Crab and Lobster Live Holding Systems Part III - (Filters and Instrumentation)

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The rapid development of the British Shellfish Industry and the requirement to export live shellfish has lead to the industry needing better methods and information about live holding. This data sheet is part of a series forming a guide to the selection of equipment needed to successfully store and transport live crabs and lobsters. These data sheets should be used in conjunction with data sheets:

Handling Crabs for the Live Trade: Part I and II. This sheet is a guide to both the filters, and instrumentation requirements of live holding and vivier systems.

Water Quality

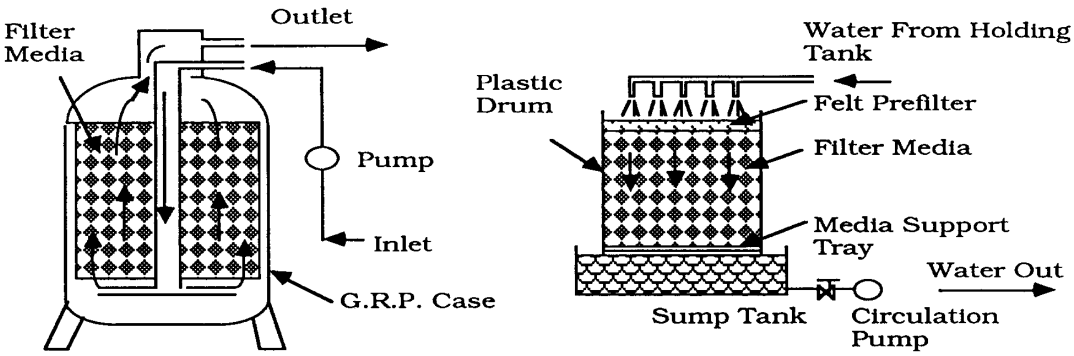
The condition of the water used in any type of live holding system is crucial. Proper filtration and careful control of its condition is essential, particularly in the case of recirculated water systems where toxic wastes can become concentrated. If fresh seawater is being used, a pre-filter is recommended. When the seawater pumps are stopped for a time, algae and silt can accumulate in the inlet pipework, and this can be flushed through into the holding tanks when the pumps are restarted. A pre-filter, removing particles down to approximately 100mn (microns), should help prevent this happening.

Biological Filters

This type of filter is extensively used in recirculating aquaculture systems. Biological filters utilise the natural action of nitrifying bacteria to break down ammonia in the water into less harmful substances. Ammonia is a product of dead and decaying matter and is present in the excretia of living animals. It is a major problem in re-circulating systems. Biological filters are effective at removing ammonia, by breaking it down into nitrous acid. The nitrous acid then combines with a base to form nitrites and finally nitrates which are harmles to fish in small quantities.

Biological filters provide an environment in which these bacteria can multiply; their main requirement is a large surface area on which they can grow. This can be done in several ways, cockle shells, coarse gravel, chopped up small diameter drain pipes, plastic pan scrubbers, and purpose made plastic Biofil media, fig no. 1.

Typical Manufactured
Biological Filter Medium



BIOLOGICAL FILTERS **Fig No 1**

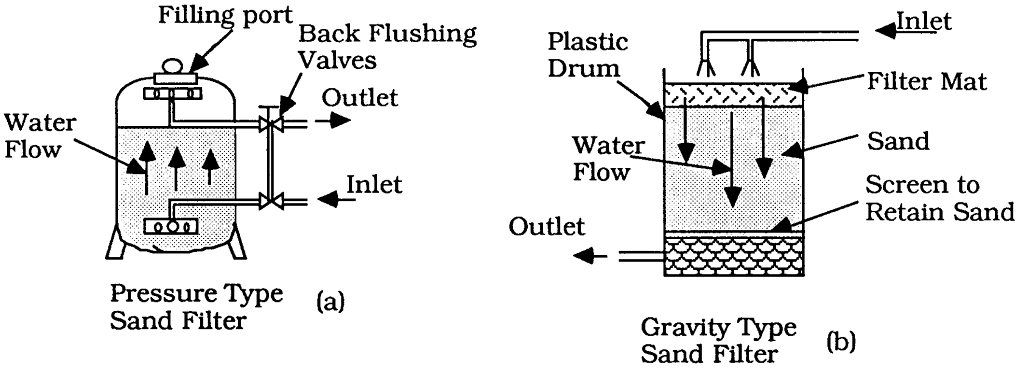
The size of a biological filter depends on several factors. The most critical is the active area of the filter bed. A biofilter with a well distributed flow will support 70 to 125kg of products per m^2 of filter area. A biological filter needs a continuous biological load to keep it alive and working, it also requires a supply of well oxygenated water. Water should be re-oxygenated before returning it to the holding tanks. The nitrifying bacteria will be introduced into the system when it is first stocked with animals, the bacteria is naturally present on their bodies. Once the bacteria has been introduced into a system it will grow on any suitable surfaces where there are nutrients (ammonia).

