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 3.12E-5M[CO2]=[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.

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