SEAFISH

Seafish Standard Design Purification Systems: Operating Manual for the Vertical Stack System

March 2018

Seafish Report (SR) No.: 722
ISBN No.: 978-1-911073-28-4

Seafish

Origin Way
Europarc
Grimsby DN37 9TZ

T: +44 (0)1472 252 300
F: +44 (0)1472 268 792
E: seafish@seafish.co.uk

www.seafish.org

Seafish Standard Design Purification Systems

Operating Manual for the Vertical Stack System

Seafish Report (SR) No.: 722
ISBN No.: 978-1-911073-28-4

Updated March 2018 by Pyke and Deane Aquaculture Consultants
Email: consultmandy@hushmail.com

Seafish Standard Design Purification Systems: Operating Manual for the Vertical Stack System

Contents

1. The Development of the Seafish Vertical Stack Purification System

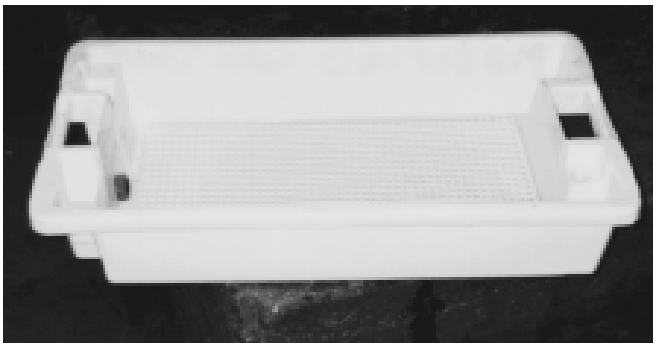
Vertical stack purification systems were developed during the 1960s and had the advantages over traditional shallow tank systems of a reduced floor area requirement and ready access to individual containers of molluscs. However, the capital cost of such systems was generally high compared with shallow tanks and consequently their use was usually limited to the purification and subsequent storage of high value molluscs such as oysters and clams.

Although the concept of the vertical stack system was good, Seafish was concerned with the apparent poor seawater flow characteristics and the methods of draining down of most systems. There was a need to ensure sufficient water flow to maintain adequate dissolved oxygen levels whilst not disturbing the molluscs, and the methods of draining down must minimize the possibility of recontamination. The original drainage methods were partly a result of such systems also being intended for crustacean storage.

Seafish built prototype systems and after extensive development work and trials this became the basis for a standard design with a nominal capacity of 2,000 oysters.

2. How Does the Seafish Vertical Stack System Work?

The molluscs are held in purpose-designed solid-sided containers, which are supported in a stainless-steel frame over a plastic pallet box (650 litres) used as a sump tank. The framework supports a total of sixteen containers in two vertical columns. Seawater is drawn from the sump up to one end of the top container of each stack. It flows along the container and then cascades down from the other end into the container below, and so on until it returns eventually to the sump. The cascades provide re-oxygenation between containers.

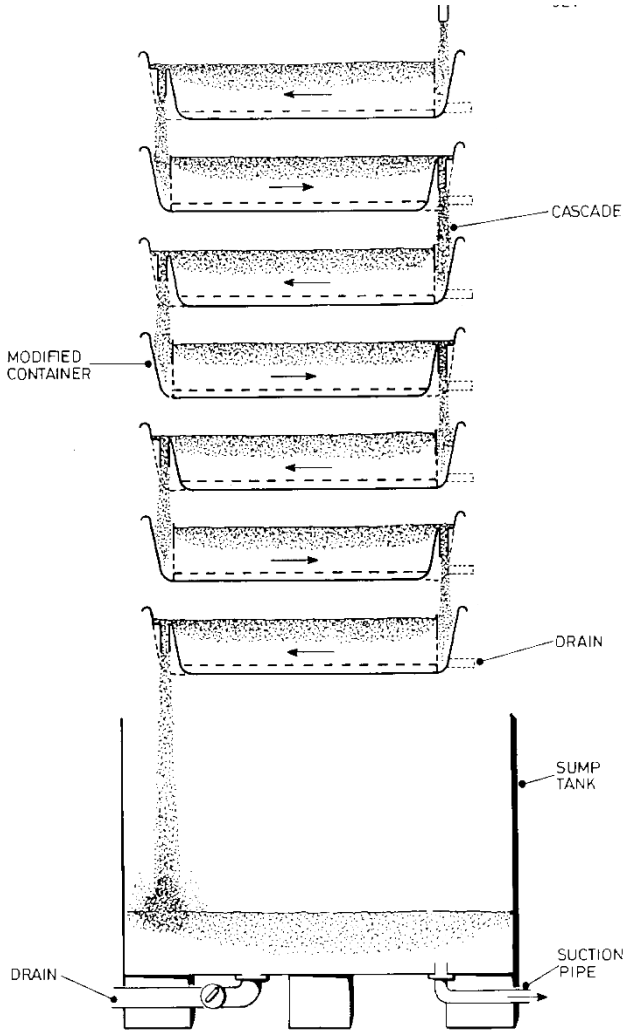


Modified container

Containers supported on stainless steel frame

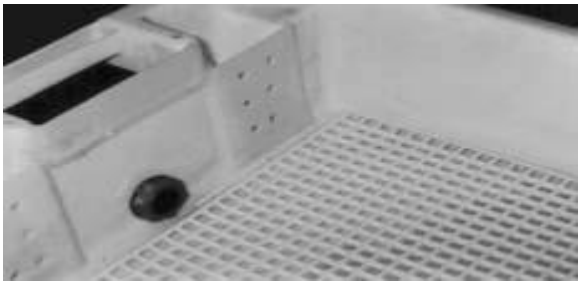
The mollusc containers used are a specially modified Allibert Type 12030 or similar, which has external dimensions of 800 mm x 450 mm x 150 mm.

