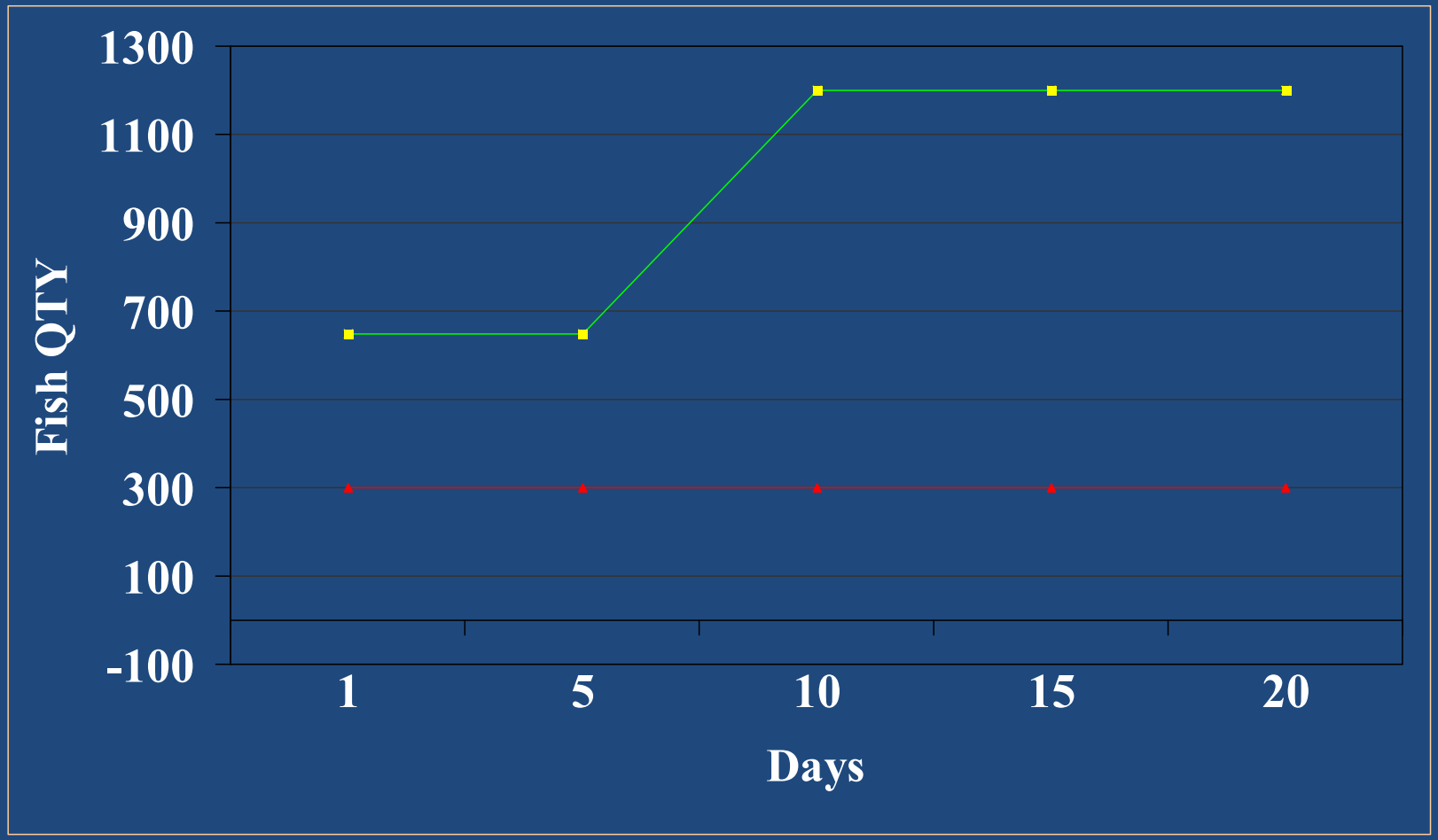
TNFDC, Aliyar (0-PPT Trials)

