

Ballast Water Treatment Technology

SAFEMED IV Project: Training on Implementation & Compliance of the IMO's Ballast Water Management Convention for Tunisia



Brian Elliott,
Senior Project Officer,
Unit 1.1: Sustainability

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Why Ballast Water Management?



- Approximately 3-4000 million t. discharged every year in ports;
- More than 10000 marine species transported every day in ballast water across the oceans;
- Serious disturbance or alteration of ecosystems by invasive alien species (**IAS**);
- Ballast water most significant pathway of unintentional introduction of IAS;
- Possible major socio-economic damage;
- Possible threats to human health, e. g. through consumption of contaminated food; and,
- **Over 60 BWMS** have Basic Approval and almost 50 have Final Approval



- **Solid-liquid separation {usually precedes chemical physiochemical unit process}**

1. Filtration:

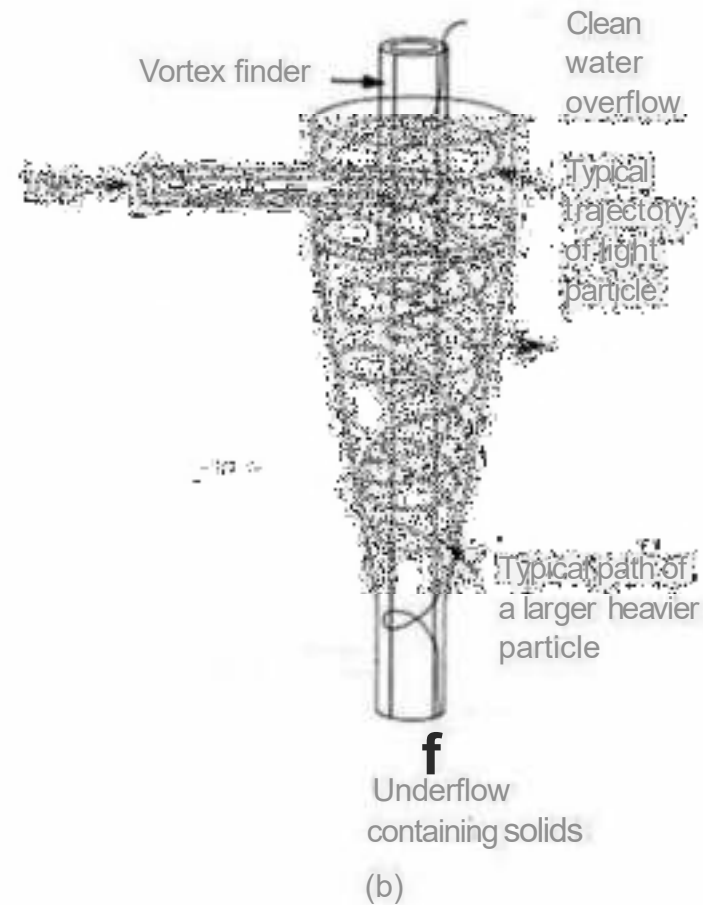
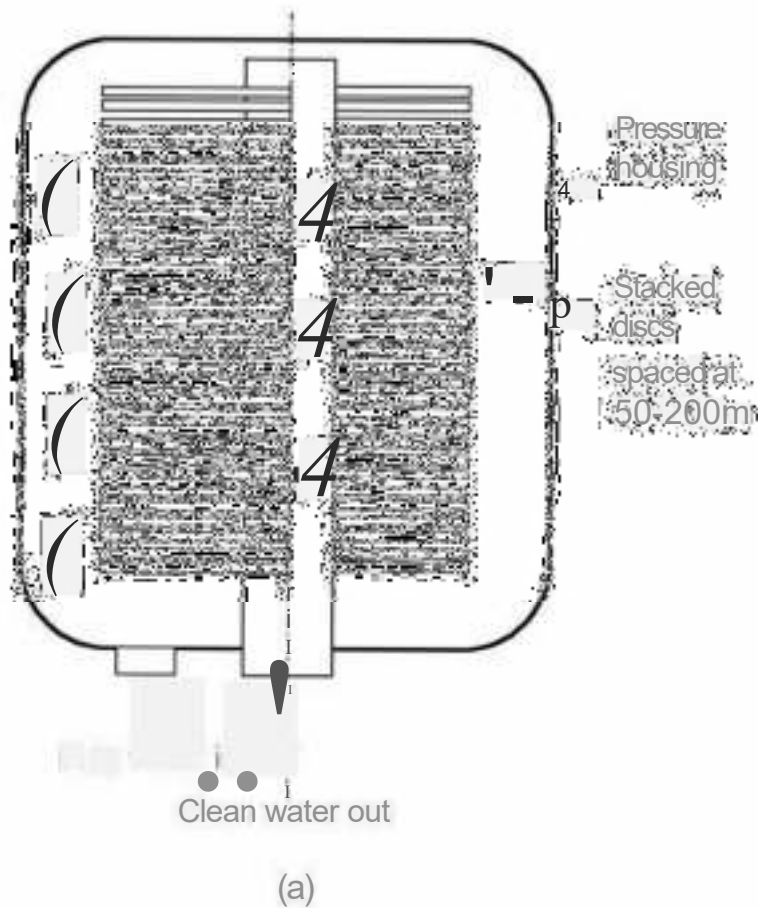
- In BWM usually backwashing system
- BWM standards are size based -> mesh size between 10 and 50µm most common
- More effective for larger particles/organisms

