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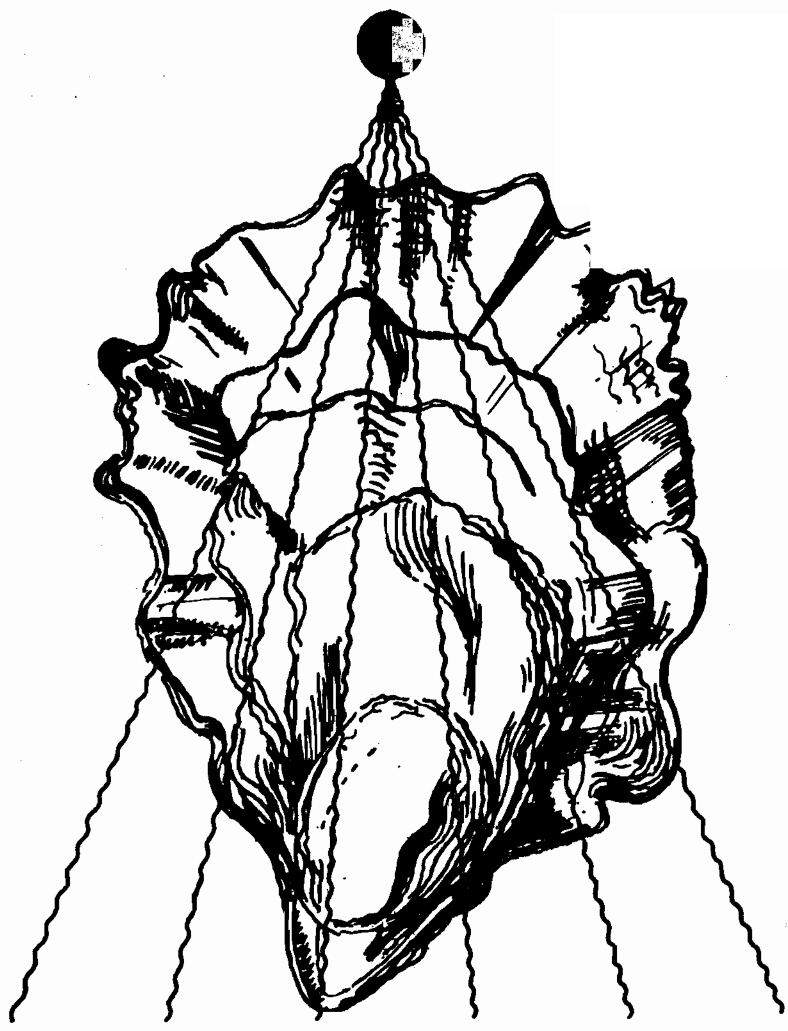
SHELLFISH PURIFICATION
IN INSTALLATIONS USING ULTRAVIOLET LIGHT



P.A. AYRES

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The author:

P. A. Ayres is a Senior Scientific Officer in the Aquatic Environment Protection Division of the Directorate of Fisheries Research. He is stationed at the Fisheries Laboratory, Burnham-on-Crouch.

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CONTENTS

		Page
1.	Introduction	1
2.	Requirements for shellfish purification	2
	2.1. Salinity	2
	2.2. Temperature and dissolved oxygen	3
	2.3. Shellfish density	3
	2.4. Pollution	4
3.	Siting of plant	4
4.	Equipment	4
	4.1. Pumps	4
	4.2. Plumbing	5
	4.3. Trays	5
	4.4. U/v sterilizers	7
	4.4.1. Weir-mounted sterilizer	8
	4.4.2. Enclosed u/v sterilizer	9
	4.4.3. General notes on the use of u/v lamps	10
5.	Tank design	12
	5.1. Large tank units (Figure 8)	12
	5.2. Prefabricated tank units (Figure 9)	13
	5.3. High density tray unit	15
6.	Operation of purification tanks	17
	6.1. Handling of shellfish	17
	6.2. Filling the system with sea water	17
	6.2.1. Natural sea water	17
	6.2.2. Artificial sea water	17
	6.3. Layout of shellfish	18
	6.4. Period of purification	18
	6.5. Removal of shellfish	18
	6.6. Breakdown of services	18
7.	Statutory and other requirements	19
8.	Check list for construction and operation of an ultraviolet purification plant	19
9.	References	20

Laboratory Leaflet Number 43

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by P. A. Ayres

1. INTRODUCTION

Purification of molluscan shellfish to render them free of faecal pollution has a history of almost half a century in England and Wales. Prior to the extensive work of Dodgson (1928) which used chlorine as a sterilizing agent for sea water in the purification of mussels, purification was undertaken during storage of oysters in intertidal pits before sale. Cole (1954) demonstrated that pits of this type could be used for purification, particularly in areas free of pollution at high water when the pits were flooded. The Dodgson system of mussel purification is still in use at Conwy, North Wales, where it was originally developed, but the process has also been adopted elsewhere with minor modifications (Reynolds 1956) and in the 1930s the method was used regularly for oysters at Brightlingsea, Essex (Wood 1957). Extensive experience in England and Wales has shown that the chlorine method is cheap to operate and ideally suited to the large-scale treatment of molluscs such as the mussel (Mytilus edulis), a relatively cheap commodity compared with oysters. The method has not been more widely adopted, even for mussels, primarily because of the lack of suitable sites and the high capital cost of constructing the large tanks necessary to purify mussels on a commercial scale.

In looking for an efficient, economic and small-scale method to be applied to the purification of the European flat oyster (Ostrea edulis), a more valuable commodity, Wood (1961) investigated the use of ultraviolet (u/v) light as a sterilizing agent for water. Following on from this initial development, tank systems of various types, all using u/v light, have been constructed in England and Wales and are operational at the majority of sites where oysters are produced. These commercial systems have permitted utilization of shellfish stocks from areas known to be polluted by sewage, including many which are closed or restricted under the Public Health (Shellfish) Regulations, 1934. An interesting result of the widespread use of purification has been to confer a special status on purified oysters which is now used as a selling point by wholesalers. In consequence, it is current practice to subject to a purification process the majority of marketable oysters in England and Wales regardless of whether they come from polluted areas or not.

All of the u/v systems operate on the same basic principle of holding shellfish in recirculated sea water for a period of 36 h during which time the water is subjected to a period of u/v irradiation. The background to the need for purification and other forms of treatment, together with a review of the methods used, has been published elsewhere (Wood 1961, 1969). Continued use of these systems by commercial operators led to a need for a small unit (capable of subsequent expansion) occupying limited floor area and suitable for processing high densities of shellfish in relatively small volumes of water.

The temperature requirements of European flat oysters and of the Pacific and Portuguese oysters (Crassostrea gigas and angulata) are such that purification may be achieved at water temperatures above 5°C and little supplementary heating is therefore required during winter months. Commercial exploitation of hard clams (Mercenaria

mercenaria) for the export market and for limited home consumption led to an assessment of the purification requirements of this species. Although more tolerant of low salinity than oysters, it was evident that the hard clam virtually ceased feeding below 10°C and to all intents and purposes hibernated during the winter months. Existing commercial purification plants for oysters and mussels were known to be generally effective for hard clams but to operate them in winter at water temperature approaching 15°C, as required by Mercenaria, was prohibitive in terms of cost. This factor added further weight to the need for a small compact system where such costs could be kept to a minimum, and a system of high density purification in trays was developed.

Additionally, there has been an increasing demand for purification and live storage facilities of all molluscan shellfish at inland sites, i.e. at market level. Here, much use is made of artificial sea water which can be conveniently prepared from tap water by the addition of a mixture of five simple salts (Wood and Ayres 1977) but the cost of preparation of the large water volumes required by conventional u/v systems are prohibitive.

