Food and Agriculture Organization of the United Nations

Centre for Environment Fisheries & Aquaculture Science

Atelier de formation sur le profilage des risques et l'assainissement des coquillages bivalves avec l'appui du Centre de Référence de la FAO

21-23 février 2023

Sénégal

Depuration and other treatment types

By Andy Younger

FAO Guidance

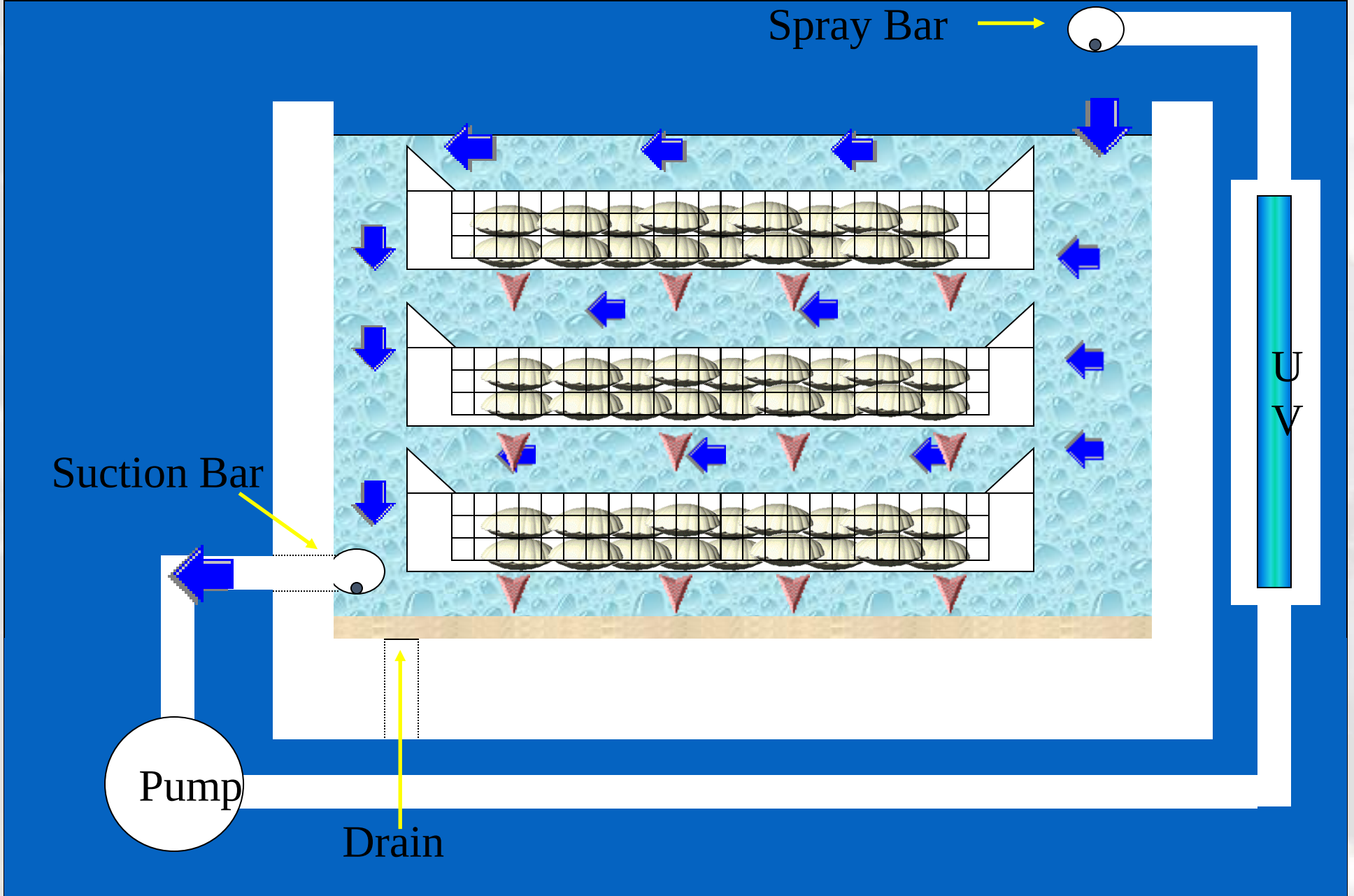
What is depuration (purification)?