The modifications ensure a uniform flow of seawater through the molluscs and that the cascade is not directed onto the molluscs in the container below. This involves the partitioning of the recesses at one end of the container with small plastic flow-screens to contain the initial turbulence of the water cascading into them. At the other end of the container plastic overflow pipes are fitted to maintain the required water level and direct the water into the recesses of the container below.



Side view through vertical stack system

A drain tap is fitted to each container to provide independent drainage of seawater directly to the sump via a central drainage pipe mounted between the columns of the boxes. This enables the removal of individual containers without draining down the whole system. The drain tap is fitted such that not all of the seawater drains out and 10% of the seawater is retained. This is to prevent the sediment that settles out on the container bottom being returned to the sump.



Partitioned recesses, drain and mesh floor mat

Each container is fitted with removal mesh plastic mat. This holds molluscs clear of the bottom of the container and accumulated sediment.

Seawater is re-circulated via the pump and the flow rate is controlled by a valve and flowmeter. This control is essential if the system is to operate effectively. The seawater receives microbiological treatment by passing through an enclosed ultraviolet light (UV) sterilisation unit.

The molluscs function naturally in the clean seawater and purge themselves of bacteriological contamination. The detritus settles on the base of the container.

3. The Approval of Purification Systems

For England, Wales and Northern Ireland approval will be decided by a Local Authority (LA) Authorised Officer (AO). AOs will follow the guidance provided by the Food Standards Authority (FSA)[1]. The Food Business Operator (FBO) should prepare for the approval process and have a Food Safety Management Plan (FSMP) in place based on Hazard Analysis and Critical Control Point[2] (HACCP). Conditional Approval (CA) can be granted by an AO, however, this must not last more than six months. If the 'establishment' is not fully compliant within this time, approval must be withdrawn. The FBO must provide evidence to the AO to demonstrate compliance. Bacteriological tests are the responsibility of the operator of the purification system and can prove time consuming and costly, particularly if repeat testing is required. Approval in Scotland is overseen by Food Standards Scotland (FSS)[3].

The AO will issue "approval" for a system only if satisfied that it is designed and operated in accordance with

[1] https://www.food.gov.uk/enforcement/monitoring/shellfish/shellfish-purification
[2] https://www.food.gov.uk/business-industry/food-hygiene/haccp
[3] http://www.foodstandards.gov.scot/business-and-industry/industry-specific-advice/fish-and-shellfish

basic rules and that there is sufficient evidence to demonstrate that the system will purify bivalve molluscs satisfactorily. This may require them to make a site visit before approval, to carry out a technical inspection, and for a bacteriological test to be carried out. The bacteriological test is the responsibility of the operator of the purification system and can prove time consuming and costly, particularly if repeat testing is required.

4. The Standard Design Concept

The range of standard design purification systems developed by Seafish are built to specified designs that meet the technical requirements and which have been tested extensively in a wide range of conditions. Being proven designs, bacteriological testing may be less stringent and consequently they have a more predictable, simplified, less time consuming and less expensive approval procedure.

5. Seawater Supply

The FBO is responsible for the quality of natural seawater used. The seawater must be free from contamination in quantities that may adversely affect the molluscs or be subsequently harmful to the consumer. Either natural or artificial seawater can be used. The FBO is responsible for the quality of natural seawater used. Guidance on this subject has been produced by Seafish and Cefas It should be 'clean' and not contain any contaminants that could become a threat to human health.[4]

Factors affecting the suitability of seawater are:

Turbidity: Turbidity is the measure of particles or opacity in seawater that obstructs light. It can be measured in Nephelometric Turbidity Units (NTU). An advisory limit for depuration plants has been set at less than 15 NTUs. Any obstruction to the transparency of seawater will inhibit the ability of UV light to disable bacteria. Turbidity meters can be obtained should there be a problem with turbidity for a plant.

Salinity: This must suit the particular species of bivalve mollusc being held and should ideally be similar to the area from which they were harvested. Seawater salinity should be checked ideally before the tank is being filled. The seawater salinity must be within the range required for the species, and can be measured using a hydrometer. If the reading shows the salinity to be too low or high it should be re-checked and if still incorrect the water must not be used.

Salinity can be too high if an incorrect mix of artificial seawater has been used or evaporation has occurred over a period of re-use.

Salinity that is too low can result from an incorrect artificial seawater mix or, in the case of natural seawater, too much dilution from a natural freshwater source. For natural seawater supply it may be possible to wait for a change in tidal conditions.

The salinity of artificial seawater can be adjusted by dilution with tap water or adding extra salt. Care must be taken to maintain the correct mixture of salts.

Minimum levels of salinity for some species are given in the table below:

[4] https://www.cefas.co.uk/media/52850/2012-water-quality-in-purification-leaflet.pdf

Minimum Seawater Salinity

Species	Min salinity ($^0/_{00}$)
Pacific oysters (*C. gigas*)	20.5
Native oysters (*O edulis*)	25.0
Mussels (*Mytilus* spp.)	19.0
Cockles (*C. edule*)	20.0
Hard clam (*M. mercenaria*)	20.5
Native clam (*T. decussatus*)	20.5
Manila clam (*T. philippinarium*)	20.5
Razor clam (*Ensis* spp.)	30
Scallops (*P. maximus*)	35
Thick trough shell (*S. solida*)	30
Peppery furrow shell (*S. plana*)	20.5
Sand gaper (*M. arenaria*)	25

Microbiological Treatment: Initial low levels of microbiological contamination are reduced by UV treatment of the water before it enters the tank[5]. Repeated cycling of water through a low wattage UV bank over time can reduce bacterial contamination[6] if high wattage lamps are not available. The use of ozone to supplement but not replace UV treatments is permitted and should be included in the FSMP if used[7,8]

Position of Seawater Intake: This must not draw in waste from other discharges, it should be sufficiently below the water surface to avoid poor quality surface water and be above the seabed where mud or fine sand are present. The times when suitable seawater may be drawn may be limited by tide and this may require the provision of water storage tanks ashore.