This leaflet describes the general requirements and principles which may be applied to the purification of shellfish in large-scale tank systems, prefabricated tank systems and high density tray type units using ultraviolet light. Although mussels are mentioned, they generally sell at a low price compared with oysters and need to be produced in relatively large quantities to make purification economic. The tanks and units discussed below are not large enough for this purpose unless the mussels are produced for a small specialized market, e.g. direct sale to restaurants, hotels, etc. However, the principles of u/v purification can be applied to mussel purification and more detailed advice can be obtained from the address given at the back of the leaflet.

2. REQUIREMENTS FOR SHELLFISH PURIFICATION

Molluscan bivalve shellfish such as oysters feed and respire by passing a current of water between the two shell valves and over the gills. On the gill surfaces oxygen for respiration is removed from the water and small particulate matter, including food, organic debris and bacteria, is trapped in mucus and passes to the mouth for ingestion. In sewage polluted waters bacteria of faecal origin including possible pathogens to man may be ingested and accumulated. When such polluted shellfish are moved to an environment free of sewage pollution they will continue to feed and accumulate material in the gut, and at the same time continuously expel digested matter as waste material (faeces). The removal of contaminating organisms is due in part to their physical expulsion and in part to their natural die-off or mortality. This is the basis of the purification process.

Although the majority of commercially exploited bivalves can tolerate some variation in salinity, temperature and dissolved oxygen levels, for each species there is an optimal set of conditions at which filtration activity is at its maximum. For successful purification it is therefore desirable to create conditions near to the optimum for the animal being treated.

2.1. Salinity

The salinity or salt content of sea water is normally expressed as parts per thousand (°/oo); full sea water being approximately 35°/oo. For general purposes it may be readily determined by the use of a reliable hydrometer and thermometer using the conversion graph published in Laboratory Leaflet No. 39 (Wood and Ayres 1977). In British waters the minimum salinity requirements for those shellfish normally treated in commercial practice are as follows:

(75 mm), a depth which corresponds approximately to 1 cwt of mussels per 16 square feet of tank area (34.0 kg/m^2).

2.4. Pollution

Water used for shellfish purification should be free of obvious contamination, i.e. visible sewage contamination, oil or chemical pollution. Some turbidity or suspended silt load is acceptable since this will be removed by the feeding shellfish. Excessively turbid water should be avoided, however, as this will seriously impair the efficiency of u/v light (see Section 4.4.3).

3. SITING OF PLANT

The site selected for construction of a purification plant will depend to some extent on the type of plant proposed, but for those systems operating on natural sea water, ready access to sea water of adequate salinity is of prime importance. The inlet for the sea-water supply should not be sited near sewage outfalls, freshwater drainage or any source of contamination. Electricity and mains fresh water should be available. The tanks themselves should be placed in a building to guard against extremes of temperatures and to give an element of security. Toilet and washing facilities on site are advisable and may in fact be required by many local authorities. Once a site is selected it is advisable to contact both the planning and environmental health departments of the local authority to ensure that the proposals meet with their approval before construction begins. Failure to do this may prove to be expensive both in time and money.

The use of artificial sea water has introduced an element of flexibility by permitting the construction and operation of purification plants at inland sites. However, where it is available, natural sea water of adequate salinity should always be used in preference to artificial sea water.

Any site must be secure against contamination or fouling by domestic animals and the unit arranged so that it can be operated and maintained in an orderly and hygienic manner.

4. EQUIPMENT

When constructing a purification plant it should be borne in mind that few, if any, components are purpose-built for incorporation into these systems. When purchasing equipment care should be taken in selection because certain items, e.g. some pumps and u/v sources, are unsuitable. The addresses of potential suppliers of suitable equipment are available on request, but the information supplied should not be taken as an official endorsement or recommendation of any of the firms or items listed. Many similar products are available which may be equally suitable and providing the general points which follow are adhered to, no difficulty should arise.

4.1. Pumps

In considering which pump to purchase and install it is important to remember that this piece of equipment performs two vital functions, namely to circulate water for sterilization by the ultraviolet light and to oxygenate it. A reliable pump is therefore paramount; failure may ultimately mean the death of an entire tank full of shellfish or at the very least inadequate purification. Reliability means buying a good pump initially and subsequent regular servicing.

The pump may be of the positive displacement or centrifugal types; the body or impeller must not contain copper or copper alloys (brass, nickel, bronze, etc.) because these are toxic to shellfish. Pumps should be constructed of plastic materials such as polypropylene; among the smaller models, those which are magnetically coupled to the motor (i.e. shaftless) are particularly useful.

Other factors to be taken into consideration when purchasing a pump are the suction and head; i.e. the lift requirements, the output of water per hour and whether or not they are self-priming and suitable for continuous running. Generally, transfer pumps designed for low pressure operation are preferable to high pressure pumps. For large or prefabricated tank units described in Sections 5.1 and 5.2 the circulating pump should deliver a minimum of half the total water volume in one hour. The high density units (Section 5.3) require a circulation rate at least equal to the total volume per hour, but as they generally operate on reduced water volumes even a small pump is usually adequate. Providing the plumbing and other facilities can cope with the flow rate there is no disadvantage in increasing the circulation rate well in excess of this.

In some circumstances the circulating pump can be used for refilling the tanks with sea water, but where there is a long suction pipe or where water must be pumped within a short period (e.g. because of low salinity at other than high tide) another larger pump may be required. Portable petrol-driven 1½ inch centrifugal pumps delivering up to 4 000 gallons (18 200 l) per hour are highly satisfactory for pumping in sea water.

4.2. Plumbing

Copper or any of its alloys should be avoided in the circulation system. Galvanized piping and cast iron valves were formerly used but both require considerable maintenance to combat corrosion from sea water. An ideal plastic material is ABS (Acrylo-nitrile Butadiene Styrene) which can be widely obtained in tube form and in a variety of sizes and gauges. ABS plastic fittings such as bends, tee-pieces, taps and valves are also available and ideally suited for amateur construction, requiring only a hacksaw and the appropriate solvent cement. Although it is possible to use ABS to plumb directly on to pumps and u/v equipment, for easy cleaning such items should be attached to the general plumbing system by short lengths of flexible hose fastened with clips. This permits easy access to the equipment for servicing or repair, and, with adequate provision at the design stage, access to the entire pipework for cleaning.

In any tank system, the suction and delivery points should be so placed as to give the maximum circulation, i.e. they should not be placed directly adjacent to each other. In the sections which follow on plant design, suction and delivery points are indicated where appropriate.

4.3. Trays

For large-scale and prefabricated units (Sections 5.1 and 5.2) trays are necessary to hold the shellfish above the tank base away from their own waste products and to facilitate loading and unloading of the tank. Trays for this purpose may be constructed with a stout wooden frame and a ¾ inch (19 mm) mesh plastic net base to give adequate water circulation and to allow waste products from the shellfish to fall to the tank base. Each tray should be fitted with stout rope or other handles for easy handling. A tray containing 500 oysters may weigh over 1 cwt (50 kg) so an overhead rail with mobile block and tackle is a useful piece of equipment to install.

For the high density tray type system (Section 5. 3) the trays need to have considerable strength since they will hold water rather than be immersed in it. These may be as illustrated in Figure 1 of fibreglass (4 oz mat with gel coat finish internally) or of wood or plastic material. Providing there is adequate circulation and drainage a variety of types and designs of tray may be used. Use of one commercially available type of plastic tray is shown in Figure 2.