2. Hydrocyclones

- Alternative technology to filtration
- Water injected at high velocity
- rotational motion of the water leads to separation of particles from water
- Effectiveness depends on difference in density of particle and surrounding water, size of particle speed of rotation and residence time

BWM Techniques {I}

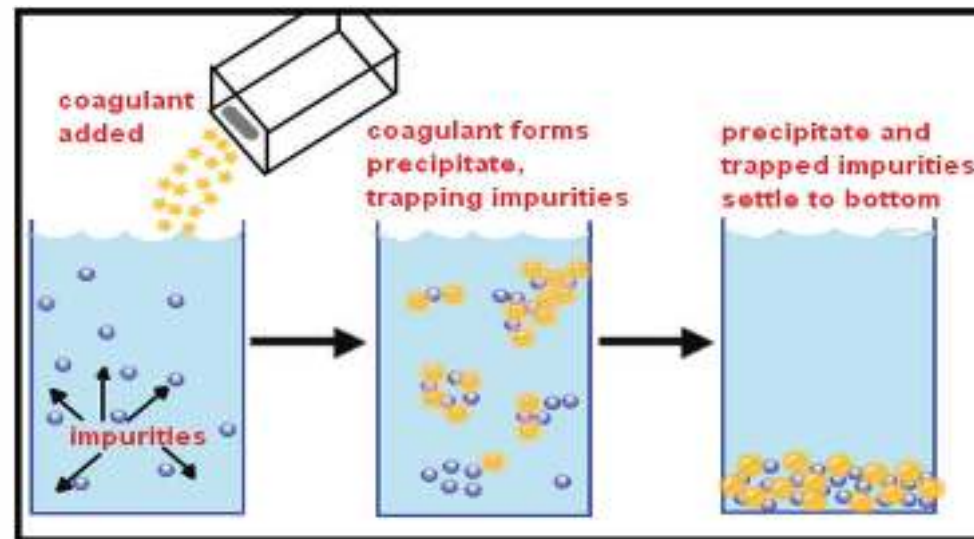
- Solid-liquid separation (examples)



BWM Techniques {II}

3. Coagulants:

- Can be used to increase efficiency of filtering or hydrocyclones;
- Time dependent
- Requires big tank
- Efficiency can be increased by adding ancillary powder of high density (e. g. magnetite or sand)