Placing bivalve molluscs in tanks fed by clean seawater for the time necessary to reduce contamination to make them fit for human consumption

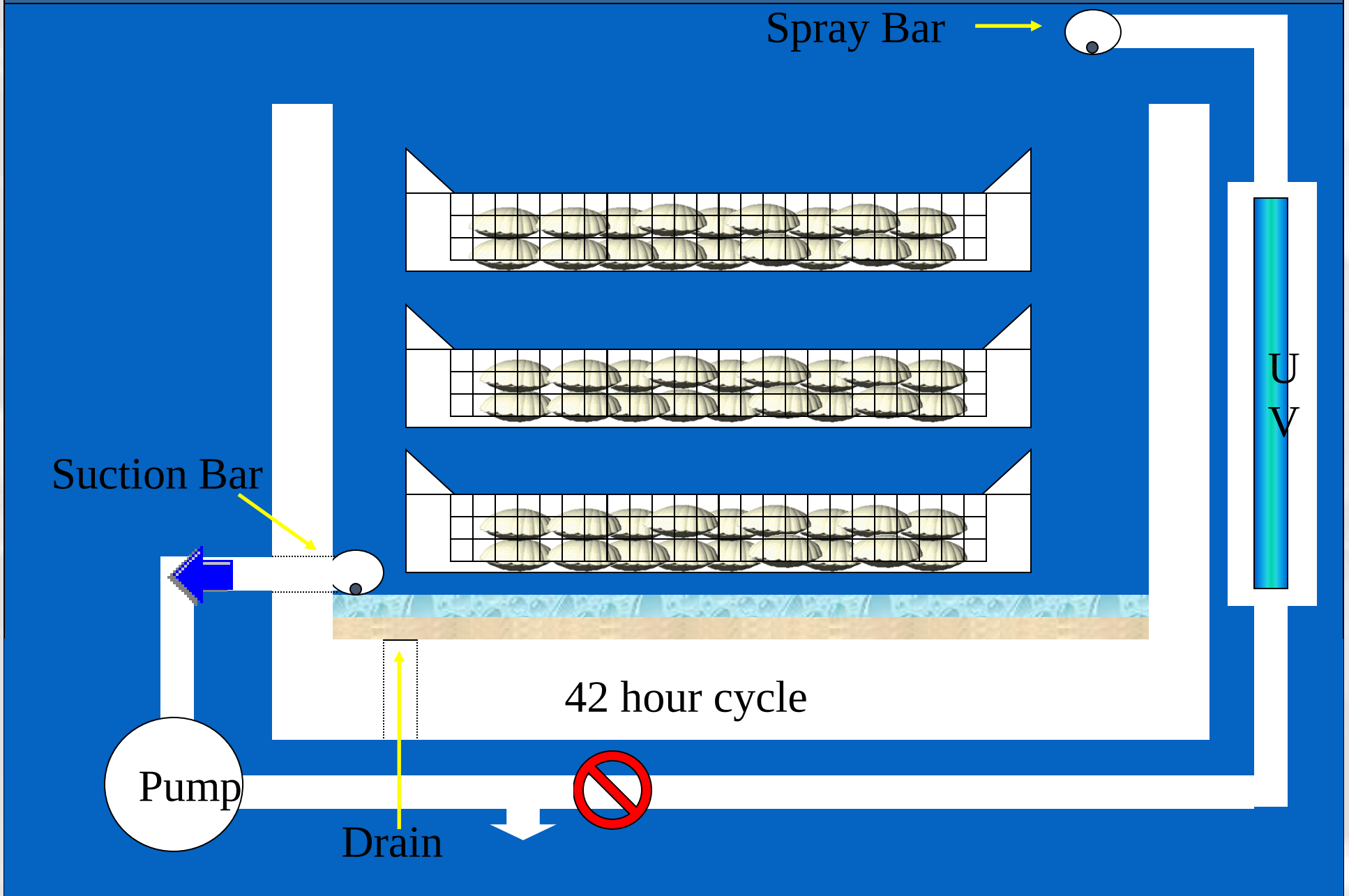
Rationale

Contamination expelled from shellfish in form of faeces/pseudofaeces which should settle to, and remain, at the bottom of the tank

How is purification achieved?

