Gravity Fed Self Regulating Bio-Suspended Solids Pillow Filter for Crab and Lobster Tanks

By Timothy C. Visel - Finfish/Shellfish Specialist
Sea Grant Marine University of Connecticut Sea Grant/Extension
Service Advisory Program - Groton, CT 06340
1988
Reissued by The Sound School Regional Vocational Aquaculture Center
Aquaculture Science and Natural Resources Class October 2004
(Exercise #11)

Abstract-

In the late 1960 and early 1970's, it became uneconomical to "car up lobsters," so to clear intestinal residues. Lobsters were arriving with full gut cavities and small-refrigerated retail systems were showing increased losses to ammonia toxicity. In finfish aquaculture, an emphasis on water reuse looked at living or bio filters to grow nitrogen-reducing bacteria as part of the culture operation. Suspended solids also needed to be lessened to keep proteins from bubbling/foaming. The lobster retail market needed clear water to provide customer appeal. A small bio/pillow - sand, gravel and broken clean oyster shell was seen to buffer ph, maintain bacteria to reduce ammonia smell and toxicity and at the same time, trap fecal matter in a shell/sand/gravel matrix.

Introduction -

The lobster and new Red Crab Fishery in Rhode Island retail recirculating systems desired to reduce holding losses. Water often appeared cloudy and frequently had an ammonia odor. Often these large systems were at floor level for customer viewing and needed remote treatment. A by-pass system loop was seen as a way to redirect 50% of the flow to a special two-tier filter system. Gravity would return treated water to the retail tank. Filter systems would be out of retail/customer view. Smaller systems could use a combined pillow and one treatment filter tank.

Description -

The filter system consisted to two rectangular tanks slightly off-center. A bypass system re-circulating pump delivers 50% of the flow to the pretreatment filter - sand and gravel pillow for solids, and an oyster shell pillow, which holds the nitrogen reducing bacteria. Solids can smother bacteria, so heavy solid loading (after a shipment of red crabs it was not unusual to lose 50%), can overwhelm the bacteria. It is necessary to remove solids before water proceeds to the bio-filter.

If the pump needs to be disconnected, it is important that the bio-filter drains to air contact. The bio-filter can remain alive for several hours in air until the pump or flow can be restarted. Stagnant low oxygen water in hot weather can ruin a bio-filter in an hour. When a bio-filter goes anoxic, it will emit the characteristic hydrogen sulfide (rotten egg) odor.

Description -

System water is redirected to a gravity fed system. Solids are removed in the upper tank before entering the oyster shell bio-filter in the second flower tank. Flow is controlled so system water has 2 minutes in treatment before returning to the primary circulation loop. The by-pass loop is self-regulating; overflow is dumped into the next level. Solids are removed in a sand gravel filter-voids fill with fines and need to be periodically changed. The bio-filter can last months, but needs at least 10 days to reach full nitrogen reducing potential. It is possible to quick start the salt-water culture by placing marine mud or sand (below the high tide) into the filter pillow. This will shorten the growth of nitrogen reducing bacteria. It is also possible to use some old oyster shell from a previous filter and place them in a new dry filter (pillow) to “jumpstart the filter). One method (not recommended for customer tanks) is to float a dead fish in the system to provide bacteria the food in which to grow. Bio-filters can store and population adjusts to food, the problem is that the filter can crash quickly, but needs days to respond to heavy loading. If loads lighten it is possible to sustain a filter by placing fish scraps in mesh bags in the filter tanker box. In that way, the filter can still be “nourished” when the lobsters or red crabs arrive, quickly remove the fish bag.

Experiments/ Trials -

The first filters were constructed from 3/8 inch square metal commercial “hardware cloth” available from any hardware store. The filter boxes measured 3 by 8 feet so several “pillows” were placed in the boxes. The solids filter consisted of beach sand and gravel placed into the hardware cloth which was clipped using hog ring lobster trap pliers. The sand fell out of these early pillows so a new attempt was made with fiberglass window screen fabric, also available from hardware stores. The bio-filter was constructed from hex chicken wire and hog ringed along the edges creating the pillow. The chicken wire pillow held about 3/4 of a bushel of oyster shells. Again because the roll of chicken wire was 36” high, 3 pillows are needed to cover all of the drain holes. Do not use copper clips as to the toxic nature of this material.

Results -

The results of the bio-filter/solids filter were immediately seen. The ammonia smell disappeared as this compound was detoxified into nitrite and nitrate. Water clarity improved as the suspended solids were taken out of the recirculation system. It did take longer for the bio-filter nitrogen reducing bacteria to grow because the system was refrigerated. Although the chicken wire held up, we used fiberglass door screen material for the next pillows with good results. Pillows did have a life period, however, especially the solids filters. When fine particles closed most of the sand/gravel voids, the filter clogged and water spilled into the overflow pipe to the system tanks, a self-regulating component of this gravity system.

Problems/Concerns -

Sunlight and algae problems seem to be a concern, the ammonia component was reduced lessening toxicity, but then provided algae the available nitrogen on which to grow. One Rhode Island operator was able to clear the tank of nuisance algae overnight by placing 24 oysters on top of the bio-filter. Oysters started feeding if the water temp was in the 55 to 58 degree F range, which it was, and cleared the 1000 gallon system in less than 10 hours. However, questions were raised if these oysters were to be resold as certified.

Shellfish needed to be sold only if harvested from clean “approved waters.” It would be difficult to distinguish the "filter oysters" from the "market oysters." Eventually, these oysters were placed in a small hardware cloth locked to tank support and a label glued on each oyster stating “not for sale.”

The second problem was changing the filter pillows especially the solids filter. The sand/gravel matrix worked well. Fines and fecal matter were removed quickly, however, caution must be taken in removing the filter pillow, avoid jerks or twists, solids are loosely held and they will come out if the pillow is pulled or pushed. Careful attention must be paid when changing the filters or the results could easily be negated.

Reusing the filter pillows-

Filter pillows were recycled by cleaning with a hose and dunk tank. The filter contents were shaken to dislodge the fines and solids. Almost no level of cleaning could completely remove all the fines without loosing most of the contents or ripping the filter pillow. It was concluded that one reuse was all that could be expected. It might be easier to just install a new one. That is up to the owner/operator.

Building and Testing the Filter Pillows -

Care should be taken to wash fines from coarse sand and gravel. Oyster shells
should be free of mud and sun-dried if possible. Once the filter pillows are built,
test the solids filter for a gallon/per minute flow rate. Set up the filter on land and time, a one gallon and 5 gallon test. This should give up a gallons per minute flow rate. If 50 gallons per minute system flow, the filter (conclusion should be able to treat 100 gallons/minute.

Conclusion -

The use of biological filters and suspended solids filter pillows was an economical way to reduce fouling in lobster and crab re-circulating and holding systems. Filter pillows could last us long as two months and reused although were

seen to be less effective with each reuse. Materials could be purchased from hardware or department stores, quickly assembled and integrated into system flows. In one case, which prevented a gravity feed system, a by-pass loop was created to treat a portion of the system water in a room apart from the tanks. This by-pass filter “loop” worked well but increased the treatment time as only 50% of the water was subjected to the treatment process as compared to the 100% gravity feed system of all flow to the solid filter which then feed the bio-filter and then entered the system tanks.

Reference: Marine Fisheries Review #1349
Volume #10 October 1978
Environmental Parameters Affecting Fish Physiology in Water
Reuse Systems Meade, Thomas L. - Pg 46-47