Unfortunately, it takes 4 to 6 weeks for a biological filter to become established and reach a balance within the system. This can be reduced by buying concentrated culture of nitrifying bacteria and specially mixed nitrogenous salts for feeding the bacteria, thus reducing the stablizing time to about 3 weeks.

Biological filters work well in large recirculating systems which can provide them with a constant biological load. Biological filters require little maintenance other than regular back flushing to prevent the media becoming clogged with silt. Good water circulation within the filter is vital to keep the bacteria alive and active.

Sand Filters

Sand filters remove particles from water by passing it through a bed of sand. Particles are trapped in the spaces between the sand grains. Filtration levels depend on the size of sand grains; using a 0.4 to 0.8mm sand should give a filtration down to 10 microns. Sand filters can be of the pressure or gravity feed type.



SAND FILTERS   Fig No 2

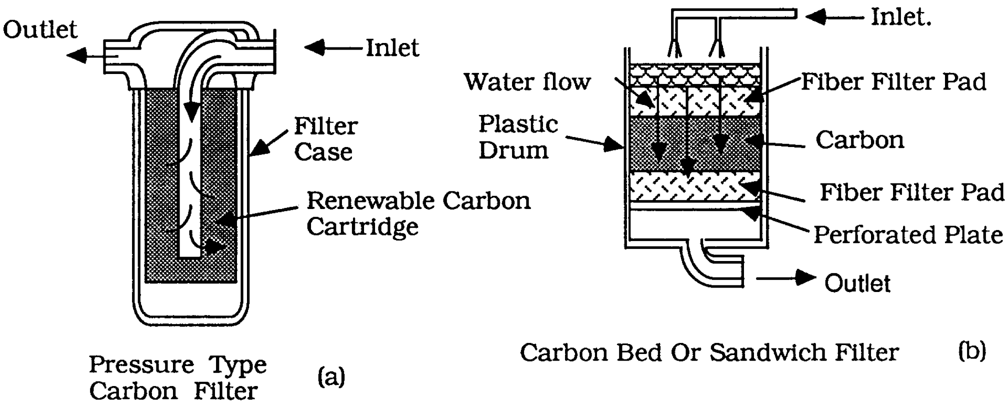
Pressure sand filters are more compact than the gravity type. They can be bought as single units with capacities up to 500 Lt/min. They are also fitted with valves for back flushing. As the sand becomes filled with solid waste, the water flow becomes restricted and the inlet pressure will increase. This increase in pressure is used as an indicator for when the filter needs back flushing. If the filter becomes clogged this can lead to a problem known as channeling, when this happens the water passing through the filter takes the route of least resistance and quantities of water can pass through the filter uncleaned. To prevent this happening the filter has to be backwashed. Backwashing is achieved by reversing the flow through the filter to agitate the packed sand thus removing unwanted particles. The water used for backwashing has to be discarded. This type of filter can be purchased with automatic backwashing facilities. Sand filters are used in small recirculating systems and as pre-filters for biological filters. They can also be used as pre-filters in non-circulating seawater systems.

Carbon Filters

A carbon filter works by removing dissolved organic material from the system, and gives the water a crystal clear look. It is for this reason known as a polishing filter. Carbon filters can be purchased as a cartridge type filter, fig no. 3 (a); these are easy to install and maintain.

A carbon bed filter can be fabricated as shown in fig 3(b). A bed of carbon is sandwiched between 2 layers of fiber filter pad. The water is allowed to flow down through the carbon. A cartridge filter makes better use of the carbon and is therefore more compact. The carbon needs to be changed on a regular basis, as it eventually becomes saturated and can remove no more impurities. It can, if left too long, release impurities back into the system. The filter manufacturer should be able to advise on the filter size for your application and the best type of carbon to use.

It should in general be a granular type of food quality. Carbonfilters are useful for small holding systems especially if the products are on view to the customer. They are also useful



in portable systems where they are compact and cartridges can be changed during the journey.

Mechanical Filters

Mechanical filters remove particles from the water by straining them out. They can be made to remove particles down to 0.2 of a micron, or up to 1mm. As they work purely by straining out particles they are no good at removing chemicals like ammonia from the water. Most filters are of the cartridge type. The filter media may be in the form of perforated metal, a woven material bag, (known as a bag filter), various types of fibre, pleated and non-woven plastics, dependent on the application.