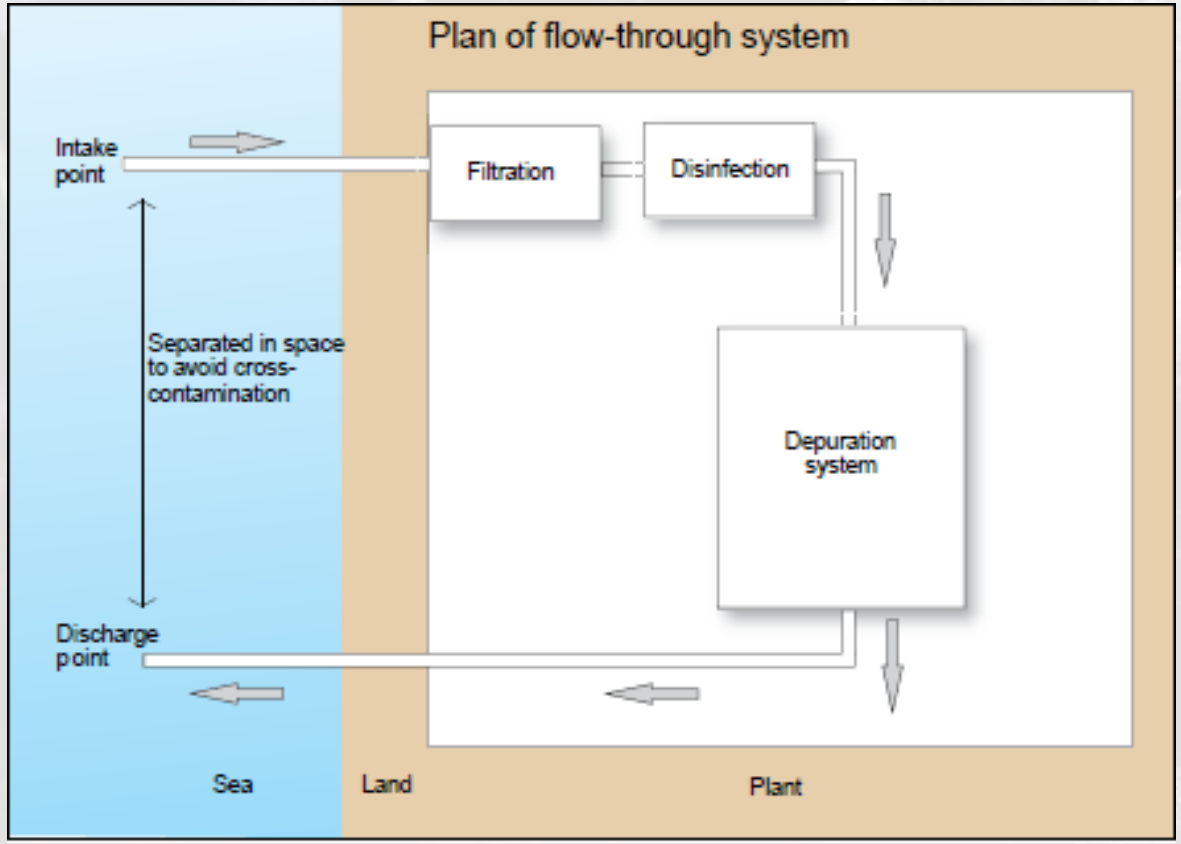


How is purification achieved?