Artificial Seawater: Artificial Seawater has higher initial cost but can offer considerable advantages where systems are to be operated inland or local supplies of natural seawater are considered unsuitable. Advice on the production and use of artificial seawater is given in a Seafish technical advisory document on the re-use of seawater for purification systems[9].

[5] WHO http://www.who.int/water_sanitation_health/emerging/depuration.pdf
[6] Cefas 'Ultraviolet disinfection in depuration systems in England & Wales'
[7] https://www.food.gov.uk/sites/default/files/multimedia/pdfs/enforcement/enfni10039annb.pdf
[8] https://www.cefas.co.uk/media/52849/20100827-ozone-discussion-document-uk-final.pdf
[9] http://www.seafish.org/media/Publications/FS32_07_09_Reuseofseawaterforpurificationsystems.pdf

6. System Installation

Tank location should avoid direct sunlight. The system must be installed such that it sits level, and the frame must be secured to the sump tank by the four pinch bolts. This is to ensure that there is a uniform depth of water maintained in the containers.

A final check on levels is made when running the initial test, as described in Section 7.

The seawater re-circulation equipment is usually installed by the manufacturer but may be self-assembled provided the manufacturer's instructions are followed.

The seawater re-circulation equipment consists of a waterproof pump attached externally to the bottom of the sump with a flow control valve, flowmeter, UV steriliser and inter-connecting pipework mounted on the panel which forms the back wall of the system.

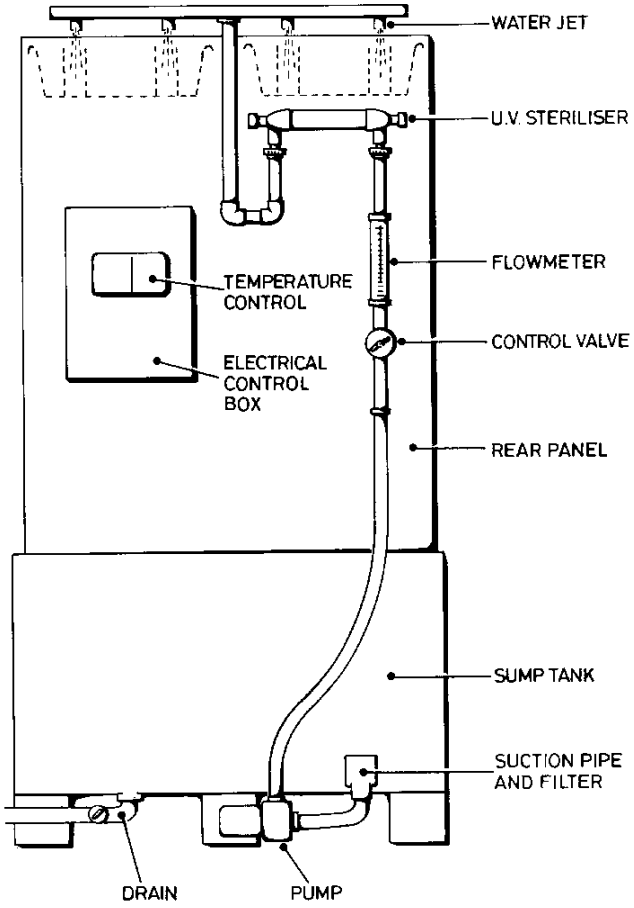
An electrical control box is also mounted on the rear panel and contains the switches. If a seawater heater is provided the thermostatic controller may also be mounted in the control box, the temperature display being visible through the clear panel in the control box door. The temperature controller must be set-up in accordance with the manufacturer's instructions.

Seawater pump

The thermostat cable and one or two titanium heater units sit in the sump. The heaters must not be located adjacent to the thermostat and must be held clear of the plastic tank surface by the collars provided.

Although the equipment is designed to be splash proof care should be taken to keep it dry by avoiding areas used for washing molluscs, etc. Clear plastic side panels are fitted to the container support frame to contain any splashing.

The controls must be accessible and the flowmeter and UV clearly visible. Pipework and equipment should be installed such that they drain when the system is emptied, to avoid leaving areas of stagnant water when not in use. If this is not practical then means of draining specific pipework or equipment should be included. Access for maintenance is important, particularly to the UV sterilisation unit which will require periodic cleaning and tube replacement.



Seawater circulation system

If artificial seawater is to be used, or the seawater re-used, the sump can act as a reservoir. The seawater feed pipe to the pump is clear of the base to avoid circulating solid material. However, the sump must not be used as a settlement tank for turbid raw seawater supply and if this is required then a separate tank should be installed for that purpose.

A single phase electrical supply is usually adequate. All connections and switches used within the working area where the system is installed must be hose proof. IP66 classification is recommended. Cables must not be left trailing on the floor.

7. Initial Testing

A new system must be run firstly filled with seawater only, to check that the water circulation system will operate correctly and that there are no leaking joints, and then be left to run overnight. The container positioning and water filling procedures are given in Section 8.3 and 8.4. Leaks will probably be a result of joints being inadequately tightened. The system must be able to operate at the required water flow of 15 litres/minute. The UV lamp must operate correctly. Check the water levels and the operation of the water spray jets and cascades.