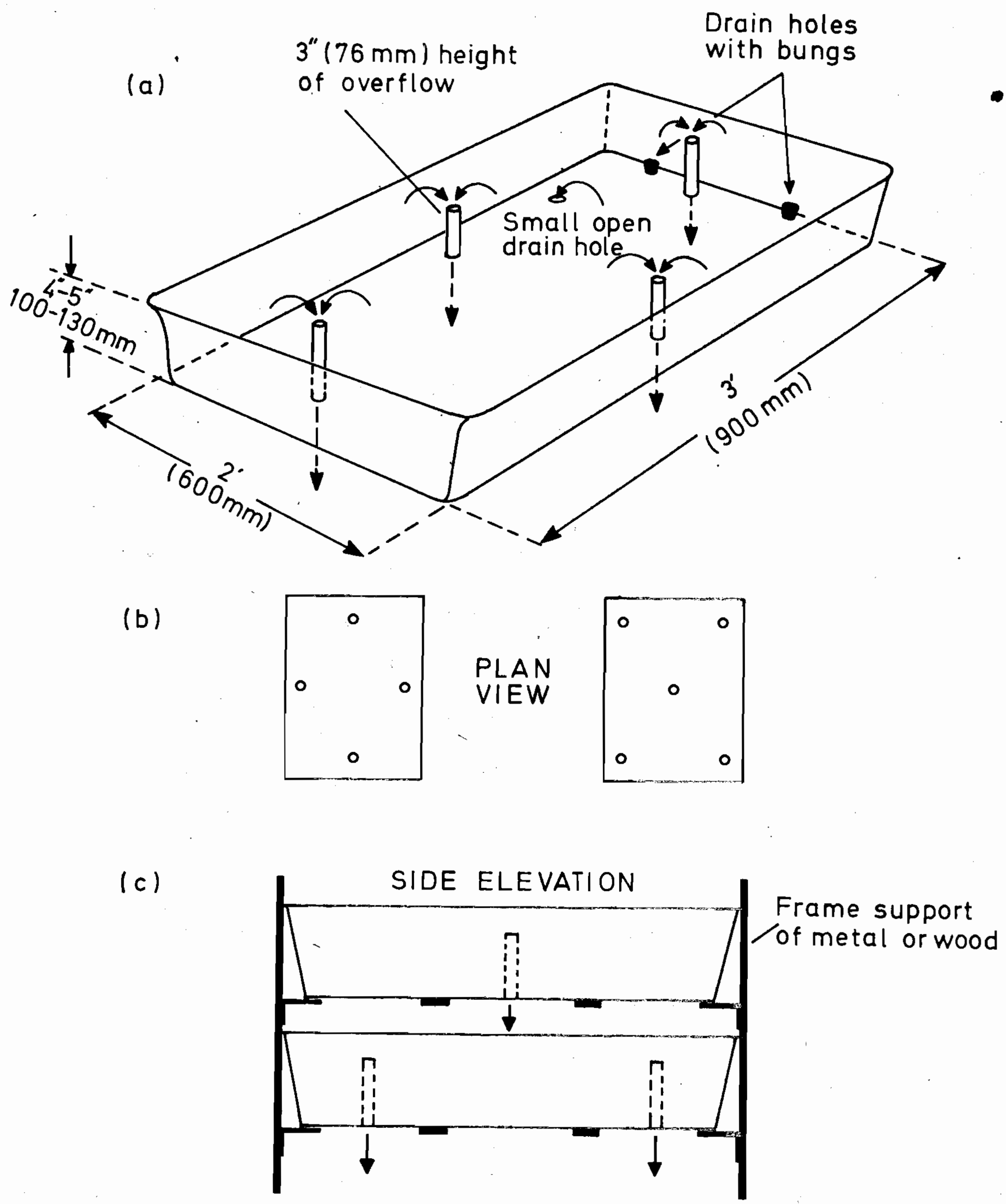

Figure 1 Diagram of trays for high density purification systems.
(a) Fibreglass tray with stand-pipe overflows.
(b) Arrangement of overflows for alternate trays (plan view).
(c) Arrangement of trays (side view).

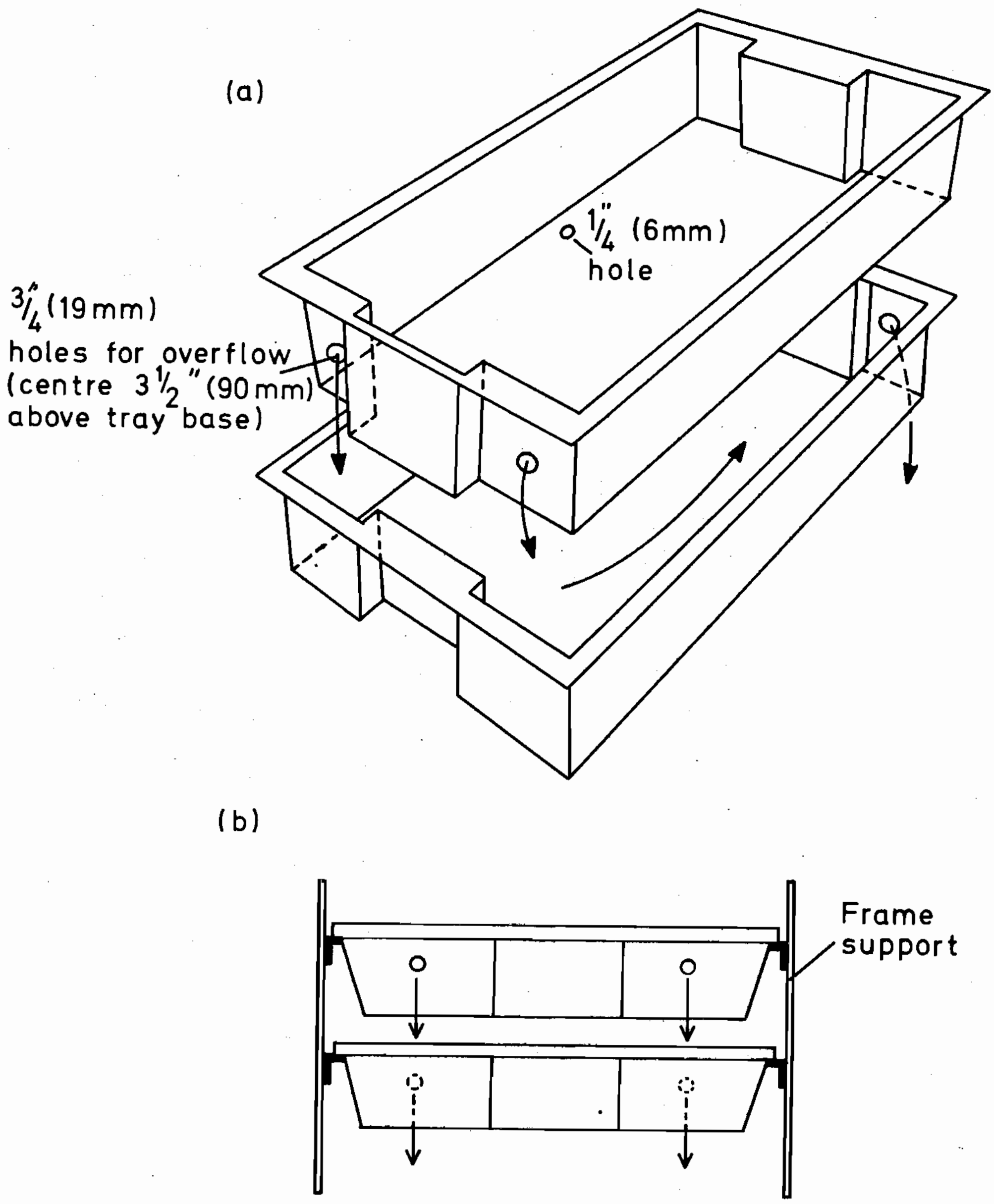

Figure 2 Use of commercially available plastic stack/nest containers for high density purification systems.
(a) Alternate arrangement of trays to ensure good water flow.
(b) General arrangement of trays (end view).