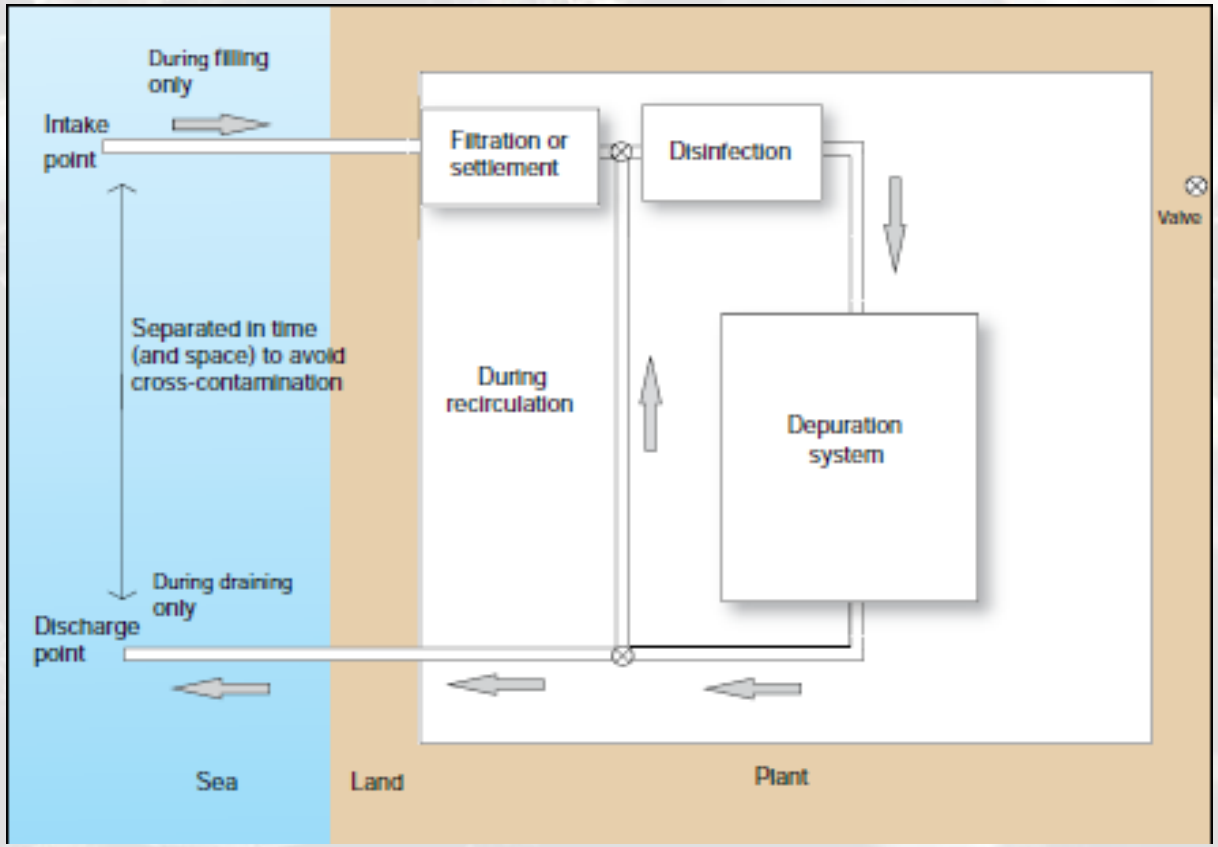


Two main seawater flow arrangements

- **Flow-through**



- **Recirculation**



Three key features of depuration

- Resumption of filtration activity
- Removal of contaminants
- Avoidance of recontamination

Resumption of filtration activity

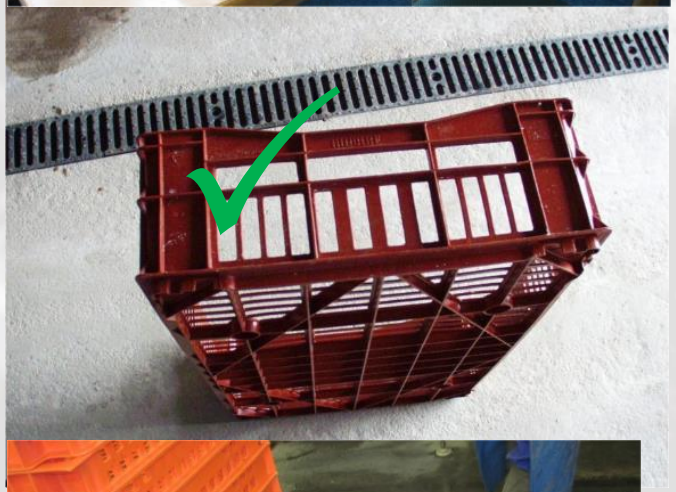
- Create conditions to optimise filtering activity – 'happy' shellfish!
- Avoid shock, stress, disturbance, extreme temperatures

Key parameters (species-specific requirements):

- Salinity - Within 20% of salinity in harvesting area
- Temperature – Higher temperatures better for removal of microbial contaminants but if too high then may stress shellfish
- Dissolved oxygen - >50% saturation or 5mg/L. Varies with temperature e.g. lower O_2 concentrations at higher temperatures when shellfish more active too

Resumption of filtration activity

- Should not be disturbed as may interrupt filter-feeding activity
  - cascades
  - aeration
  - do not move shellfish

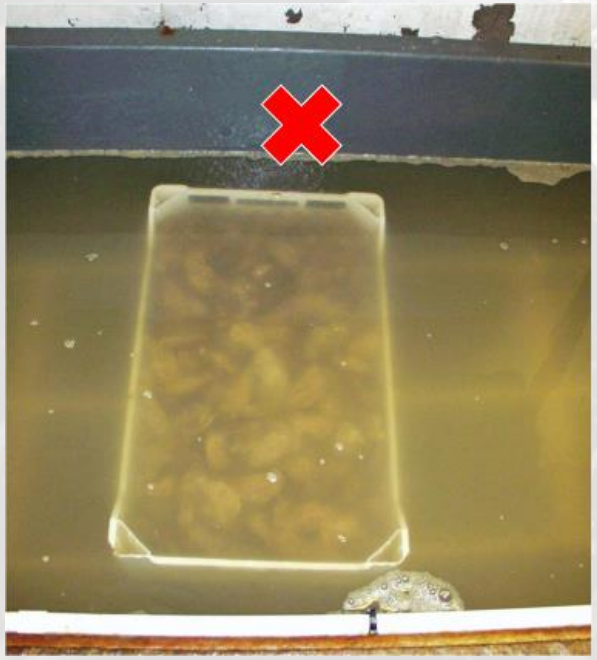


Containers used to hold live bivalve molluscs in purification systems must have a construction that allows clean seawater to flow through