Fish: Koicarp (10grms)

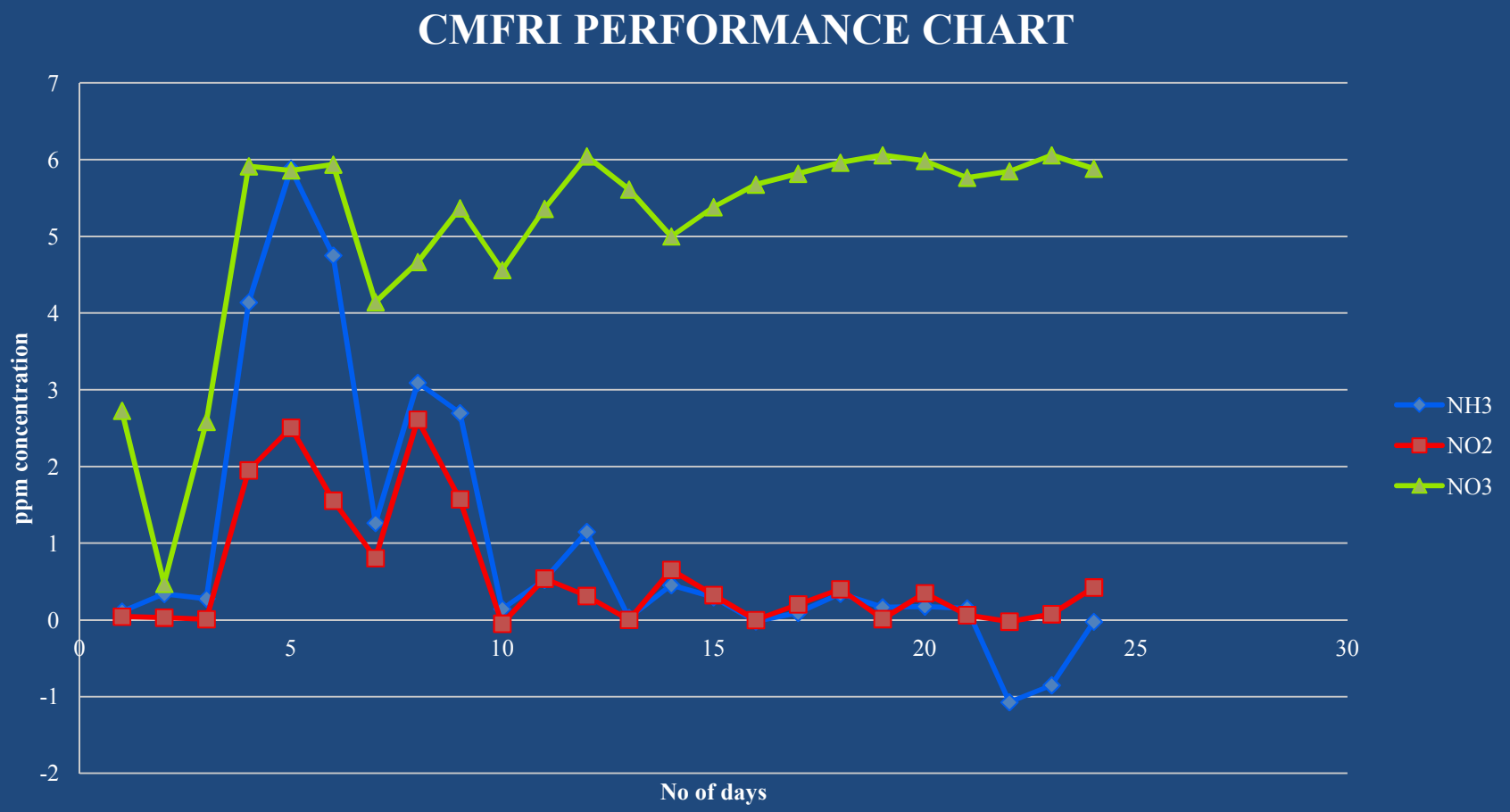


Golden fish farm ,Calicut (0-PPT Trials)

