

Resnick Sustainability Seminar 10/3/2022

Title

Electrochemical hydrogen looping for carbon dioxide capture from ocean water

Abstract

Efficient capture of carbon dioxide is extremely important, yet current methods are cost and energy intensive. In this work, we focus on carbon dioxide capture from ocean water because the ocean serves as a sink for atmospheric carbon dioxide, containing over 100 times the amount of carbon per unit volume than air. We propose a simple scheme for capture of carbon from the ocean water: (1) add acid to a volume of ocean water, decreasing the pH and shifting the bicarbonate buffer equilibrium toward gaseous carbon dioxide; (2) remove the gaseous carbon dioxide from the acidified ocean water by, e.g., a gas-liquid contactor; and (3) add base to neutralize the acid before returning the water back to the ocean. We show that an electrochemical cell can produce acid via hydrogen oxidation reaction at the anode and can simultaneously produce base via hydrogen evolution reaction at the cathode. In net, no hydrogen is consumed or produced; it is looped from the cathode to the anode. We also show how a hydrogen-looping cell can be constructed without expensive and failure-prone ion exchange membranes, resulting in an efficient, cheap, and potentially long-lasting system that can be leveraged for carbon dioxide capture from ocean water.