Seawater quality

- Good quality seawater is essential for effective depuration
- Properties needs to suit requirements of the particular species
- Artificial seawater use possible – standard formulation of 5 salts

Avoid using turbid water (>15NTU)



Seawater source

Seawater from any source where harmful microbiological contamination, substances and/or toxic plankton are not present in such quantities as may affect the health quality of fish, shellfish and their products (Codex Alimentarius Code of Practice)

Location:

- Avoid docks/marinas

Timing:

- high tide best
- not after rainfall

Removal of contaminants

- Need correct physiological conditions for each species to optimise activity (especially temperature and salinity)
- Higher temperatures are usually necessary for removal of viruses
- Provide sufficient, even flow of water to allow the depurated faecal material (i.e. contamination) to be taken away from the shellfish
- Method of oxygenating seawater should not impede settlement of expelled faeces (gut) and pseudofaeces (gills) e.g. no aeration directly under shellfish

Table 3.2 Recommended or specified temperature limits for depuration

Latin name	Common name	Temperature °C		Country
		Lower	Upper	
Crassostrea gigas	Pacific oysters	8[1]	18[2]	UK
Ostrea edulis	Flat or native oysters	5[1]	15[2]	UK
Mytilus edulis	Mussels	5[1]	15[2]	UK
Cerastoderma edule	Cockles	7[1]	16[2]	UK
Mercenaria mercenaria	Hard clam	12[1]	20[2]	UK
Tapes decussatus	Native clam	12[1]	20[2]	UK
Tapes philippinarum	Manila clam	5[1]	20[2]	UK
Ensis spp.	Razor clams	10[1]	-	UK
Not specified	Oysters	10[3]	25[3]	USA
Mya arenaria	Soft clam	2[3]	20[3]	USA
Mercenaria mercenaria	Hard clam	10[3]	20[3]	USA

[1] UK specification by Cefas on behalf of the Food Standards Agency.
[2] Seafish Industry Authority recommendation.
[3] US NSSP – recommended values unless shown otherwise by process verification studies.

Pre and post- depuration washing

Must be carried out in clean seawater or clean freshwater
Avoid immersion of shellfish when washing

Avoidance of recontamination

Operate “all-in/all-out” batch system i.e. no shellfish added to system once depuration cycle has started

No movement of shellfish during cycle - resuspension of settled faecal material may occur if shellfish/trays are removed whilst immersed in the system

Water must be drained below the level of the lowest shellfish before any are removed

Avoidance of recontamination

- Settlement of shellfish faeces – where the contaminants are!
- Removal of faecal material at end of each cycle
- Sufficient purification times – commonly 42 hours in GB

Types of System Used in GB

There are five main recognised standard design systems used in GB :

Small scale standard design (90kg)

Vertical stack standard design (150kg)

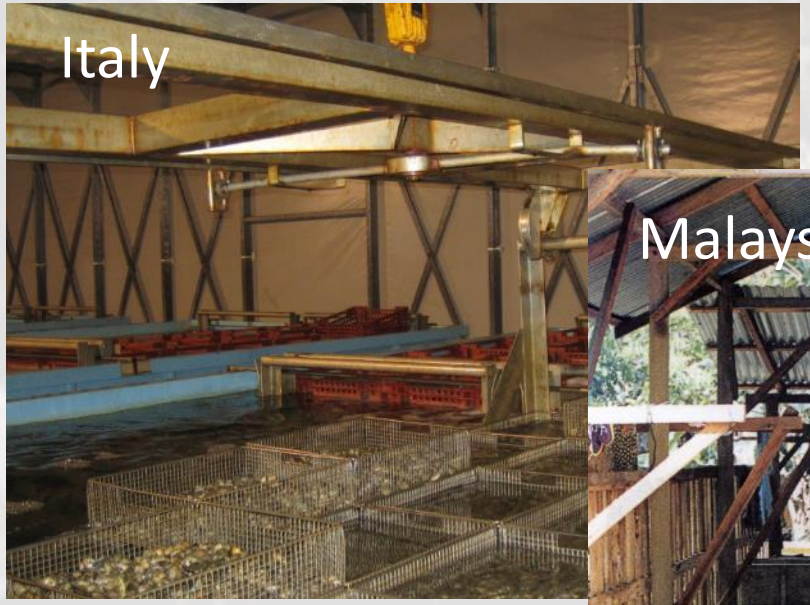
Medium scale standard design (750kg)