Dimensions of tray:

		Length	Width	Height
External	in	31.5	17.7	5.9
	mm	800	450	150
Internal	in	24.5	14.5	4.5
	mm	620	370	116

4.4. U/v sterilizers

U/v lamps are manufactured for a variety of purposes but it is only those which emit u/v light in the germicidal range (2537 Å) which are of interest in the context of shellfish purification. A number of different types are available commercially, usually incorporating high-pressure mercury vapour lamps inside a jacket designed to sterilize water or other liquids during a single passage through the lamp unit. Such units are normally expensive, often costing over £300 (at 1977 prices), and unduly sophisticated

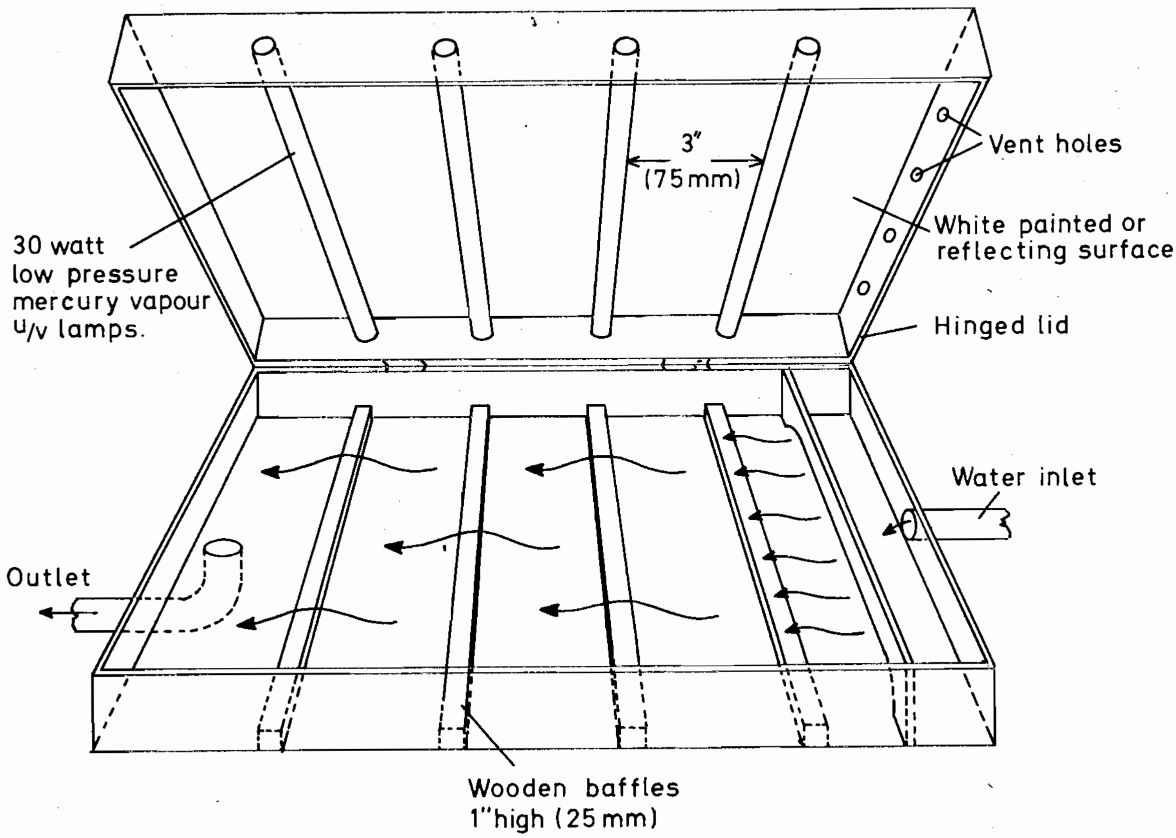

Figure 5 Multi-tube sterilizer unit, based on Kelly-Purdy system. Distance between lamps and water surface should be 3 in (75 mm) when lid is closed. Unit width 37 in (940 mm); length to suit number of tubes fitted, which should be at least 3 in (75 mm) apart.

The unit illustrated in Figure 6 is now commercially available. It is specifically designed for incorporation into a shellfish purification plant and uses relatively cheap replaceable components. The body of the unit is of ABS plastic piping with inlet and outlet hose connections. The barrel of the unit has screw threaded end caps each fitted with an 'O' ring gasket to grip the quartz sleeve and provide a watertight seal. A 30 watt low-pressure mercury vapour u/v lamp is inserted through the quartz sleeve and connected to the electricity supply. When more than a single 30 watt lamp is required the units may be used in series, or placed within a single water jacket (Figure 7) using several quartz tubes and a larger diameter plastic pipe.

4.4.3. General notes on the use of u/v lamps

(1) When 30 watt low-pressure lamps are purchased they should be left to burn continuously for 100 h before use in a purification system. This is necessary to stabilize the output of u/v irradiation, and unless it is done the lamp will initially operate well below its sterilizing efficiency.

(2) The 'glass' envelope of these lamps is of quartz composition to permit transmission of u/v light. If it is handled with bare hands, moisture and oil from the skin will mark the quartz and reduce transmission. Therefore the tubes should be handled either by the terminal ends or with a soft cloth or tissue.

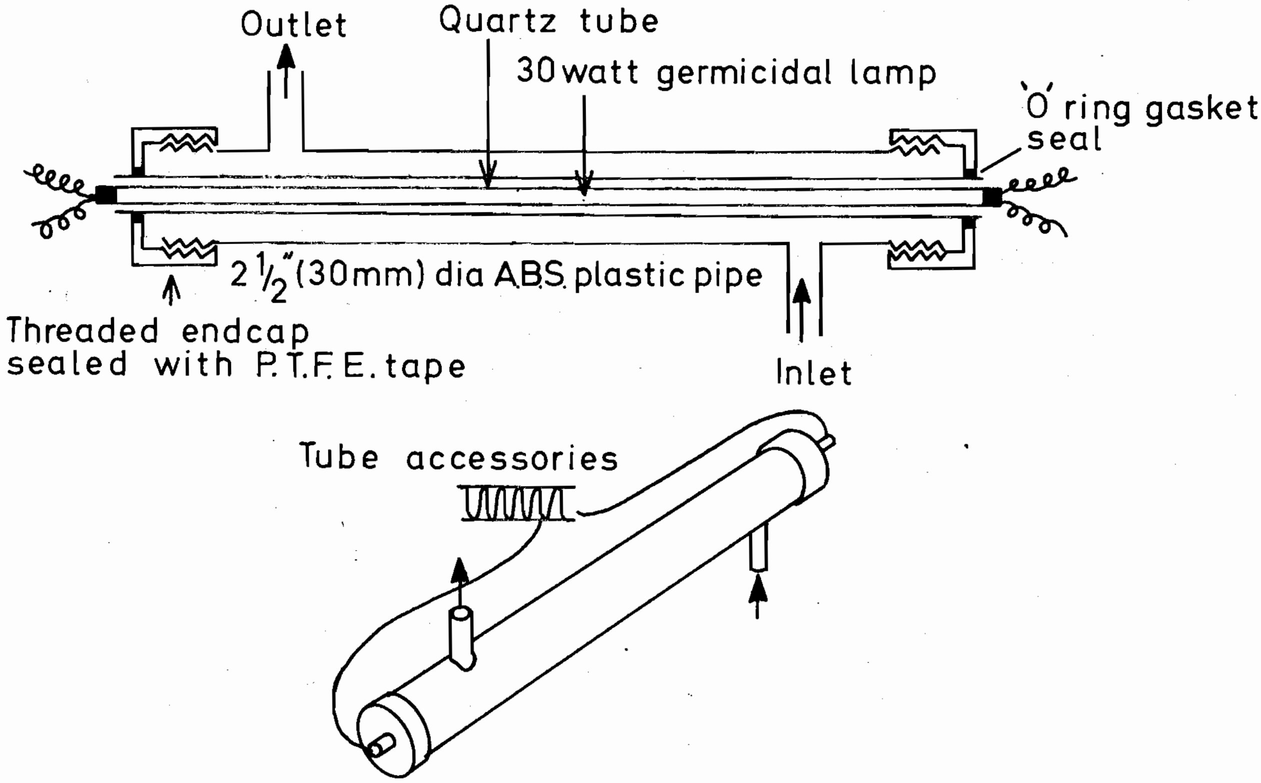

Figure 6 Diagrammatic layout of enclosed ultraviolet sterilizer (single 30 watt lamp).