BWM Techniques {III}



Chemical Disinfection

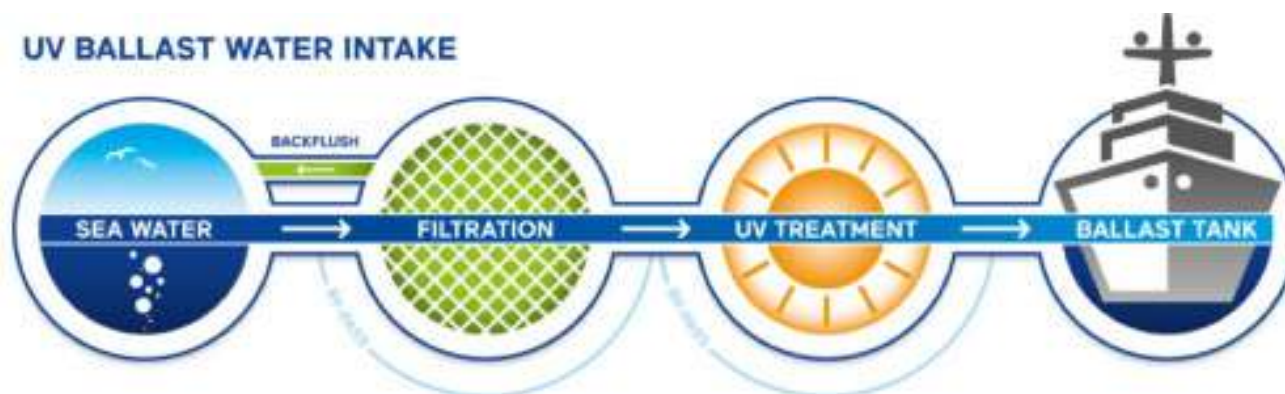
- Chlorination/Electrochlorination: relatively inexpensive, but virtually ineffective against cysts. Can lead to undesirable chlorinated by-products;
- Ozonation: fewer harmful by-products, but requires relatively complex equipment to both produce and dissolve it into the water;
- Chlorine dioxide: normally produced on the spot, but critical (reagents used are themselves hazardous);
- Peracetic acid: infinitely soluble in water, few harmful byproducts, relatively stable as Peraclean. Problem: relatively expensive, dosed at high level and require considerable storage facilities;
- Hydrogen peroxide: see peracetic acid;
- Menadione / Vitamin K: natural product and safe to handle;

Pre-treatment desirable (filtering, hydrocyclones);

Post-treatment of residuals necessary

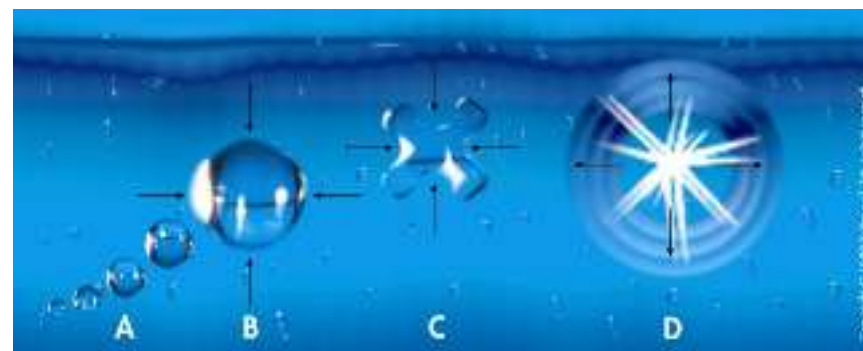
Physical Disinfection

- Ultraviolet irradiation:
 - well established method;
 - well known to be effective against wide range of micro-organisms (e.g. viruses and cysts);
 - relies on good UV transmission through the water
 - needs clear water and unfouled clean quartz sleeves;
 - removal of water turbidity essential;
 - UV can be enhanced by combining with another reagent, such as ozone, hydrogen dioxide or titanium dioxide



Physical Methods

- Deoxygenation: takes a couple of days to come into effect due to the length of time it takes organisms to be asphyxiated;
- Cavitation: acts at the surface of the organism and disrupts the cell walls through the collapse of micro bubbles;
- Ultrasonic treatment: see cavitation;
- Heat Treatment ; The ballast water is heated to a temperature that's high enough to kill the organisms.
- Electric Pulse and Pulse Plasma Treatments - short blasts of energy are produced in the ballast water to kill the organisms.
- Magnetic Field Treatment - magnetic powder is mixed with coagulants and added to the ballast water forming magnetic flocs or flakes containing large quantities of marine organisms. These are then removed magnetically.



Which system?

Which system is the most suitable depends on various factors, including the following:

- Flow ballast water (m^3/hr);
- Total amount of ballast water to be cleaned;
- CAPEX vs OPEX;
- New build or retrofit;
- Company's policy about waste disposal (chemical); and,
- Sailing to the USA or not (US Coast Guard regulations).





Any questions?

Thank you!

Brian.Elliott@emsa.europa.eu
www.emsa.europa.eu