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A SIMPLE BIOLOGICAL FILTER FOR RECIRCULATING SEAWATER SYSTEMS

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ABSTRACT

A biological filter using air lifts for recirculating seawater through a bed of gravel has been developed at the Narakkal Prawn Culture Laboratory of the CMFRI for rearing marine animals. The details of construction are given in this paper. The effectiveness of this recirculating system is discussed.

INTRODUCTION

IN CLOSED system aquaculture of crustaceans and fishes, ammonia which is their main excretory product accumulates in the water and, if not removed, proves toxic to the animals. Even at sublethal concentrations, ammonia has been shown to retard the growth of the animals (Wickins, 1976). Hence it is imperative that the ammonia should be removed from the medium, if the animals are to grow normally. Various types of biological filters have been used to convert the toxic ammonia into harmless nitrates by bacterial action (Spotte, 1970). The principle is well known. When the water is passed through a layer of gravel on which nitrifying bacteria normally settle and grow, the ammonia is oxidised to nitrites by bacteria belonging to the genus *Nitrosomonas* and the nitrites are further oxidised to nitrates by the bacteria of the genus *Nitrobacter* (Wickins, 1976). An inexpensive submerged biological filter developed at the Narakkal Prawn Culture Laboratory of the Central Marine Fisheries Research Institute, to maintain brood-stocks of penaeid prawns in recirculated seawater is described here.

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DESCRIPTION OF FILTER

The filter consists of a rectangular wooden frame 136 cm long, 90 cm wide and 20 cm high, divided into two compartments by a horizontal wooden partition made of reepers set 25 cms apart (Plate I). The upper open compartment is 5 cm deep filled with gravel chips 0.5 to 1.0 cm in size. The lower compartment is closed when the frame rests on the bottom of the pool. A beading of split polythene tubing is given to the lower margin of the frame to make the bottom water tight. The horizontal wooden partition is covered with a velon screen having 64 meshes to a sq. cm to prevent the gravel chips from falling into the lower compartment. Water from the lower compartment is airlifted to the surface through 4 rigid PVC stand-pipes, 85 cms in length and 5 cm in outer diameter, kept in round holes in the horizontal partition. To replace the water that is airlifted, water in the tank passes downwards through the gravel layer and thus a recirculation of water through the gravel is set up. Ammonia from the water

is oxidised by the nitrifying bacteria growing on the gravel substrate, when the water circulates through the filter. The aerating stones that are kept in the airlift, apart from providing the motive force for recirculating the water, also keep the water well oxygenated. Broken pieces of oyster shells are kept mixed with the gravel

ing experiments were conducted. Two 1.8 m diameter plastic lined pools containing 1600 litres of seawater were set up. One of the pools contained one unit of biological filter which had previously been conditioned in seawater for 15 days. The other was without a filter but had 4 aerating stones. Each pool contained

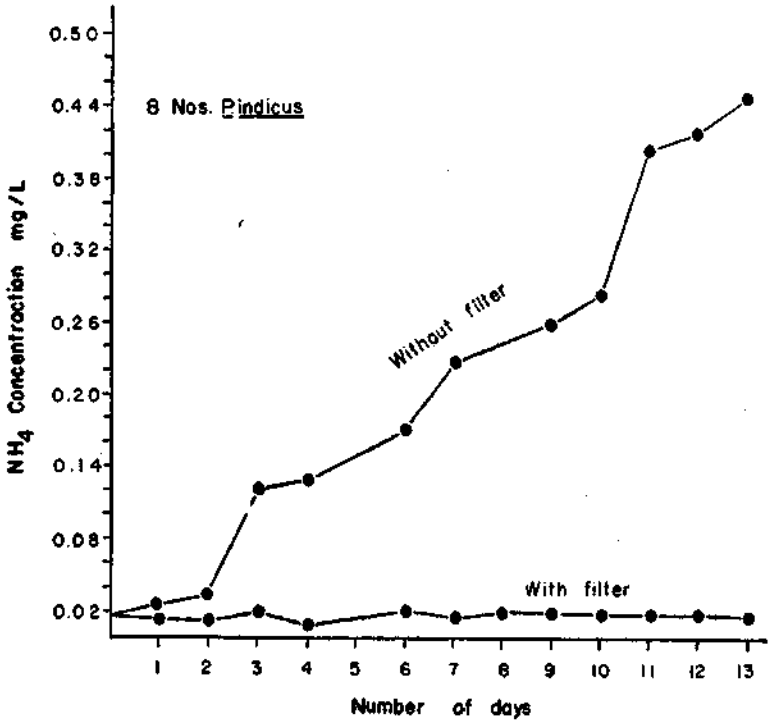

Fig. 1. Ammonia concentration in pools with and without biological filter. 8 specimens of *P. indicus* were kept in each pool.