Large scale standard design (1000kg)

Bulk Bin system for mussels (300kg x n)

Various non-standard designs

Example systems elsewhere



UV disinfection

Most popular and simple form of disinfection

Typical UV lamp unit:

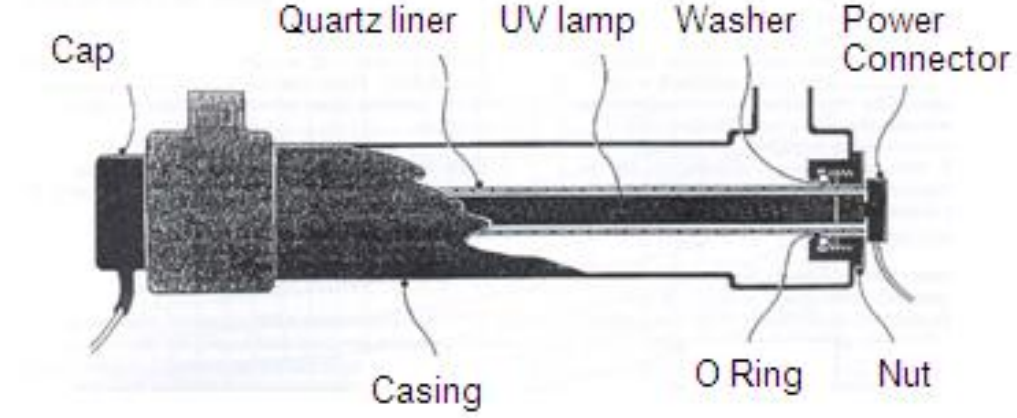
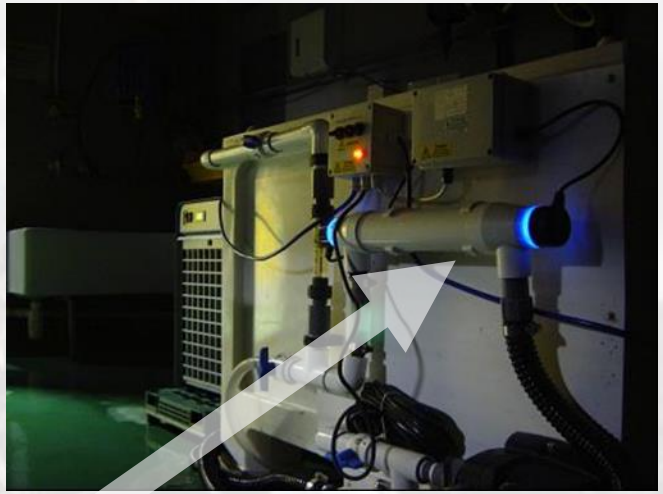
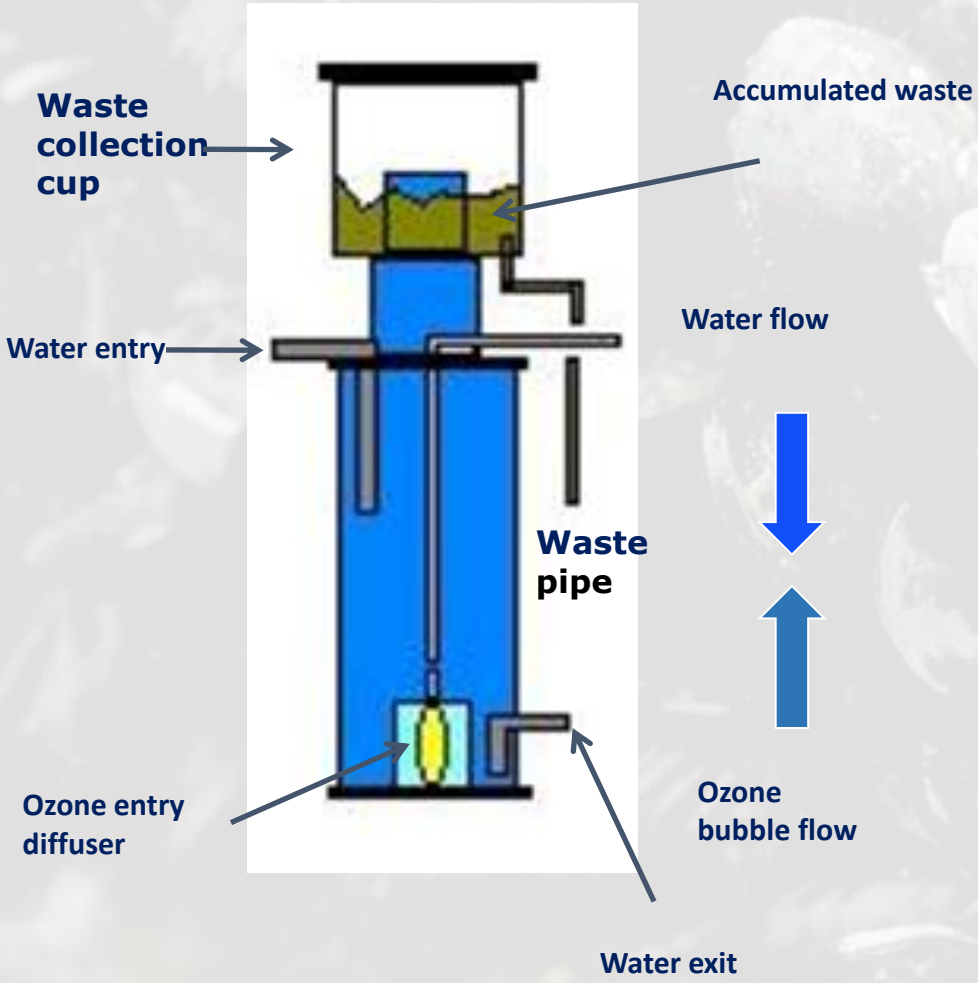