Bag filters can be made to cover very large flow rates up to 4500m^3 /h. This makes them useful as prefilters for large non-circulating holding systems.

The smaller cartridge filters with elements filtering down to approximately 5 microns can be used in small holding systems or transport systems.

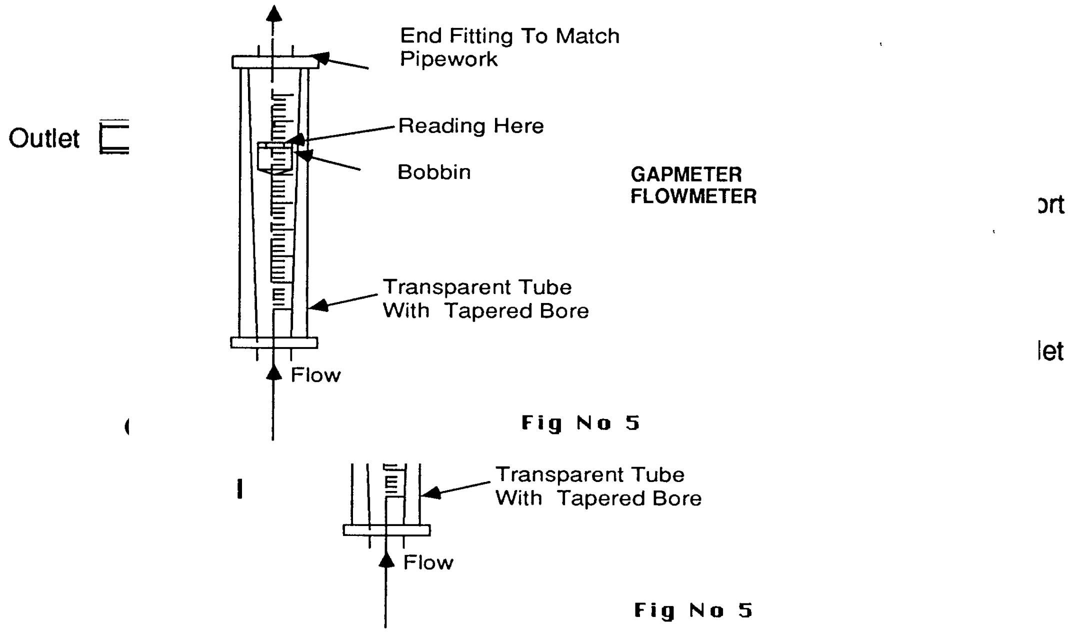


Fig No 5

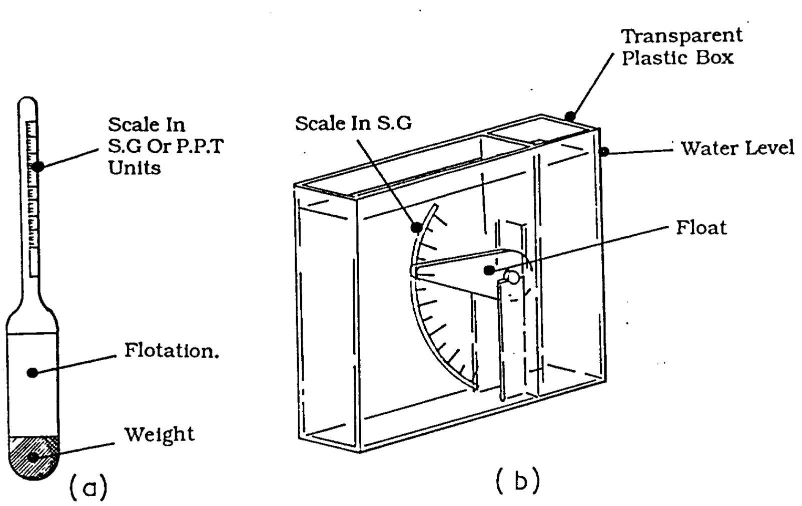
Fig No 5

Instrumentation

It is important that the water conditions in live holding systems are as close as possible to those the animals would see in their natural habitat. This can only be done by using instruments to make measurements. Instrumentation can take the form of extremely complex and expensive systems with alarms and controls. Here will will consider the basic parameters and instrumentation to measure them.

Flow Meters

A simple Gapmeter Type flow meter, fig no. 5 is adequate.