to stabilize the pH. The surface area of each filter unit is 1.22 sq. metres. A number of filter units can be kept side by side to increase the surface area according to the size of the pools. In our broodstock tanks which are 3.6 metres in diameter we use 4 filter units.

Experimental Evidence of Control of Ammonia Levels

In order to verify whether the filter actually removes ammonia from the water, the follow-

8 specimens of *Penaeus indicus* each weighing about 12 gm. The animals were fed with fresh clam meat and the uneaten food and excreta were removed by siphoning every day. The ammonia excreted by the prawns provided the ammonia source. The ammonia concentration was monitored daily for 13 days by the improved phenyl hypochlorite method of Harwood and Kuhn (1970). The initial concentration of ammonia was 0.018 mg NH_4/litre in both the pools. The ammonia level remained more or less stationary in the pool with the biological

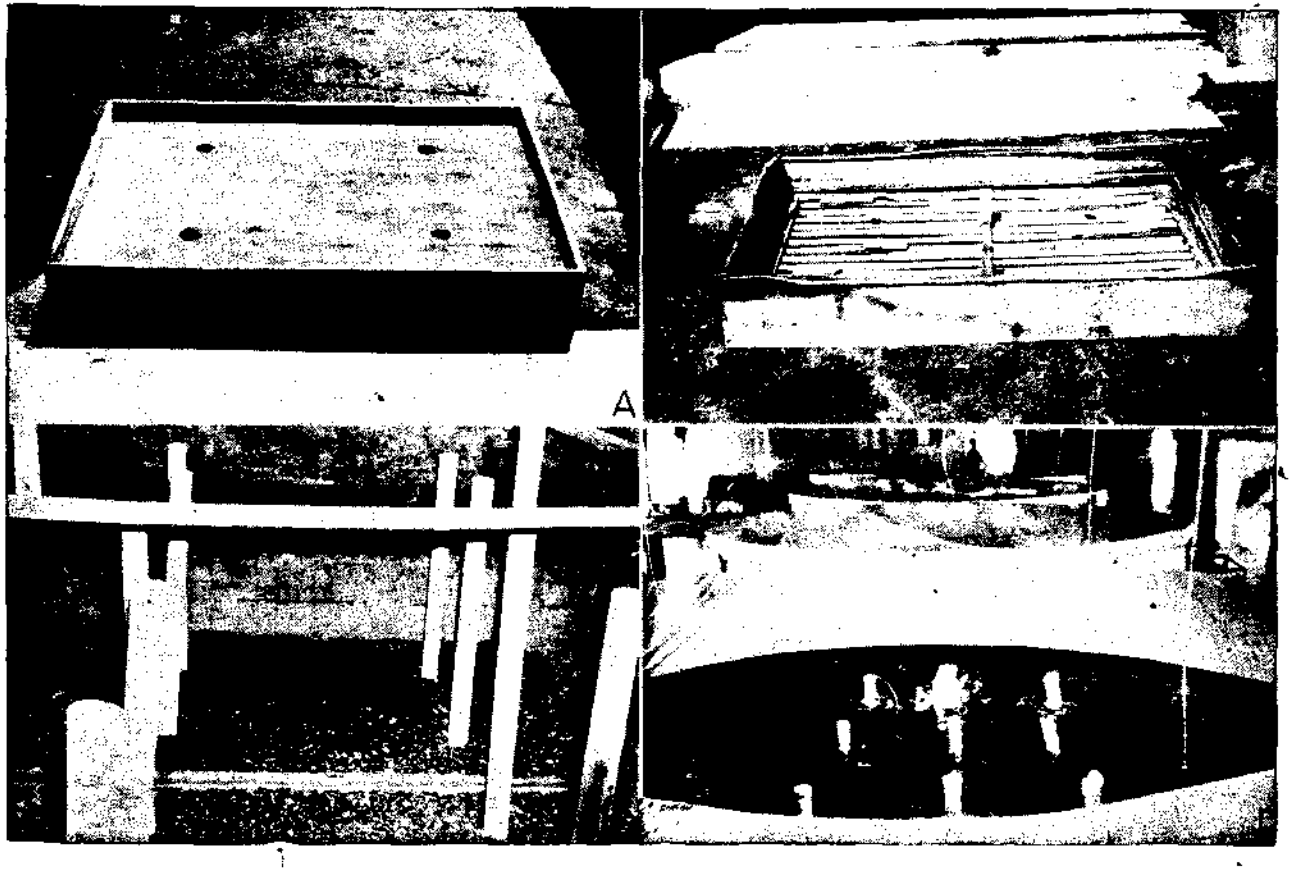

PLATE I. Details of biological filter. A. Dorsal view of wooden frame of filter with velon screen covering the reapers, B. Ventral view of wooden frame of filter showing reapers, C. Biological filter with gravel and PVC stand pipes in position and D. Biological filter installed in the maturation pool.

