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Bioremediation of sediments polluted with petroleum hydrocarbons : a case study of the port of Heraklion, Crete

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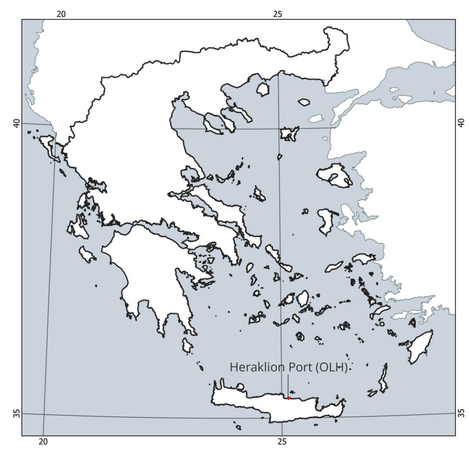
Introduction

Marine polluted sediments present one of the most recalcitrant environments for bioremediation and are often the final repository of petroleum contaminants, as a result of runoff and deposition. In this research, we focused on aerobic bioremediation of marine sediments by aerating the sediments through nanobubble tube diffusers. Marine sediments were collected from different stations of the port of Heraklion to be tested for hydrocarbon pollution, and a significant amount was contracted from one station for mesocosm bioremediation experiments with aeration.



Sediments from different port stations

Sediment samples from the different port stations, were collected from experienced divers in specific sampling tubes. Upon arrival to the Biochemical Engineering and Environmental Biotechnology (BEEB) lab, the samples were extracted by the Soxhlet method, in order to determine the hydrocarbon content in each sediment sample.

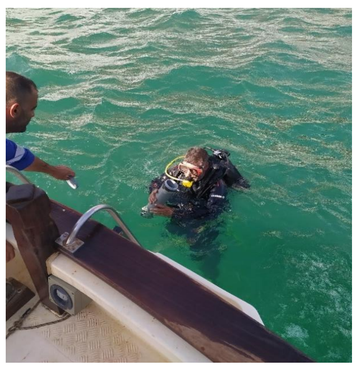


Fig 1.Sediments collected.

Fig 2.Soxhlet extraction.

Results showed that the most hydrocarbon polluted sediments were on station H0 while the one with the lowest hydrocarbon load was on station H6, almost 6.7 times lower than H0. The low hydrocarbon content on this station was easy to assume since the H0 station is very enclosed, and thus leading to entrapment of pollutants, while H6 is closer to the open sea (better nutrient supply, water exchange etc.).

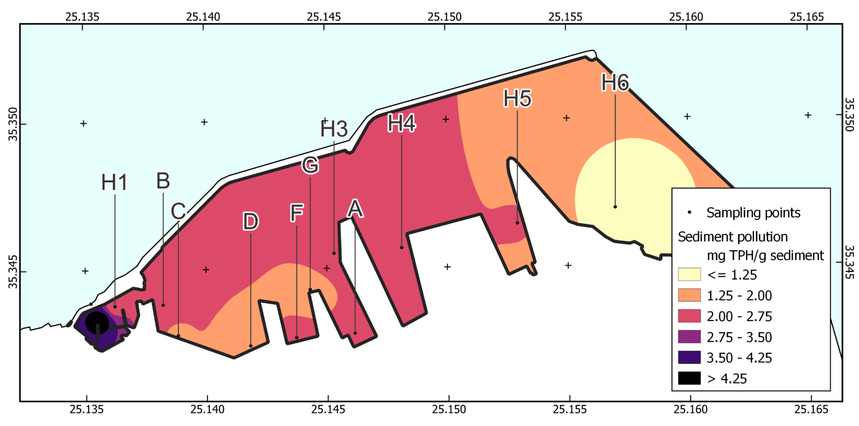


Fig 3.Sampling points-Sediment pollution / Total Petroleum Hydrocarbons (TPH) (mg/g-sediment).

Mesocosm Bioremediation Experiment

A 1 m^3 tank was set up in the greenhouse located in the School of Chemical and Environmental Engineering. For the aeration testing, one polyethylene nanobubble diffuser was employed and air was provided in the tank through an air compressor. The air compressor was equipped with oil and water retention filters to avoid instrument damages and a flowmeter to regulate the air flow inside the tank.

- Three different positions of the nanobubble diffusers were tested, one on the top of the water tank, one in the middle and one at the bottom of the tank, to see how DO and saturation change with time.
- Three different air flow rates were tested, one at 100% of the maximum air flowrate (~90L/min), one at 50% (~45L/min) and one at 10%(~9L/min), to see how DO and % saturation change with time.

Fig 3.Uploadind sample.

Fig 4.Aeration tank.

Fig 5.Algae formation.

Results of Mesocosm experiment

The TPH results show that the aeration experiment did not aid the hydrocarbon removal. TPH levels remained practically constant over the period of 22 days. This may be due to a low microbial load in the sediments and water, but also due to the type of sediment, since it is very muddy and may inhibit air diffusion. The algal layer that was created in the first few days may also have played an adverse role in the diffusion of air into the sediments. In addition, the environment is not dynamic as in the open sea, where there is a constant replenishment of nutrients, since the lack of nutrients can inhibit the action of microbes.

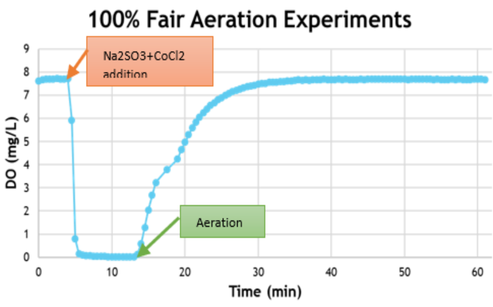


Fig 6. Results of Aeration experiments.

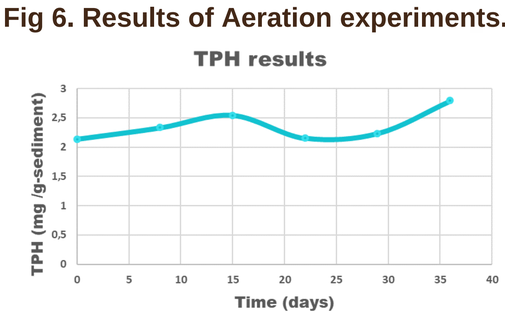


Fig 7. TPH results.

Conclusions-Further research

The implementation of this aeration system using nanobubble diffusers directly on marine sediments at the bottom of the port of Heraklion, which is a dynamic environment with constant replenishment of nutrients and microorganisms, will provide much better results in terms of achieved sediments remediation.

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