The water depth in the containers must be uniform and the water jets and cascades must be even and be directed into the partitioned recesses of the containers. Adjustments to level can be made by placing shims between the frame and the sump tank. These should be provided by the supplier of the system.

After draining down, the tank should be cleaned as described in Section 9.3.

Even water flow from overflow pipes

Level adjustment between frame and sump

8. System Operation

When used for purification, the operating requirements specified in the FSMP must be followed. Although the instructions given in this manual are in line with established practices, the FSMP apply to each individual system and may incorporate special conditions depending on the particular circumstances of operation.

Purification is a batch process. Firstly, the containers are loaded with molluscs and positioned in the frame, then water circulation commences and the containers fill with seawater from the sump. After the requisite period the circulation is stopped and the seawater is drained from the containers back to the sump. The purified molluscs can then be removed. The system must not be disturbed (i.e. trays moved or molluscs added or removed) during the requisite period of depuration.

Batches of molluscs from different sources must be kept separate for documentation purposes, enabling the tracing of molluscs back to source, but different batches from the same category of harvesting area can be held in the same purification system. Current legislation prohibits the mixing of species in a purification system. The mixing of species would be harmful if the conditions did not suit all the species concerned. Although the vertical stack system has two columns of boxes, they share the same water and still form part of a single system.

8.1 Mollusc Supply

It is often forgotten when handling live bivalve molluscs that they are a live animal and even though encased in a hard shell they are easily damaged and physically or thermally shocked. Molluscs must be in good intrinsic condition if they are to be active when re-immersed and it is advisable, therefore, that the handling history between harvesting and arrival at the purification or dispatch centre is known and acceptable.

Depending upon species and harvesting techniques, damage to a few molluscs may be inevitable. However, if more than a few molluscs are dead, gaping or showing signs of excessive shell damage then the batch should be rejected. The time from harvesting should be known as molluscs should not be out of seawater in excess of the stated period in the FSMP. For some species, such as those grown in sub-littoral areas and not used to being out of water, this time period must be short. For cockles a maximum of 12[10] hours is recommended. When out of seawater a raw material storage temperature of between 2°C and 10°C is generally recommended, however native oysters should not be held at less than 4°C and mussels can be iced.

When approaching their spawning season bivalve molluscs are more susceptible to shock, and great care needs to be taken if spawning in the tank is to be avoided. Molluscs are weakened by spawning, and often they are not harvested until they have sufficiently recovered.

8.2 Loading the Containers with Molluscs

The molluscs must have been thoroughly washed with clean water to remove silt, sand and weed before being put into the containers, and care taken not to roughly handle them. Any dead or damaged molluscs should be removed.

[10] Minutes of Meeting to discuss depuration issues – Cefas/FSA/Seafish 1 December 2008 Aviation House, London

Container Loading

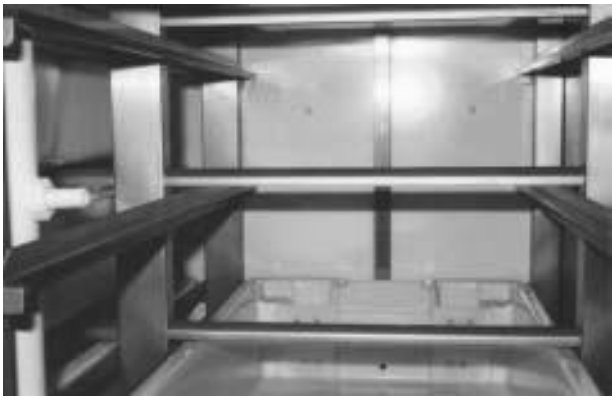
Species	Depth	Nominal Amount
Mussels	80mm	15kg
Pacific Oysters	Double layer	125 oysters
Native Oysters	Single Over- lapping Layer	125 oysters
Clams	80mm	21kg
Cockles	80mm	15kg

The mesh matting must first be placed in the bottom of the containers and then the molluscs can be loaded to depths no greater than those specified in the table above. The nominal weight (or number in the case of oysters) is only a guide and will vary with season, harvesting area and size.

8.3 Loading the Containers into the Frame
Because of the alternating flow direction through the stack, the containers are 'handed' and each must be loaded such that the jets or cascades from above are directed into the partitioned recesses of the container below, and the drain taps are to the front. The containers may be marked or numbered to assist in this.

The containers are slid into the frame, supported on their rims, to position against the stop at the back of the frame. The drain taps are then connected into the flexible pipes leading to the central drainage pipe to the sump, although the bottom pair of boxes drain directly into the sump. The drain taps must be closed.

If the system is to be only part loaded all the containers should still be installed to aid water circulation and reduce splashing.



Vertical stop bar, frame runners and support

Flexible drain tubes and central drain

8.4 Filling and Recirculating the Seawater
The sump is usually filled prior to loading the containers (if the water is being re-used it will already be in the sump). Filling from an external source requires a gravity or separate pumped feed via a hose directly into the sump. Before filling the coarse suction filter on the sump, the suction pipe should be unscrewed, cleaned and replaced. The sump must be filled with sufficient seawater to fill the containers, which is usually indicated by a water level mark inside the tank. This is 50 mm from the top of the tank. If there is not enough seawater in the tank the pump can be damaged by running dry.

Before switching on the circulation pump, the UV unit must be switched on and care taken to ensure that the tube is functioning correctly. This is usually indicated by an annular ring of green/blue light at the end caps of each unit. If the light flickers, is dull or is not on, refer to Section 10.4. The water must then pass through the UV before reaching the molluscs.

If a seawater heater is to be used the thermostat unit in the control box should be set to the required seawater temperature (Section 8.6) and the heater switched on.