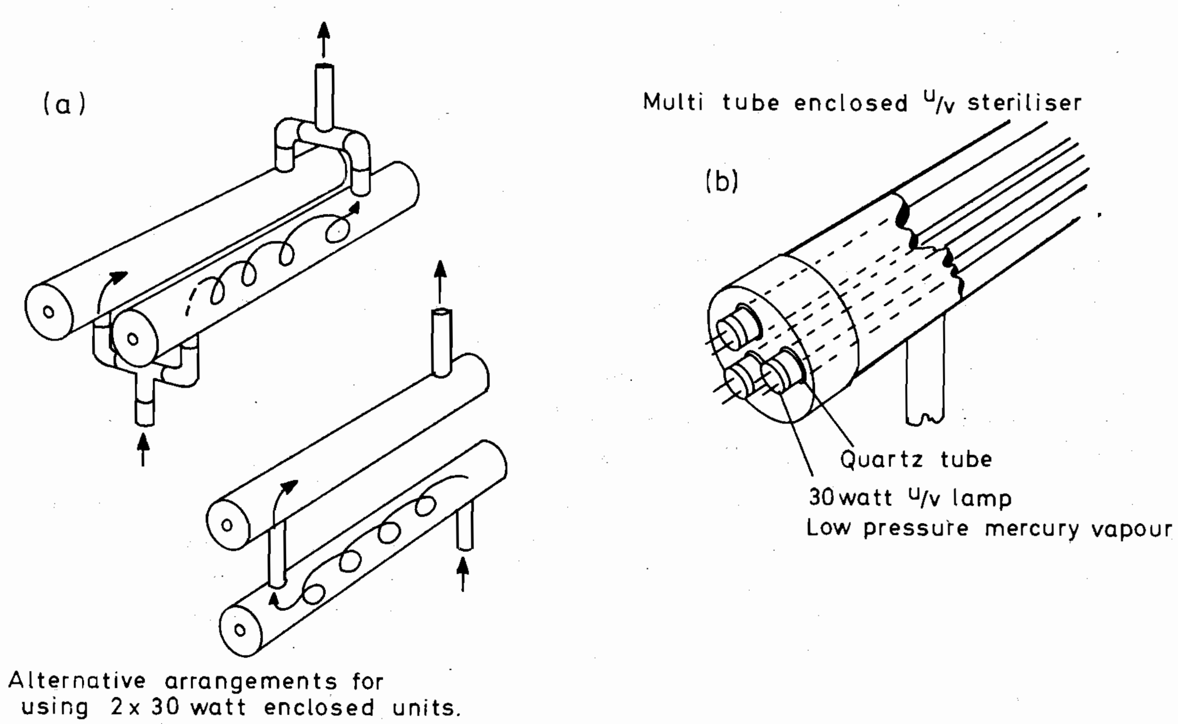

Figure 7 Use of enclosed ultraviolet sterilizers for large volumes of water.
(a) Alternative arrangements for using two 30 watt enclosed units.
(b) Multi-tube enclosed u/v sterilizer. Construction as for single tube unit (Figure 6) but with larger bore piping according to number of u/v lamps.

(3) During use tubes and the reflector (where used) will inevitably become dusty and may even become encrusted with salt, both of which conditions seriously impair transmission and reflection of u/v radiations. Tubes and reflectors should therefore be wiped frequently with a soft damp cloth.

(4) The terminal end caps of the lamps should be lightly smeared with grease to prevent corrosion and waterproof terminal covers fitted.

(5) U/v lamps may appear to be functional after years of intermittent usage. However, the transmission of u/v light by the tube reduces with age and for germicidal purposes tubes should be replaced after 2 000 h usage. Tubes can be tested with a special u/v meter if available but this is an expensive item. It is therefore desirable to keep a log of the number of hours use.

(6) In turbid or naturally highly coloured waters u/v irradiations may not be effective due to limited penetration of the radiations.

(7) U/v light from lamps can cause painful burning and dermatitis of the skin. More important, it can be extremely painful, and in some cases cause permanent damage, to the eyes, if it is viewed directly or by reflection. Therefore OBSERVE SAFETY PRECAUTIONS AND DO NOT LOOK AT U/V LIGHTS WHEN THEY ARE ON (see NRPB publication "Protection against ultraviolet radiation in the work place").

5. TANK DESIGN

There are two basic tank designs in current use in the United Kingdom; open tank systems and high density tray units. Open tank systems comprise one or more tanks of sea water in which shellfish are placed on netting trays. The water is pumped from one end of the tank(s), sterilized under an ultraviolet lamp, allowed to fall a distance of about 2 feet (600 mm) (during which it is re-aerated) and finally returned by jets into the opposite end of the tank(s). Two types of open tank systems are described here, one uses a double large tank and the other a series of smaller prefabricated units: the dimensions of these tanks may be modified to suit individual requirements.

5.1. Large tank units (Figure 8)

The unit illustrated holds up to 10 000 oysters or clams at a time (or 12 cwt (600 kg) of mussels). Since cleansing takes at least 36 h, the tank is divided into two and each part may be used alternately to provide daily batches of 5 000 cleansed shellfish (6 cwt (300 kg) of mussels). Each half tank measures internally 20 feet (6 m) long by 5 feet (1.5 m) wide and has a water depth of 20 inches (500 mm), and thus a total water content of approximately 1 000 gallons (4 540 l).

The tank may be of concrete, stone, cement block, brick, wood or any other non-toxic material resistant to sea water. If it is of concrete, the base and walls should be reinforced and a waterproofing compound used. On soft foundations piling may be required. If the tank is of bricks or blocks, piers should be placed at intervals along the walls for support. The internal surfaces of concrete, brick or block tanks should be rendered to prevent adsorption of water and if they are situated in an exposed locality some external protection may be necessary to prevent frost damage. If wood is used, tie bars should be situated at intervals across the top of the tank walls and the internal surfaces made non-porous with paint, bitumastic material or fibreglass or by fitting an internal butyl rubber tank liner. Each tank should empty through a simple drain of 4 inch (about 100 mm) internal diameter glazed earthenware or plastic pipe which can be sealed with an expanding drain plug or a simple bung; screw valves become blocked with stones and shram and are unsuitable.