Fish: Angel (Size:1cm to 3cm)



CMFRI -Kochi


CMFRI PERFORMANCE CHART
ppm concentration
No of days
NH3
NO2
NO3
7
6
5
4
3
2
1
0
-1
-2
0
5
10
15
20
25
30

IP Status

- **Patent in India** :
- Patent Application # 828/DEL/2000
- **International Patent** :
- International patent classification: C02F 3/13.
- International application No. PCT/IN00/00097
- **Technology is also patented** in South East Asian Countries with a well-developed aquaculture industry such as
  - ☑ Thailand
  - ☑ Japan
  - ☑ Philippines
  - ☑ Indonesia and
  - ☑ South Korea.

Publication

Aquacult Int
DOI 10.1007/s10499-008-9218-2

Stringed bed suspended bioreactors (SBSBR) for in situ nitrification in penaeid and non-penaeid hatchery systems

V. J. Rejish Kumar · Cini Achuthan · N. J. Manju · Rosamma Philip · I. S. Bright Singh

Received: 17 January 2008 / Accepted: 1 September 2008

Abstract For establishing nitrification in prawn (non-penaeid, salinity 10–15 ppt) and shrimp (penaeid, salinity 30–35 ppt) larval production systems, a stringed bed suspended bioreactor (SBSBR) was designed, fabricated, and validated. It was fabricated with 5 mm polystyrene and low density polyethylene beads as the substrata for ammonia and nitrite oxidizing bacterial consortia, respectively, with an overall surface area of 684 cm^2. The reactors were activated in a prototype activator and were transported in polythene bags to the site of testing. Performance of the reactors activated with the nitrifying bacterial consortia AMONPCU-1 (ammonia oxidizers for non-penaeid culture) and NIONPCU-1 (nitrite oxidizers for non-penaeid culture) was evaluated in a *Macrobrachium rosenbergii* larval rearing system and those activated with AMOPCU-1 (ammonia oxidizers for penaeid culture) and NIOPCU-1 (nitrite oxidizers for penaeid culture) in a *Penaeus monodon* seed production system. Rapid setting up of nitrification could be observed in both the static systems which resulted in a higher relative per cent survival of larvae.

Keywords Closed system shrimp hatchery · Immobilization · Nitrification · Nitrifying bioreactors · Nitrifying consortia · Shrimp/prawn larval production

World J Microbiol Biotechnol
DOI 10.1007/s11274-008-9905-1

ORIGINAL PAPER

Mass production of nitrifying bacterial consortia for the rapid establishment of nitrification in saline recirculating aquaculture systems

V. J. Rejish Kumar · Cini Achuthan · N. J. Manju · Rosamma Philip · I. S. Bright Singh

Received: 17 July 2008 / Accepted: 29 October 2008

Abstract Two distinct nitrifying bacterial consortia, namely an ammonia oxidizing non-penaeid culture (AMONPCU-1) and an ammonia oxidizing penaeid culture (AMOPCU-1), have been mass produced in a nitrifying bacterial consortia production unit (NBCPU). The consortia, maintained at 4°C were activated and cultured in a 2 l fermentor initially. At this stage the net biomass (0.105 and 0.112 g/l), maximum specific growth rate (0.112 and 0.105/h) and yield coefficients (1.315 and 2.08) were calculated respectively, for AMONPCU-1 and AMOPCU-1 on attaining stationary growth phase. Subsequently on mass production in a 200 l NBCPU under optimized culture conditions, the total amounts of NH_4^+–N removed by AMONPCU-1 and AMOPCU-1 were 1.948 and 1.242 g/l within 160 and 270 days, respectively. Total alkalinity reduction of 11.7–14.4 and 7.5–9.1 g/l were observed which led to the consumption of 78 and 62 g Na_2CO_3. The yield coefficient and biomass of AMONPCU-1 were 0.67 and 125.3 g/l and those of AMOPCU-1 were 1.23 and 165 g/l. The higher yield coefficient and growth rate of AMOPCU-1 suggest better energy conversion efficiency and higher CO_2 fixation potential. Both of the consortia were dominated by *Nitrosomonas*-like organisms. The consortia may find application in the establishment of nitrification within marine and brackish water culture systems.