The pump can now be switched on and the seawater will start to fill the containers. The flow valve can be turned fully open but must be turned down to the required flow rate of 15 litres/minute once the containers are full.

The flowmeter is of the in-line flow-through type and is read from the widest part of the indicator.

A check must be made to ensure that all the containers have been correctly orientated and that the water cascades are even. All molluscs must be immersed and should initially be well covered by about 30 mm of seawater. Once respiratory/filter feeding activity begins there is a tendency for molluscs to move up within the container, reducing the depth of water above them. During the first few hours of operation the water level in the sump may fall slightly if the molluscs have lost intervalvular fluid during transport or storage and replenish it as their shell halves open.

8.5 Seawater Salinity

Seawater salinity should be checked whilst the sump is being filled.

The seawater salinity must be within the range required for the species as given in Section 5 and can be measured using a hydrometer as described in Section 12.2. If the reading shows the salinity to be too low or high it should be re-checked and if still incorrect the water must not be used unless corrective action is taken. Salinity that is too low can result from an incorrect artificial seawater mix or, in the case of natural seawater, too much dilution from a natural freshwater source. For natural seawater supply it may be possible to wait for a change in tidal condition.

The salinity of artificial seawater can be adjusted by dilution with tap water or adding extra salt. Care must be taken to maintain the correct mixture of salts.

8.6 Seawater Temperature

Mollusc activity is dependent upon seawater temperature and adequate dissolved oxygen levels. Minimum seawater temperatures are stipulated for the purification of each species to ensure adequate mollusc filtration activity. A maximum seawater temperature is stipulated for mussels, which have a high oxygen demand. In addition, if seawater temperature is too high all molluscs will weaken, spawn or die and so maximum temperatures are recommended for all species. These depend upon species, growing conditions and season. The temperatures normally required for purification are shown below.

Seawater Temperature

Species	Minimum	Maximum
Mussels	$5^{O}C$	$15^{O}C$
Native Oysters	$5^{O}C$	$15^{O}C$
Pacific Oysters	$8^{O}C$	$18^{O}C$
Clams	$12^{O}C$	$20^{O}C$
Cockles	$7^{O}C$	$16^{O}C$

Large temperature differentials between molluscs and seawater when filling the purification system should be avoided as this may reduce mollusc activity, induce spawning or even cause mortality. To avoid this, molluscs should be allowed to reach the required temperature slowly.

If suitable seawater temperatures cannot be maintained the system must not be used for purification.

A seawater chiller can be fitted as well as a heater but must be installed and operated such that the water flow is not disrupted. Further information should be obtained from the tank manufacturer and approval must be sought from the AO.

8.7 Mollusc Activity

When the molluscs are immersed in seawater they should exhibit signs of activity by slightly opening their shell halves. Often air bubbles will be seen rising to the water surface as entrapped air is released. After a few hours the shell halves should be more open and, depending upon species, mantles or syphons should be visible. Some species are more active than others. Mussels are often active within minutes, whereas hard shell clams exhibit intermittent activity. After two to three hours the molluscs should be active and the seawater clear (tank bottom visible). If not, the system should be drained down and the reason sought. Inactive molluscs will not purify satisfactorily.

Foaming on the water surface is created as a result of the build-up of dissolved waste excreted by molluscs. The amount of foam will depend upon species, level of activity and the extent of re-use of seawater. It is not normally a problem with a vertical stack system as any overflow will return to the sump.

8.8 Immersion Time

For purification, the minimum immersion time required will usually be 42 hours. It is possible in certain circumstances to reduce the depuration time[11]. However, this can only be done with the approval of the AO.

The immersion period can be extended prior to draining down if it is desired to store the full load of molluscs in the system. Extended storage of cockles is not recommended as they become exhausted and die.

If during a purification cycle the system should stop operating, the time lost must be made up to ensure the required purification time has been achieved. If the system has been stopped or is operating at a reduced flow for more than a few hours the molluscs may have been weakened. If they show signs of weakness such as gaping, or even mortality, the molluscs must not be consigned for human consumption.

8.9 Draining and Unloading the Containers

At no time whilst they are immersed must molluscs be disturbed or removed as this can cause re-suspension and ingestion of settled out material. Containers must be drained before removing the molluscs.

To drain the containers, turn off the circulation pump and UV, then, checking that the flexible tubes are connected to the central drain pipe, open the drain taps to allow the seawater to return to the sump. Once drainage has stopped, close the drain taps and separate the flexible pipes. Some water and the detritus will be left in the bottom of the containers but this will be below the molluscs.

The containers can then be slid out of the frame and the molluscs removed from the container. The molluscs must then be washed with clean water, without re-immersion and the required sorting and packing operations carried out. As the finished product must be alive, this should be done with care to minimise shock and damage. Packaging must be clean and labels attached as instructed by the LA. A product storage temperature of 2°C to 5°C is generally recommended, however, native oysters should not be held at less than 4°C and mussels can be iced.

The seawater left in the bottom of the container cannot be re-used and must be tipped to waste with the

[11] http://www.seafish.org/media/publications/Red_Dep_Time_V3IB_RF.pdf

detritus. The containers and floor mats should be washed whilst wet before sediment dries on.

If only some of the molluscs are to be packed after purification and the system is to be used for immersed storage of the remainder, all the containers must still be emptied and washed out and then be re-loaded. Instructions on part-loading the system given in section 8.3 should be followed.

If the seawater is to be re-used, that lost to waste will have to be replenished with new seawater as necessary. Also, in warm weather there may be a need to make up evaporative losses.

Sump drain

If the seawater is to be totally replenished the sump is emptied via the drain valve situated under the front of the pallet box and any sediment flushed out.