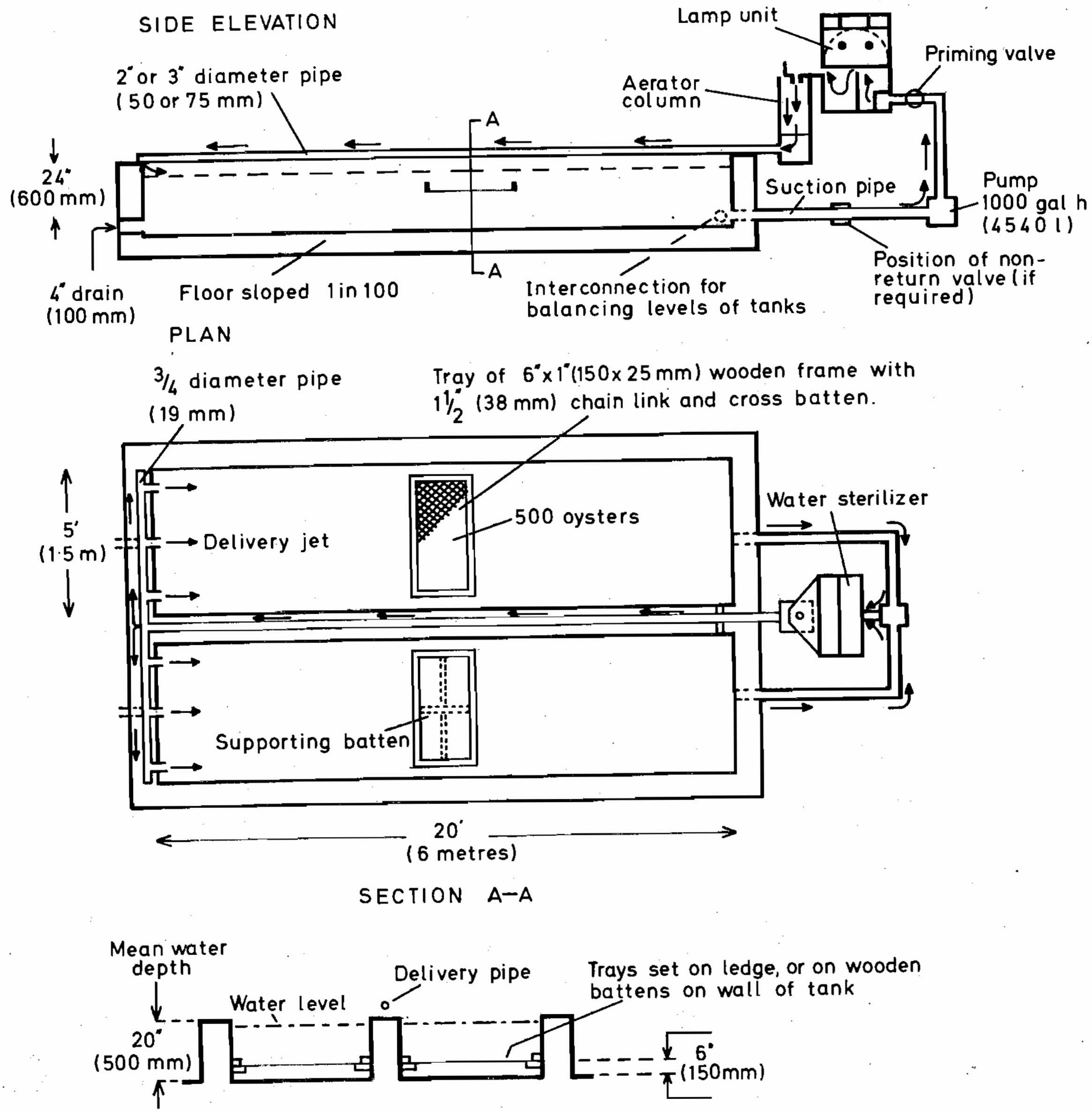

Figure 8 Layout of concrete purification tanks to treat 5000 oysters per day. Each tank contains 10 trays of 500 oysters and holds 1000 gal (4540 l) of sterilized water.

5.2. Prefabricated tank units (Figure 9)

This form of cleansing plant comprises a number of smaller open tanks, coupled together and placed in parallel; the number of tanks will depend upon the capacity required. The popular tank unit used for this type of installation consists of a precast asbestos cement tank. Other containers such as fibreglass may be used, provided they have a non-porous surface, are non-toxic to shellfish and hold water to a depth of 20 inches (500 mm). Asbestos cement tanks are ideal for this purpose and may be obtained in a variety of sizes. The largest has a nominal capacity of 180 gallons (820 l) and measures 40 x 48 x 29 inches (1 m x 1.2 m x 750 mm) deep; for purification purposes it can accommodate a maximum of 660 oysters. Other tank arrangements can be made to suit the premises or site. If more than five tanks are joined together, two interconnecting pipes between each group of tanks are desirable to ensure a good flow of water through the system. The delivery pipe to each tank should have its own valve so that the water flow can be balanced out evenly between the tanks.

