Offshore biomethane production: the new frontier of anaerobic digestion in aquaculture and maritime operations

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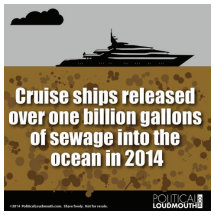
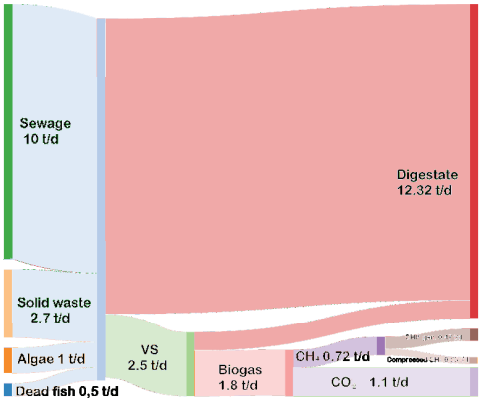
Euthrophication and GHG emissions from maritime activities

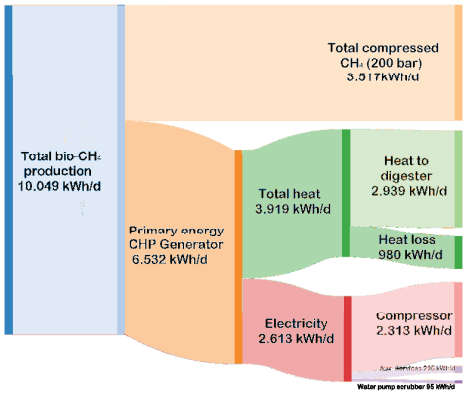
- Current MARPOL directives allow dumping of ships waste (solid and sewage) directly to the sea, as long as this operation is carried out at a minimum distance of 12 nautical miles from the coast.
- Sea pollution caused by maritime traffic is a rising source of concern for consumers.
- Fish farming activities cause euthrophication and adverse impact on the seabed, leading to anoxic conditions and associated CH_4 emissions. Dead fish attract predators and unbalance the throphic chain.
- All current ships' motors run on fossil fuels and emit CO_2.

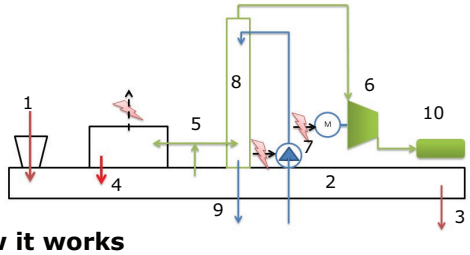


The Floating Anaerobic Digester (FAD)

- Concept developed within the **H2Ocean** project (www.h2ocean-project.eu), co-funded by the **EU 7th Framework Programme** (FP7/2007-2013) under grant agreement No 288145 within the OCEAN OF TOMORROW JOINT CALL 2011 .
- Goals: to reduce the organic load to the marine environment and to produce biomethane offshore, in order to partially replace Diesel oil for fisher boats and commercial vessels.







How it works

Organic waste from maritime operations is loaded to the hopper and shredded (1); the waste stream is digested in (2), a novel type of oscillating reactor (patent pending); the digestates (30% of influent COD) are dumped to the sea (3); the digester is kept at 38ºC with the hot water from a CHP generator (4) running on biogas (5) and producing electricity to feed the biomethane compressor (6) and sea water pump (7) which washes the excess biogas in a scrubber (8), discharging the saturated water back to the sea (9). The compressed biomethane is stored in steel cylinders @ 200 bar (10).

Materials and methods

Samples of different species of algae were taken from several locations in the Mediterranean and North Atlantic. Samples of several species of fish waste were collected from a fisher's shop. The BMP (biochemical methane potential) was measured with an **AMPTS II** (Automatic Methane Potential Test System) of **Bioprocess Control AB** with different inoculums. The feasibility of H_2 production by means of dark fermentation was assessed, finding conventional biomethane production more effective and convenient. A novel type of digester, suitable for operation in offshore environment, was conceptually developed and a patent applied. A new protocol for minimum error in the BMP assay was developed and is still under test prior to its publication.

Conclusions

1. In the special case of offshore biomethane production, 2,53 Nm^3 of CH_4 must be produced from organic waste in order to obtain 1 Nm^3 compressed @ 200 bar, ready for use as fuel in ships. The resulting EROIE (energy return on invested energy) is 0,4.
2. Washing the biogas with sea water in order to obtain biomethane is feasible, since the energy consumption for pumping the seawater is less than 1% of the LHV of the biomethane.
3. Producing electricity to compress the biomethane by means of a conventional CHP generator leads to a very low EROIE hence it is advisable that the compressor is fed with energy from the wind or the waves.

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