8.10 Monitoring the System Operation

For a purification centre, details of molluscs received, start and finish times of purification, and details of subsequent consignments must be recorded and checks of seawater salinity, temperature and UV lamp life made. These details are best recorded in tabular form using a log sheet such as that shown at the end of the manual.

The source column could include registration document number. It is recommended that seawater temperature is measured at the start, middle and end of purification. If a time recorder is not fitted to the UV sterilisation unit then hours switched on should be recorded cumulatively to give an indication as to when the lamps need replacement (Section 9.2). The comment column can be used to note anything that occurred during purification such as a power cut or pump failure and subsequent action taken. The dates also allow a check on seawater re-usage.

If more than one purification system is used each should have its own log sheet to avoid confusion.

Log sheets must be filled in legibly and be kept somewhere dry, such as an office, and not be left lying around in the purification or dispatch centre. It is a good idea to keep basic system details of start and finish time, salinity and temperature on a chalk or pen board mounted on a wall. This serves as a daily reminder of status and can be transferred to the log book on a weekly basis.

8.11 Seawater Re-Use

The approved FSMP prescribe conditions under which seawater can be re-used for each purification system, and generally permit re-use over a specified period of time. However, this period is prescribed as the maximum limit of water usage and the operator of a purification system must satisfy himself at each successive re-use within the period that the water quality is adequate. If molluscs appear inactive when immersed (see section 10.6) and water quality is suspected, new seawater should be used. If seawater quality is the cause, molluscs will usually become active when re-immersed in the new seawater.

The re-use of seawater for successive purification cycles can result in dissolved waste from the molluscs accumulating in the seawater to a level which may inhibit purification. This depends upon the species of molluscs, their intrinsic condition, the loading of the purification system and the seawater temperature. The Seafish vertical stack system was originally developed for oyster purification using artificial seawater, and for this usage the re-use of seawater over a period of one month would normally be permitted. However, for more active molluscs, such as mussels, this would not be advisable.

When re-using seawater, the salinity will increase as a result of evaporation, particularly when

temperatures are high, and care must be taken to ensure it does not go beyond the prescribed level. Seafish have produced guidance[12] on this subject.

8.12 Microbiological Sampling

Operators of purification systems are required to carry out microbiological testing on samples of molluscs. Microbiological sampling for end product testing and/or system efficacy can only be determined by the FBO as they will understand the risks associated with the batch and processes under their control.

Sampling frequency will be based upon the assumed level of microbial contamination on harvesting, standards of operation at the purification centre and adherence to industry good practice guidelines (13.1). The laboratory should carry out a prescribed microbiological or viral analysis procedure.

A sample of molluscs must contain sufficient shellfish flesh for a test to be carried out; 10-15 molluscs would normally be taken as a sample. With large molluscs it may be possible to use less (although never less than six). Dead or gaping molluscs should not be used. The laboratory will advise if sample size is inadequate and sometimes will not accept samples below a certain number, so it is advisable to check.

The sample molluscs should be put into a clean plastic bag and be kept in cool conditions, ideally at 4°C (an insulated box containing freezer packs is the method normally used) and be delivered to the laboratory within 24 hours. Molluscs must not be frozen. The samples must be labelled to enable identification.

The microbiological results must show that the purified molluscs comply with any relevant legislative or FSMP requirements. If these standards are not met then the AO must be contacted for further advice.

9. Cleaning and Maintenance

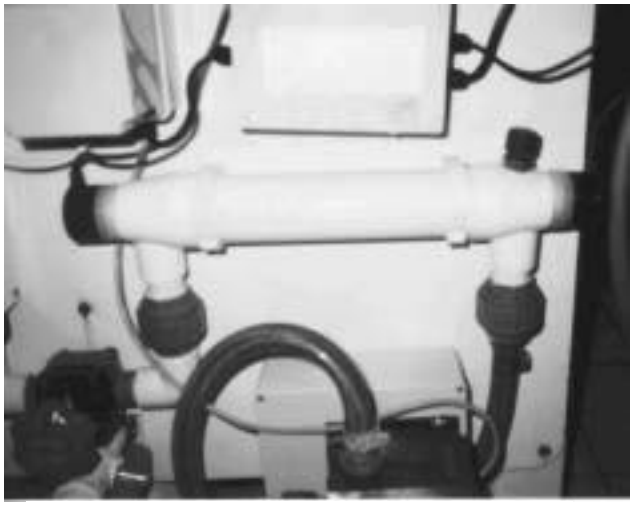
9.1 Pump Filter

A coarse filter is fitted within the sump on the suction pipe to the pump to prevent any large shell pieces from entering the pump and causing damage. This requires occasional cleaning and is removed (with the pump switched off) by unscrewing the filter assembly from the suction pipe. The filter element is then removed and rinsed with clean tap water. The assembly can then be replaced.

9.2 Ultra Violet Light (UV) Sterilisation Unit

A single 25-watt UV lamp unit is fitted.