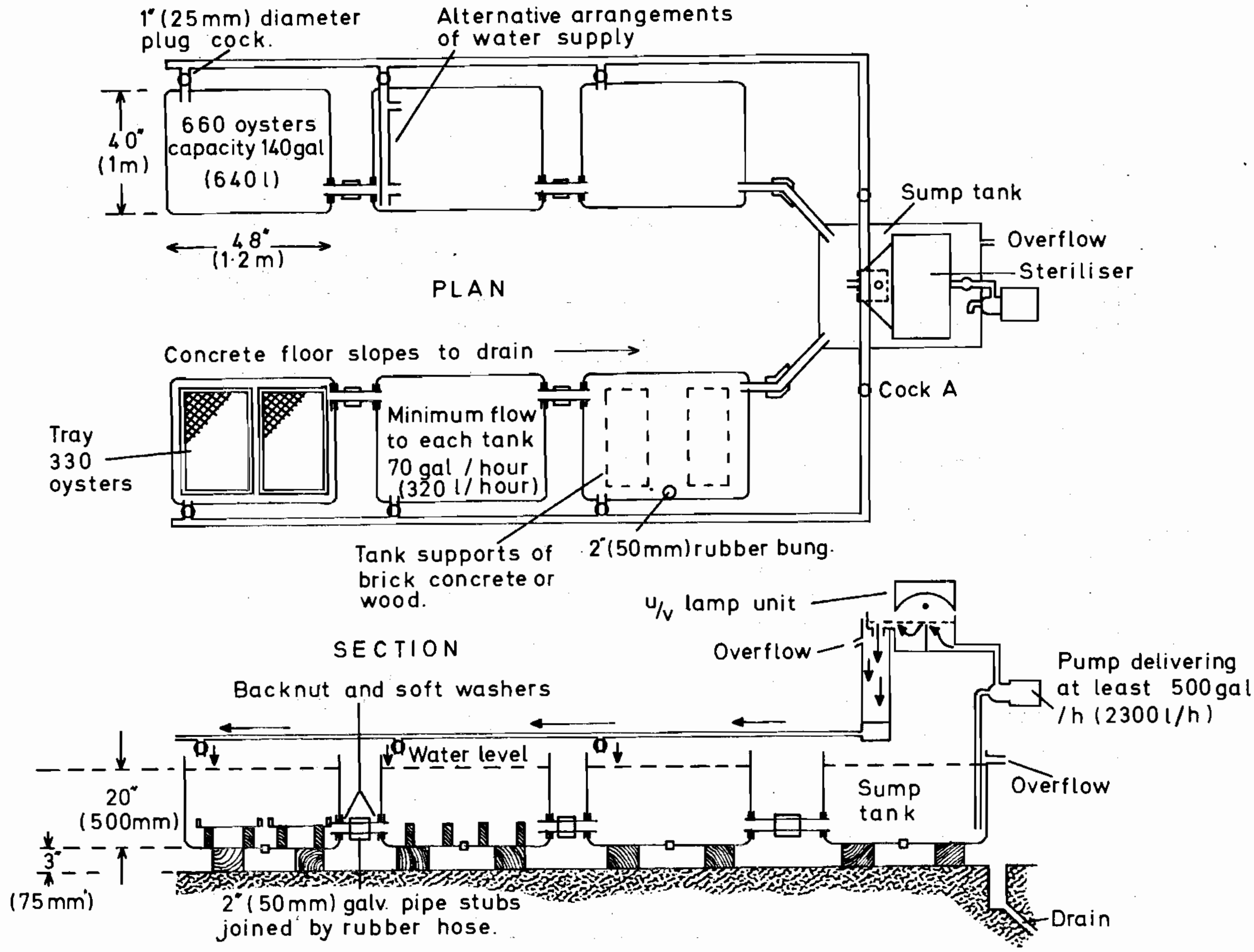

Figure 9 Layout of ultraviolet cleansing plant using prefabricated asbestos cement tanks. Capacity 4000 oysters. 1½ in (38 mm) dia. plastic pipe (with slow bends where necessary) for delivery system to tanks. 2 in (50 mm) dia. delivery pipe is required if 5 or more tanks are placed in each circuit. The layout should allow adequate space for handling trays and hosing down oysters. Each tank contains 2 trays, 40 x 24 in (1 m x 600 mm) with 4 x 1 in (100 x 25 mm) wooden frame, and 1½ in (38 mm) chain-link or mesh bottom, raised 9 in (230 mm) above tank base by supports. Cock A should be adjusted to provide a minimum flow of 210 gal/h (950 l/h), i.e. 70 gal/h to each tank. Delivery jets should be arranged to give equal flow to each tank.

The size of plant may be adjusted to suit requirements:

Total no. of oysters	660	1320	1980	2640	3300	3960	4620	5280	5940	6600	7260	7920	8580	9240
No. tanks excluding sump	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Min. pumping rate gal/h	70	210	280	350	420	490	560	630	700	770	840	910	980	1050
l/h	320	950	1270	1590	1900	2220	2540	2850	3200	3520	3800	4150	4470	4770
u/v light (W)	15	15	15	30	30	30	60	60	60	60	60	60	60	90

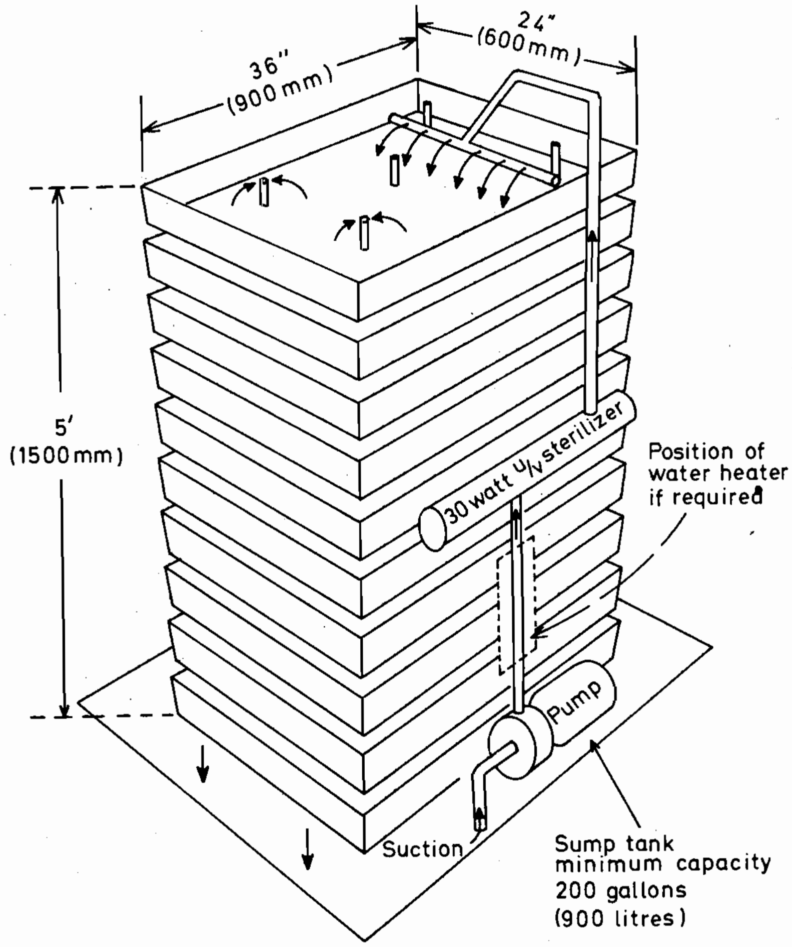

Figure 10 Diagram of general layout of high density purification system (details of framework omitted).

5.3. High density tray unit

The high density tray system was devised in an attempt to fulfil the following requirements:

(1) Reduction of water volume relative to quantity of shellfish, so making it economic to heat water and to use artificial sea water.

(2) Compact configuration for use in markets, restaurants, etc. where floor area is limited.

(3) Multi-species purification and live storage (including storage of Crustacea).

(4) Demountable (if required) light-weight construction, with improved handling of shellfish.

(5) Easy extension of capacity when required.

These needs have been satisfied by development of the system illustrated in Figure 10. The unit consists of a framework of metal or wood holding ten moulded plastic or fibreglass trays supported on runners one above the other. Initially, specially made fibreglass trays were used (Figure 1), each fitted with plastic standpipe overflows to allow the trays to fill to a depth of 3 inches (75 mm) before overflowing into the tray below and so on down to the sump or collecting trays. In practice, such trays are difficult to stack when not in use and the overflow pipes are easily broken off. A commercially available stack/nest container in high density polyethylene has proved to be an ideal alternative and is easily modified for use in a purification system (Figure 2). Other types of tray may be used but it is important to arrange the overflow system from one tray to another in such a way that good circulation within each tray is achieved. Note should be taken of the small drain hole in the bottom of each tray which is left open during operation. This is small so that it does not permit excessive loss of water other than by the overflows (and does not allow undue disturbance of faeces, which might pollute shellfish in the tray below). Its purpose is to allow the trays to drain slowly and completely should the pump be switched off or fail. Exposed shellfish (and particularly lobsters if stored in the unit) survive for considerably longer than those left in a tray of static water in which they rapidly deplete the oxygen.

The sump tank or reservoir is, in purification terms, wasted space and where possible may be sunk below ground level so that a maximum number of trays can be accommodated within a workable height. When the sump tank is placed at ground level, only half the number of trays can be held, unless special arrangements are made for trays above normal working height. Experiments have shown that suitable heavy duty castors fitted below the frame holding each tier of trays can give increased mobility and flexibility of operation, permitting a tier of trays to be moved as a single unit of a much larger system (Figure 11).

Figure 10 shows an enclosed u/v sterilizer incorporated in this type of unit for which it is ideally suited, but there are no technical objections to the use of the lamp housing/ weir chamber in such a unit if it is preferred.