filter throughout the experimental period, while in the pool without the filter the ammonia level increased steeply due to the accumulation of the ammonia excreted by the prawns and reached a concentration of 0.44 mg NH_4/litre on the 13th day (Fig. 1). The experiment was repeated from 8.1 at the start of the experiment to 7.6 towards the end. It is therefore advisable to replace at least 50% of the water in the pool every week with fresh seawater.

Based on these results it was estimated that in the 3.6 m dia. broodstock tanks at the Prawn

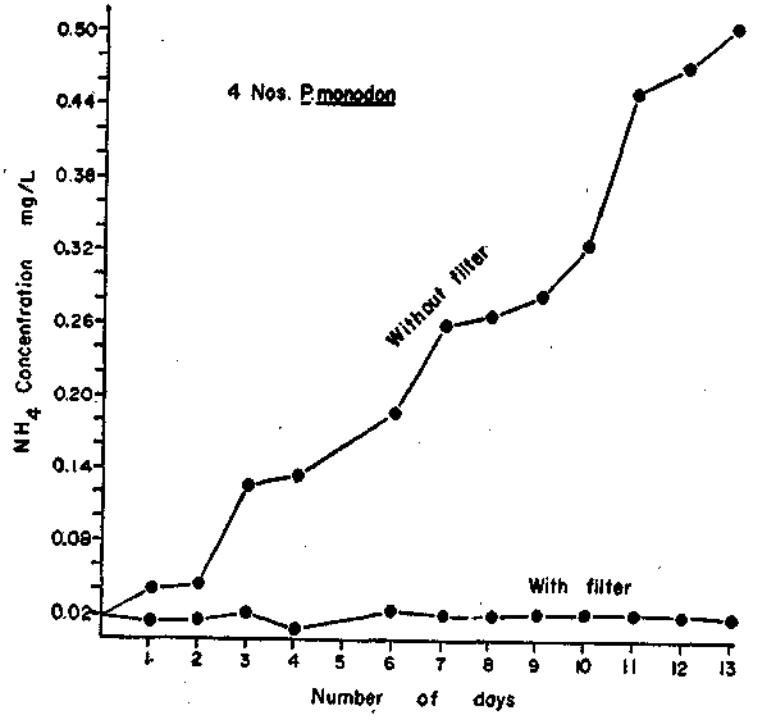

Fig. 2. Ammonia concentration in pools with and without biological filters. 4 specimens of *P. monodon* were kept in each pool.

with 4 *P. monodon* (av. weight 80 gm) as the ammonia source and similar results were obtained (Fig. 2).

Conclusion

The above experiments conolusively proved that the ammonia excreted by the animals was effectively removed by the biological filter. However, the pH of the seawater declined from 8.1 at the start of the experiment to 7.6 towards the end. It is therefore advisable to replace at least 50% of the water in the pool every week with fresh seawater.

Based on these results it was estimated that in the 3.6 m dia. broodstock tanks at the Prawn Culture Laboratory, Narakkal, where 4 units of the biological filter were used, a minimum of 32 *P. indicus* or 16 *P. monodon* could be safely kept. However, the optimum 'carrying capacity' of the filters can be assessed only on the basis of further experiments where the ammonia levels should be monitored daily in filter-fitted tanks stocked with different numbers of animals.

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