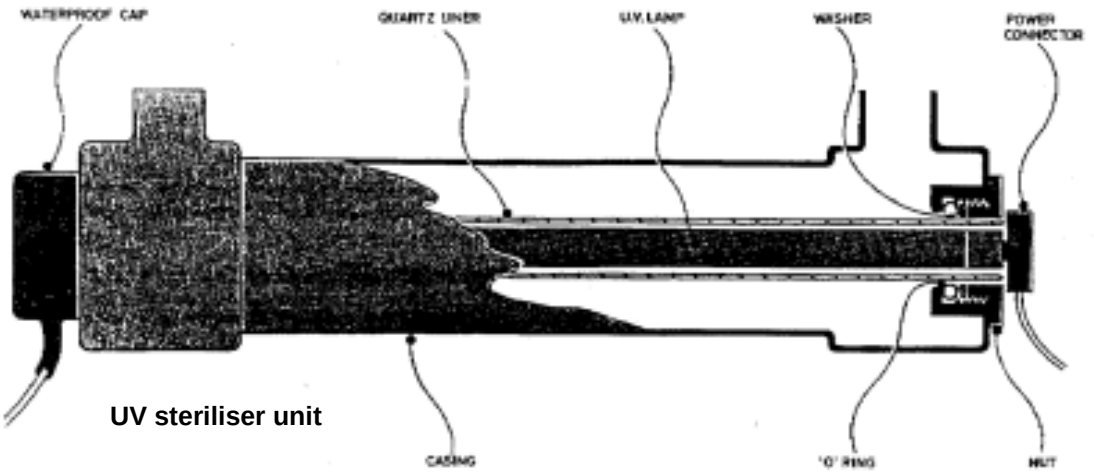
Safety: UV light is dangerous to the eyes and skin and the lamp must never be operated outside its housing. A green/blue glow may be seen at the ends of the unit to indicate that it is on in normal use. Before any cleaning or maintenance is carried out the electrical power must be switched off.



25-watt UV lamp Unit

[12] http://www.seafish.org/media/Publications/FS32_07_09_Reuseofseawaterforpurificationsystems.pdf

Lamp Replacement: The lamps gradually deteriorate in use and must be changed as specified in the FSMP. This may be based upon the intervals specified by the lamp manufacturer in terms of hours of use, however, a calendar time interval may be given instead.



UV steriliser unit

To replace a lamp:
- Switch-off the power
- Carefully pull-off the lamp connectors and covers from either end, supporting the tube if mounted vertically
- Gently slide the lamp out of the quartz sleeve
- Fit the new lamp in the reverse procedure

Cleaning: The quartz sleeve may need cleaning occasionally as a result of sediment building up on its outer surface. The accumulation of sediment will depend upon the clarity of the water supply and it is recommended that the sleeve is checked after a few weeks to give a guide to the frequency of cleaning required.

To remove the quartz sleeve:
- Switch off the power and remove the UV lamp as described above
- Make sure the water has been drained out of the unit
- Unscrew the end nuts and remove the “O” ring seals and washers (this is sometimes difficult). The tube will need support at the bottom of the unit if mounted vertically to prevent it falling out
- Withdraw the quartz sleeve, taking care to handle it at the ends only, and inspect it carefully. If cracked the sleeve must be replaced. The sleeve should be cleaned with soapy water and gentle brushing if necessary. The sleeves discolour after many years of use and if badly stained should be replaced
- Rinse and dry the sleeve and replace it in the unit Inserting a clean wooden dowel into the sleeve can assist in this and reduce the chance of breakage
- Replace “O” rings and washers and tighten the nuts with hand pressure only and, if necessary, re-connect to the plumbing system
- Turn on the water and check for leaks
- Replace the lamp

If access to the UV unit for servicing is difficult it may be easier to first remove it from the tank.

9.3 Purification System Cleaning

After each purification cycle the purification tank should be thoroughly flushed out with clean water to remove silt and shell debris. Containers should be hosed down.

To prevent accumulation of slime and dirt the tank and pipework should periodically be cleaned with a

suitable cleaning agent. Hypochlorite solution (as found in household bleach) is recommended. The empty containers should be loaded into the tank, the system filled with tap water and the hypochlorite added (with care, following manufacturer's instructions). It should then be switched on and left for a few hours, preferably overnight. After cleaning the system must be thoroughly flushed through with clean water to remove any traces of residual chlorine, which will harm molluscs.

Cleaning agents must be stored in a safe place away from the mollusc handling and purification areas.

9.4 Sand Filter

If a sand filter is used for seawater supply (it must not be fitted such that it forms part of seawater re-circulation), care must be taken to follow the manufacturer's operating instructions. In particular, the pressure gauge should be checked, as excess pressure indicates the filter is becoming clogged and requires back flushing.

10. Possible Problems and Answers

Occasionally things can go wrong due to equipment failure, poor handling, poor seawater quality or poor intrinsic quality of the molluscs, or simply incorrect operating procedure. The following gives some of the more likely problems and answers but by no means covers every possibility. If the cause of a problem cannot be found, further advice should be sought by contacting Seafish.

10.1 Difficulty in Filling the Tank with Seawater

- Water level in reservoir too low (below pump)
- Air lock in supply pipework
- Valves incorrectly set
- Pump filter partly blocked

10.2 Water Flow Stopped

- Power supply off (if circuit trip in control box will not re-set, contact electrician)
- Pump failure
- Control valve turned off
- Pump filter blocked
- Water level in tank below suction pipe

10.3 Water Will Not Flow at Required Rate

- Pump filter partly blocked
- Pipework fouled with marine growth (in particular spray or suction bar)
- Air leak on pump suction. When this occurs, air can be seen passing through the sight tube of in line flowmeters, or air accumulates in the saddle type
- Valves partly blocked or incorrectly set
- Worn pump

10.4 UV Lamp Unit Not On or Flickering

If the green/blue light does not appear at the ends of the unit when switched on, or the lamp flickers, the unit is not operating correctly.