Figure 1 UV steriliser unit (adapted from Seafish technical report)



Maximum UV absorbance of DNA/RNA, 260-265 nm - peak output of low-pressure mercury arc lamps typically used on systems is 253.7 nm

Ozone and protein skimmers



Ozone bubbles introduced at the bottom of the skimmer strip the water of impurities which cling to them by surface tension

Bubbles burst at the top of the column and deposit the waste into a collection cup

Powerful oxidising agent
Harmful to LBM - must be removed from water

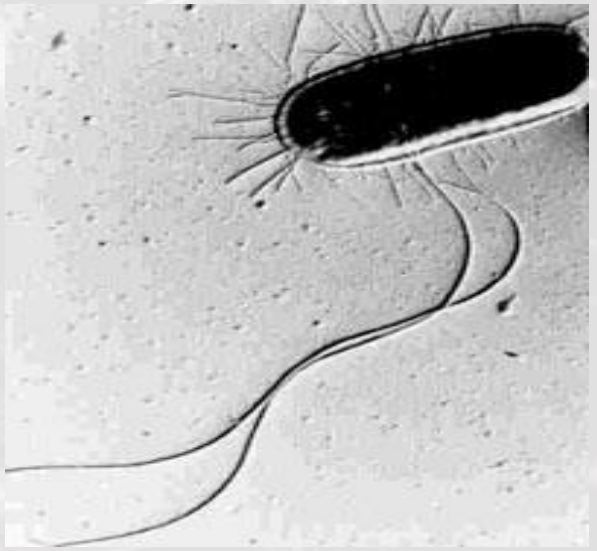
Harmful by-products e.g. Bromates (carcinogens)

Health Criteria for live bivalve molluscs

FAO: Single post-depuration samples should not exceed 230 *E. coli* (300 faecal coliforms) per 100 grams.

- properly designed and operated system should be capable of consistently producing levels of ≤80 *E. coli* (100 faecal coliforms) per 100 grams.