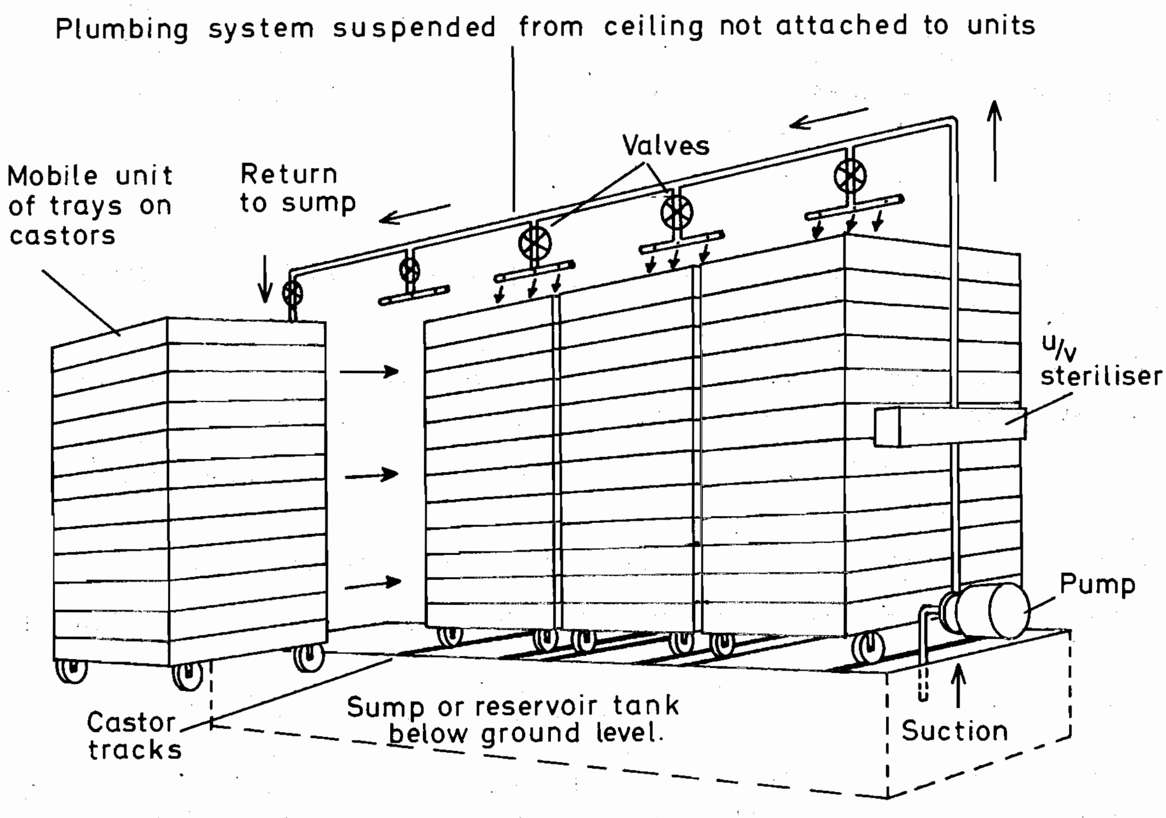

Figure 11 Use of mobile tray units for mechanized handling and large-scale purification.

6. OPERATION OF PURIFICATION TANKS

6.1. Handling of shellfish

(1) The bags or baskets containing shellfish for purification must not be roughly handled or dropped (see Dare 1977). Damaged, weak and gaping animals must be excluded as they may remain polluted even after treatment.

(2) The shells of the animals must be clean and free from mud and weed. Damage to the shell margin or 'flare' of oysters should be avoided as this may lead to weakness and possibly death.

(3) Shellfish should not be kept out of water for more than two days before treatment.

(4) Shellfish stored prior to treatment must not be exposed to extremes of temperature, e.g. frost, or to a prolonged period of direct sunlight.

6.2. Filling the system with sea water

6.2.1. Natural sea water

(1) When the purification plant is newly filled with water and shellfish a period of at least two nights (36 h) must elapse before shellfish may be sold, even if, at the time of filling, shellfish have already been treated for one or two nights. (This is to ensure that the water receives adequate u/v sterilization to permit full purification of shellfish in the tank.)

(2) In order to prevent the build-up of waste products water may not be held in the tank for longer than two weeks during the period October to May and not longer than one week between June and September. More frequent changes are beneficial, providing the rule relating to new water is adhered to (see 1).

(3) The specific gravity of the water must be checked with a hydrometer after filling and thereafter at intervals.

(4) When the water is changed the purification plant must be thoroughly scrubbed to remove mud etc., or flushed before refilling.

6.2.2. Artificial sea water

(1) Only water containing recommended quantities of salts should be used; mixtures sold as sea salts, bay salts, etc. are unsuitable.

(2) Sufficient salt mixture should be added to tap water to give salinities not less than those specified in Section 2.1.

(3) When a new batch of artificial sea water is prepared the water should be thoroughly circulated to dissolve all the salts before shellfish are placed in the system.

(4) The specific gravity must be checked after salts have dissolved.

(5) Tanks may be topped up only with water of equivalent salinity.

(6) Water should not be used for more than one week.

7. STATUTORY AND OTHER REQUIREMENTS

Under the provisions of the Public Health (Shellfish) Regulations 1934, local authorities in England and Wales are given power to make an order which prohibits or restricts the commercial gathering of shellfish for human consumption from within their district. The regulations apply only to commercial gathering, i.e. collection for sale to the public, and do not prevent individuals from taking shellfish for their own personal consumption, although such activities in a polluted area are clearly undesirable. An order made under the regulations states the extent of the area covered by the restrictions and may cover all shellfish (molluscs) or list particular species of local importance. In extreme circumstances, i.e. in areas of gross pollution, gathering of shellfish may be totally prohibited, but usually the regulations permit commercial gathering of shellfish provided they are subjected to an approved process of treatment. Methods approved are (1) relaying in clean water, (2) sterilization in flowing steam for 6 minutes (cooking) and (3) purification in an approved installation. If it is desired to exploit shellfish from an area covered by an order and to use purification as a method of treatment the plant must first receive approval by the Department of Health and Social Security. Once approval is granted, the purification plant may be used to treat shellfish from other areas subject to restrictions under the 1934 regulations. In Northern Ireland similar powers are served by Statutory Rules and Orders 453, 1973; in Scotland, the Food and Drugs Act, section 13 has provisions for similar orders but none has been made to date.

Strictly speaking there are no other statutory requirements covering the fishing and production of shellfish for consumption although the Food and Drugs Act is interpreted by some authorities to include purification plants as food preparation premises. This may lead to requests for plant operators to install toilet and washing facilities but in the interests of hygiene it is normally anticipated that such facilities will have been incorporated. Irrespective of orders made under the regulations described above, in England and Wales any shellfish of an unsatisfactory quality may be seized and further sales stopped under the Food and Drugs Act.

8. CHECK LIST FOR CONSTRUCTION AND OPERATION OF AN ULTRAVIOLET PURIFICATION PLANT

(a) Planning and construction

(1) Select site having an adequate seawater supply of good salinity; electricity; mains water; good access; security of tenure.

(2) Check whether the area is covered by an order made under the Public Health (Shellfish) Regulations 1934 (see Section 7).

(3) Plan properly and allow room for expansion.

(4) Obtain advice on general matters of public health and hygiene from the local Environmental Health Department at an early stage.

(5) Obtain advice on technical matters of design, construction and operation from the Ministry of Agriculture, Fisheries and Food at the addresses given in this leaflet.

(6) Make an early representation to the local authority for planning consent.

(7) Purchase reliable equipment. Cheap equipment (e.g. pumps) and makeshift facilities may prove expensive in the long term. A properly constructed plant will give years of trouble-free operation with a minimum of maintenance and expense.

(b) Operation

(8) Only use u/v lamps designed for germicidal purposes.

(9) Keep lamps and reflector surfaces clean at all times.

(10) Keep a daily log of lamp operation to ensure that lamps are replaced after 2 000 h use.

(11) Adhere to the notes on operation of purification systems given in Section 6 of this leaflet.

(12) Take advantage of slack or out of season periods to service pumps and other equipment.

(13) If in doubt ask for advice.

Further information can be obtained by contacting:

Ministry of Agriculture, Fisheries and Food

Fisheries Experiment Station
Benarth Road
Conwy
Gwynedd LL32 8UB

Phone Conwy (049263) 3883

Fisheries Laboratory
Remembrance Avenue
Burnham-on-Crouch
Essex CM0 8HA

Phone Maldon (0621) 782658

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