- UV lamp faulty and requires replacement
- Starter unit in control box faulty
- Corrosion on terminal ends

10.5 Excessive Foaming

- Water flow greater than that prescribed
- Water re-use. With seawater re-use there can be a gradual build-up of the dissolved waste that causes foaming, particularly with mussels and at higher seawater temperatures. More frequent water replacement may be necessary

10.6 Molluscs Appear Inactive Whilst Immersed

- Incorrect salinity
- Seawater temperatures too low or too high
- Seawater quality poor (re-used too often)
- Inadequate water flow
- Molluscs in weakened condition as a result of poor handling and/or delays between harvesting and re-immersion
- Molluscs in seasonally weak condition (post spawning)
- Thermal shock. Molluscs subjected to too great a temperature change when re-immersed

10.7 Seawater B ecomes Cloudy

If during purification or immersed storage the seawater becomes clouded (usually a milky colour) the molluscs have probably spawned and if held in the system will die. Spawning does occur naturally but can be precipitated by shock and high-water temperatures. The clouding of the water should not be confused with the slight turbidity that can sometimes occur when molluscs are initially immersed. This can be caused by mud and silt not removed completely by washing and should disappear within a few hours.

10.8 Molluscs Die or Appear Weak

Molluscs generally gape when dead or are in a weakened condition, and will not close their shell halves at all or only close them slowly when disturbed.

- Molluscs have spawned
- Molluscs in a weakened condition (see 11.6)
- Water temperature too high
- Too long a period of immersion
- Molluscs stressed following a period with no water flow

11. Modifications to Purification System

Modifications to the system or its method of operation should not be made without first contacting the AO. The design flow conditions in the system must be maintained if it is to operate effectively and modification may disrupt this. The LA must approve of any changes made.

12. Measurement of Seawater Salinity and Temperature

12.1 Temperature

A hand held digital electronic probe thermometer is recommended. A robust and water-resistant type should be used and its calibration checked at intervals (for example in a container of clean, iced, fresh water). Glass thermometers are prone to breakage and if used to measure seawater temperature this should not be directly in the purification system but in a suitable container (as used for salinity measurement) filled from the tank.

The continuous monitoring of seawater temperature is possible using special electronic sealed units that can be positioned in the purification system.

12.2 Salinity

Seawater salinity should be checked normally using a hydrometer. These are usually made of glass so care must be taken and measurement made in a suitable container filled from the tank. The container must be clean and be deep and wide enough to allow the hydrometer to float without touching the sides or bottom (a soft drinks bottle with the top cut off can be used).

The hydrometer will usually give a reading of specific gravity (SG). From this and seawater temperature the conversion chart is used to obtain a salinity reading.

Some hydrometers can give a direct reading of salinity with built-in temperature compensation. For this type the salinity conversion chart is not required.

Using the traditional type hydrometer:

1. Fill the container with seawater, place on a bench at eye level and let any air settle out
2. Insert the hydrometer (ensuring it is clean) and let it settle making sure it is afloat and not touching the container sides
3. Read the hydrometer scale level with the water surface ignoring the surface tension meniscus around the hydrometer stem. The scale is usually between 1.000 and 1.050 and is a reading of specific gravity (SG)
4. After use, wash the hydrometer and container with tap water

13. Further Information

13.1 Other Operating Manuals

Seafish have produced a series of these operating manuals for the range of standard design purification systems available. These include shallow tank, multi-layer and bulk bin systems. There is also a manual for those who wish to operate a system constructed to their own none-standard design.

Title	Seafish Report No.	ISBN No.
Operating Manual for the Bulk Bin System for Mussels	718	978-1-911073-24-6
Operating Manual for the Large Scale Multi-Layer System	719	978-1-911073-25-3
Operating Manual for the Medium Scale Multi-Layer System	720	978-1-911073-26-0
Operating Manual for the Small Scale Shallow Tank System	721	978-1-911073-27-7
Operating Manual for the Vertical Stack System	722	978-1-911073-28-4
Generalised Operating Manual for Purification Systems of Non-standard Design	723	978-1-911073-29-1

13.2 Seafish and Seafish Advice

At Seafish[13] our mission is to support a profitable, sustainable and socially responsible future for the seafood industry. Our remit includes everything - and everyone - from fishermen and processors through to importers, retailers and food service providers. We offer an advisory role to industry, local food authorities and government departments. Where resources permit, Seafish will provide general advice when possible and appropriate, and/or signpost enquirers to other sources of information and service providers.

13.3 Artificial Seawater

Artificial Seawater has higher initial cost but can offer considerable advantages where systems are to be operated inland or local supplies of natural seawater are considered unsuitable. Advice on the production and use of artificial seawater is given in a Seafish technical advisory document on the re-use of seawater for purification systems[14].

13.4 Seafish Technical Reports

Technical Reports describing much of the work upon which the Vertical Stack Systems have been developed can be obtained from Seafish.

[13] http://seafish.org/
[14] http://www.seafish.org/media/Publications/FS32_07_09_ReuseofseawaterforpurificationsystemS.pdf

Title	Seafish Report No.
Biological Criteria for the Depuration of the Pacific Oyster (*Crassostrea gigas)* and the Design of Prototype Small Scale Depuration Plant.	433
Repeated re-use of Artificial Seawater in a Small Scale Vertical Stack Oyster Purification Plant Under Development by Seafish.	459

Further information on the operation of the Vertical Stack Purification System or any of the above-mentioned publications can be obtained from:

Lee Cocker, Aquaculture Manager and/or Lee Cooper, National Learning and Standards Manager
Seafish, Origin Way, Europarc, Grimsby, NE Lincolnshire DN37 9TZ
Tel: +44 (0)1472 252 300
Fax: +44 (0)1472 268 792
Email: seafish@seafish.co.uk

Purification System Log Sheet

Species	Amount	Source	Start		Finish		Seawate				UV Hours	Consignment	Comment
			Date	*Time*	*Date*	*Time*	*Sal*	*Temp*	*Temp*	*Temp*			