E. coli

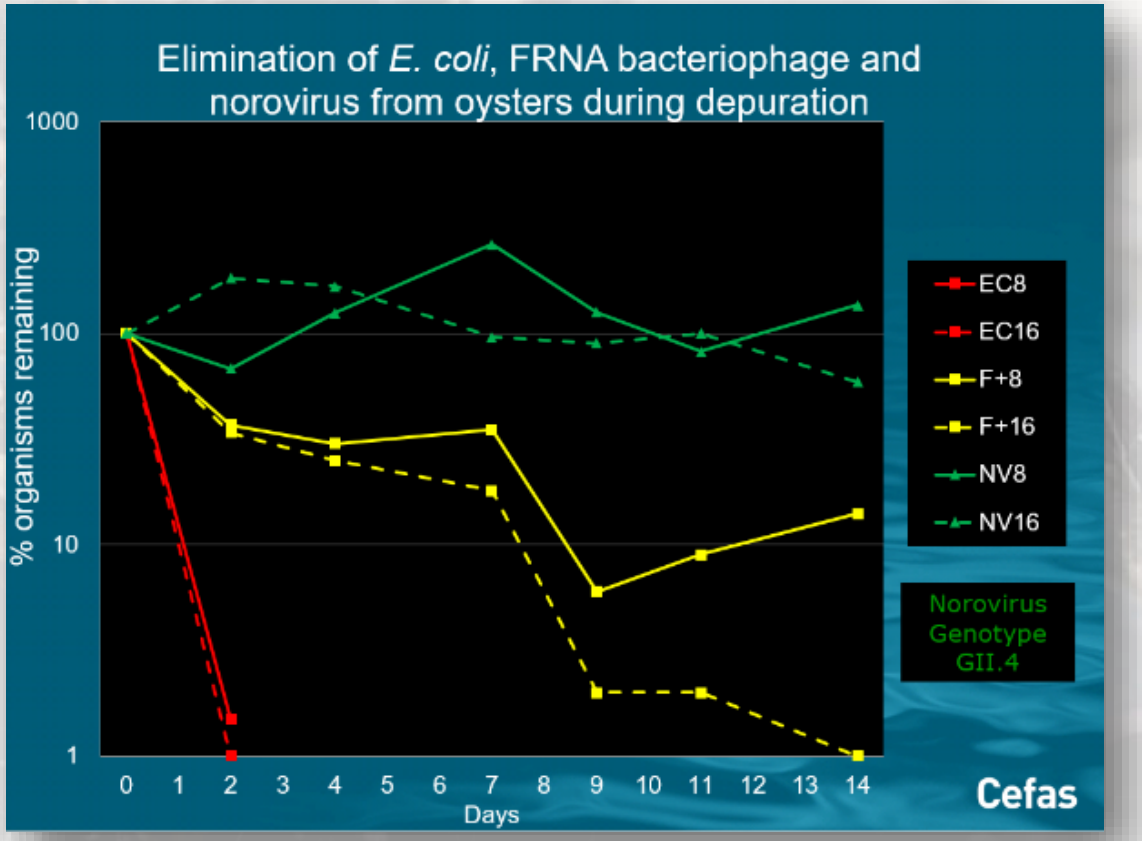


Key points to remember

- Treat shellfish gently
- Use clean sea water
- Provide optimal conditions (species-specific)
- Contaminants expelled in shellfish faeces and pseudofaeces – these should be allowed to settle to bottom of tank
- Disturbance of this material must be avoided
- Drain down tank before removing any shellfish

Key issues/limitations:

- Only effective up to moderate levels of microbial contaminants
- Not for chemicals or biotoxins
- *E. coli* removed quicker than viruses
- Shellfish meeting end product standard (<230 *E.coli*/100g) after purification may still contain Norovirus
- Possible Vibrio growth at higher temperatures (>20C) and lower salinities (20-25ppt)



Other treatment options

Heat treatment

For example, under EU regulation 853/2004:

(a) sterilisation in hermetically sealed containers; and
(b) heat treatments involving:

(i) immersion in boiling water for the period required to raise the internal temperature of the mollusc flesh to not less than 90°C and maintenance of this minimum temperature for a period of not less than 90 seconds;

(ii) cooking for three to five minutes in an enclosed space where the temperature is between 120 and 160°C and the pressure is between 2 and 5 kg/cm2 , followed by shelling and freezing of the flesh to a core temperature of -20°C; and

(iii) steaming under pressure in an enclosed space satisfying the requirements relating to cooking time and the internal temperature of the mollusc flesh mentioned under (i). A validated methodology must be used. Procedures based on the HACCP principles must be in place to verify the uniform distribution of heat.

High pressure processing (HPP)

Non-thermal treatment for foodborne pathogens associated with raw bivalve shellfish.

Pressure used to treat commercial shellfish is typically 275-300-MPa - applied for several minutes

Relaying

under EU regulation 853/2004

- Must be classified (ideally class A)
- Buoys, poles etc. must identify the boundaries of the sites
- Minimum distance between relaying areas and production areas to minimise risk of cross-contamination
- Must ensure optimal conditions for purification
- Relay for a period (depends on water temperature) – minimum two months unless risk assessment justifies a shorter period
- ‘All in, all out ’ system must be used; no new batches until previous batch has been removed.
- Must keep permanent records of operation.


Any Questions?