Keywords Ammonia oxidizing consortia · Nitrifying bacteria · Mass production · Maximum specific growth rate · Nitrification · Yield coefficient

Introduction

The most prominent requirement of any recirculating aquaculture system (RAS) is an efficient biofilter to prevent the accumulation of toxic metabolites such as ammonia and nitrite. High levels of ammonia and nitrite undermine commercial production objectives, as their toxic impacts are manifested through impaired growth or chronic diseases (Cheng et al. 2004; Svobodova et al. 2005). This is especially true in shrimp/prawn hatcheries where the daily specific excretion of ammonia by larvae and post-larvae is five fold higher than that of adults. To address this issue, fixed film biofilters are commonly employed for total ammonia nitrogen (TAN) removal (Seo et al. 2001; Shnel et al. 2002). Experience has shown that the biofilters in

J Ind Microbiol Biotechnol
DOI 10.1007/s10295-008-0504-9

ORIGINAL PAPER

Activated packed bed bioreactor for rapid nitrification in brackish water hatchery systems

V. J. Rejish Kumar · Cini Achuthan · N. J. Manju · Rosamma Philip · I. S. Bright Singh

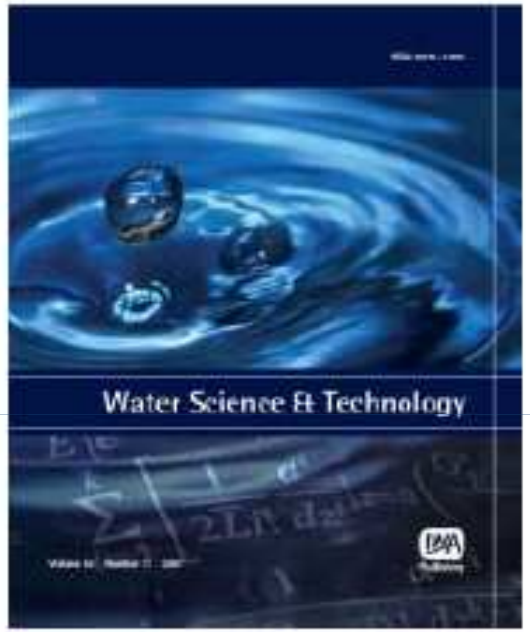
Received: 23 September 2008 / Accepted: 11 November 2008

Abstract A packed bed bioreactor (PBBR) was developed for rapid establishment of nitrification in brackish water hatchery systems in the tropics. The reactors were activated by immobilizing ammonia-oxidizing (AMONPCU-1) and nitrite-oxidizing (NIONPCU-1) bacterial consortia on polystyrene and low-density polyethylene beads, respectively. Fluorescence in situ hybridization demonstrated the presence of autotrophic nitrifiers belong to *Nitrosococcus mobilis*, lineage of β ammonia oxidizers and nitrite oxidizer *Nitrobacter* sp. in the consortia. The activated reactors upon integration to the hatchery system resulted in significant ammonia removal ($P < 0.01$) culminating to its undetectable levels. Consequently, a significantly higher percent survival of larvae was observed in the larval production systems. With spent water the reactors could establish nitrification with high percentage removal of ammonia (78%), nitrite (79%) and BOD (56%) within 7 days of initiation of the process. PBBR is configured in such a way to minimize the energy requirements for continuous operation by limiting the energy inputs to a single stage pumping of water and aeration to the aeration cells. The PBBR shall enable hatchery systems to operate under closed recirculation mode and pave the way for better water management in the aquaculture industry.