HYDROMETERS Fig No 6

Salinity

The salinity of the water can change in a flow through system if the intake water is diluted with rain run off water. In a recirculating system evaporation losses can cause an increase in salinity. Basic instrumentation is required to measure and control the condition and quality of the water. Thus, one of the first parameters that will need to be measured is the salinity of the water; this is difficult to measure directly. It is found by measuring the specific gravity of the water with a Hydrometer. The standard Hydrometer, fig no 6, is delicate and easily broken. The type shown in fig. no. 6(b) is easy to read and very robust. Specific gravity of water is affected by temperature and Hydrometers need to be used with a correction table or graph. These tables can also be used to convert the specific gravity readings directly into salinity in parts per thousand. The readings to be aimed at are given in table no. 1.

Temperature

The temperature of the system is also important. The thermometers used should have a range of 0^o to 30^oC. Any of standard spirit in glass thermometers is quite adequate for this purpose. With Mercury thermometers there is a possibility of Mercury contaminating the system.

The modern electronic digital thermometers are very accurate, robust and versatile. Water temperatures should ideally be held in the range 5^o to 10^oC. Rapid changes in water temperature should be avoided.

pH

The pH of the water is a good indication of the quality of the water in a system. pH is a measure of the acidity or alkalinity of the water. The pH scale ranges from 1 to 14, 1 being the most acid and 14 alkaline, 7 is neutral. The accumulation of Ammonia or Nitrate in the water will cause the pH to drop and the water will become more acid. The measurement of pH is relatively easy. Electronic instruments are available to measure pH directly but require a degree of expertise to get reliable readings. pH test paper or liquid kits are available (both rely on either paper or a liquid mix change in colour. The colour is then compared with a standard chart) they are inexpensive and adequate for this type of work.

It is recommended that the pH of a system is held in the range 7 to 8.5 (see Table No. 1). The pH of the water has an effect on the toxicity of the ammonia in the water so for this reason it is worth holding the pH as close to neutral 7 as possible. Most of the salts used to prepare artificial salt water contain buffering compounds that slow any changes in pH. pH values can be increased by the addition of proprietary chemicals to the filter beds. In a flow through system the pH will be at that of natural seawater, approximately 8.5, as with a flow through system there will be no accumulation of waste products, there should be no problems with ammonia concentration.

Ammonia

Ammonia is toxic to all aquatic animals. Unfortunately it is also part of the animals' waste products, and is also produced by decaying matter. In recirculating systems ammonia can accumulate if it is not filtered out and for this reason dead animals should be removed on a regular basis. Ammonia levels should not be allowed to rise above 10 parts per million. Ammonia test kits are available that work in a similar way to the pH test kits where tablets are added to a sample of the water and its colour is matched to a standard chart.

Table No. 1

Paramter	Meter Reading
Temperature	5^{o} - 10^{o}C
Specific Gravity	1.024 - 1.029
Salinity	28 - 32 parts/thousand
pH (Acidity/Alkalinity)	7.0 - 8.5
Ammonia (NH3)	Less than 10 parts/ million
Dissolved Oxygen (DO2)	7 milligrams/litre 75% saturation (min)

Dissolved Oxygen

The level of dissolved oxygen in the system water is very important, if the levels are low the animals will suffocate or suffer high levels of stress. In a new sytem it is important to measure the dissolved oxygen levels in all areas of the tanks to ensure there is good water circulation. The amount of oxygen that water can hold is related to its temperature: the higher the temperature the lower the quantity of oxygen it can hold. Electronic instruments are available which measure dissolved oxygen directly. The meters are calibrated in milligrams per litre or % of saturation. As a guide the reading should not fall below 7 milligrams per litre or 75% saturation. Operating instructions for this type of instrument should be followed carefully if the readings are to be reliable.

It is good practice to perform water quality checks once per week or more regularly during the start up period, and to make records. A graph of changes will help predict performance or problems. In a flow through system check water temperature and salinity every day and make records. This will help predict the effects of ambient temp changes and heavy rainfall on the quality of the wter entering the system.

Further Reading

MAFF Laboratory Leaflet No. 37. The Live Storage of Lobsters.
MAFF Laboratory Leaflet No. 39. Artificial Seawater for Shellfish Tanks.

Guide to Controlled Environment Re-Circulatring Systems
Guide to Intensive Culture of Lobsters
Dr M Ingram BSc PhD
Consultancy Associates
(MICA)
Port St mary
Isle of Man

Design and Operating Guide for Aquaculture Seawater Systems
John E Huguenin and John Colt

Aquacultural Engineering, Frederick W Wheaton