

Concurrent Removal of Rising, Soluble Ocean Carbon Dioxide and Oil-in-Water Contaminants via Multi-Functional Remediation Framework

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The oceans absorb nearly a third of airborne CO₂ emissions, while 1.3 million gallons of crude oil are spilled into oceans every year. Both issues continue to detrimentally affect marine biodiversity, and human health. This research provides a highly efficient and practical method for the concurrent removal of CO₂ and soluble oil-in-water contaminants through the creation of a Multi-Functional Remediation Framework (MF-RF) utilizing Styrofoam hypercross-linked polymers (HCPs). First, HCPs were synthesized from Styrofoam through a one-pot Friedel–Crafts reaction according to Dong et al. (2020). HCPs alone remediated 88% of the soluble-benzene in water (1.7g/L), via measure of benzene's fluorescence. Regarding CO₂, 95% of the contaminant was removed, or $3.12 \times 10^{-5} \text{M}[\text{CO}_2] = [\text{H}^+]$ (via pH measure). For the MF-RF, HCP-sponges were constructed on 8x1.3x0.7cm of melamine, PTFE adhesion, and 450mg HCP for pollutant removal. Air-tight modeling receptacles to measure remediation were subsequently constructed. HCP-sponges remediated 92% of the benzene contaminant, and 95% of CO₂. Realistic concurrent oceanic experiments with a 0.1pH difference and maximum solubility of benzene highlight 92% remediation of oil, and only 12.6min needed to reach suitable oceanic pH. High-load concurrent removal experiments with 100x more CO₂ demonstrate 71% remediation of oil and 85% remediation of CO₂. Via reuse studies, the MF-RF may be reapplied in contaminated water until its capacity is reached (5.99g oil/HCP-sponge and 3700ppmCO₂/HCP-sponge). Stability studies demonstrate prolonged integrity, as a dual-functioning, marine-safe, easy-to-use oil and CO₂-remediation tool, which is simply lowered into contaminated water, left until saturated, and then lifted out for contaminant recovery/recycling.

Awards Won:

United States Environmental Protection Agency: The Patrick Hurd Sustainability Award covers travel for the ISEF finalist to attend and participate in EPA's National Sustainable Design Expo

Fourth Award of \$500