Keywords Nitrifying bioreactors · Nitrifying consortia · Immobilization · Nitrification · Closed system shrimp hatchery

Introduction

On assuming the dimensions of an industry, aquaculture systems are bound to operate under strict environmental safety standards. With high land and water costs, the systems are destined to maintain high biological carrying capacity in relatively little space with minimal water exchange. These requirements led to the advent of recirculating aquaculture systems (RASs) which allowed companies to (1) be competitive in both domestic and world commodity markets by locating production closer to markets, (2) improve environmental control, (3) reduce catastrophic losses due to diseases, (4) avoid violation of environmental regulations on effluent discharge, (5) reduce management and labor costs, and (6) improve product



APPLICATION

- Ornamental fish
  - FRESH WATER
  - MARINE WATER
- Edible fish
  - SEA BASS
  - LOBSTER
  - SHIRMP
  - PRAWN
  - CRAB
  - COBIA etc

Nitrifying Bioreactor - Advantages

- Improved quality of fish produced (Organic)
- Increase in fish survival rate
- Increase in rate of growth and the size of fish
- Better resistance to diseases
- Reduction in production costs
- Improvement in surrounding environment

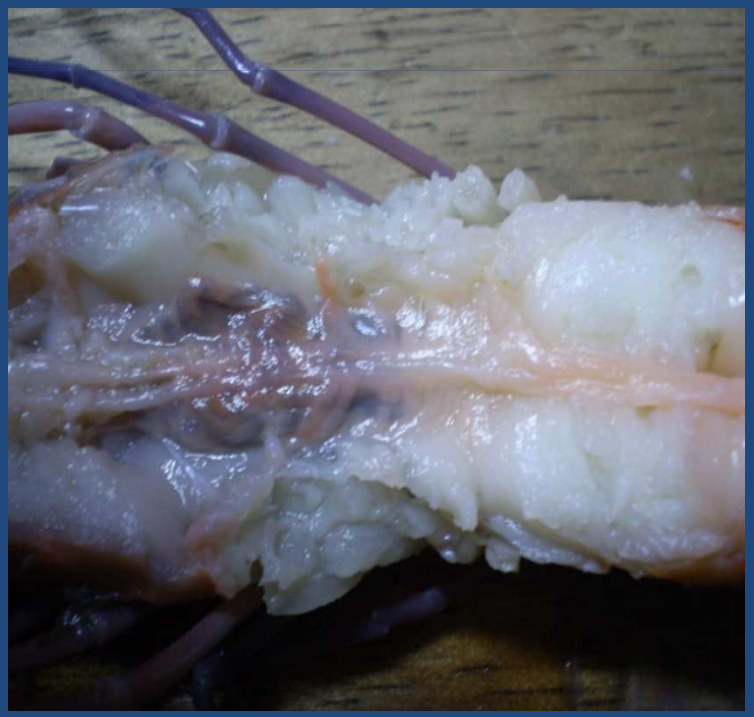
Nitrifying Bioreactor - Technology

- Patented technology
- First of its kind in the world
- Maintains reef-like conditions in aquaculture tanks
- Can be used for any level of salinity
  - Fresh Water
  - Salt Water
  - Brackish Water
- Can be used to farm a variety of marine animals
  - Shrimp
  - Ornamental Fish
  - Crabs/Lobsters

BENEFITS

Maturation

(Developing ovary in the animals reared in the recirculating system)



Brood-stock Maintenance and Rearing

Increased stocking & survival rate

RECIRCULATING AQUACULTURE SYSTEM

- Location flexible – transport costs minimized
- Fewer tanks – less capital outlay
- Temp and other parameters controlled
- Planned production schedules, control supplies of fingerlings to target seasonal market demand by cage farmers Lower mortality, improved FCRs
- RAS allow diversification of the farmed species base for the market substituting seafood imports and opening new markets in live fish sales

Thank you

Mohan Kandaswamy
Director
Oriental Aquamarine Biotech India P Ltd
U-7 Kovaipudur, Coimbatore - 641042
Mobile : 91 94429 51725
E-mail: mohan@nitrifying-bioreactor.com