Internship: Electrochemical oceanic CO_2 removal

Motivation

To mitigate climate change, worldwide carbon dioxide emissions should be reduced to zero by 2050 [1]. The biggest challenge lies in the major harder-to-abate sectors such as heavy industries and heavy-duty transport (i.e., more than 10 $GtCO_2$/yr emission). Additionally, the "previously emitted CO_2" should also be removed from the atmosphere. Consequently, in addition to CO_2 reduction, CO_2 removal (i.e., via negative emission technologies) is vital to reach NetZero. At $SeaO_2$ we perform an electrochemical oceanic CO_2 removal to offset CO_2 emissions and battle ocean acidification.

Technology

$SeaO_2$'s technology removes the dissolved inorganic carbon (DIC) from the ocean in the form of CO_2 gas [2-4]. Consequently, the CO_2 concentration in the atmosphere will be reduced through the equilibrium between the ocean and the atmosphere (i.e., indirect air capture). The technology uses a bipolar membrane-based electrochemical stack that converts oceanic bi/carbonate into CO_2(aq) (Figure 1). The CO_2 gas is then vacuum stripped and separated from the seawater.

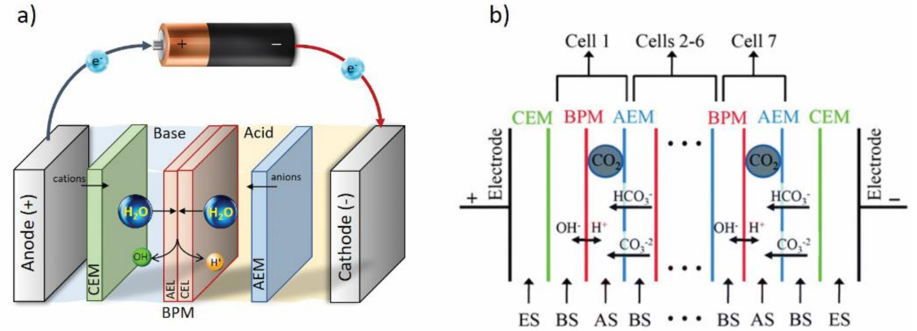

Figure 1 A) The electrochemical bipolar membrane electrodialysis (BPMED) stack for sustainable carbon capture from a bi/carbonate rich stream e.g., seawater. The BPMED cell consists of two end electrodes, multiple cation/ anion exchange membranes (CEM, AEM) and multiple bipolar membranes in series (B). In the bipolar membrane (BPM), the water dissociation reaction takes place and acid, and base are produced. Upon acid addition, the bicarbonate turns into dissolved CO_2(g) that can be vacuum stripped in a subsequent degasser.

Work description

After having shown the feasibility of the technology in lab scale, $SeaO_2$ is currently designing its 250 tCO_2/yr capture capacity pilot in the Netherlands. To reduce the overall energy consumption of the technology, we have designed and built a novel degasser unit. Inside of the degasser, the applied vacuum pressure, pH, temperature, size of water droplets, and residence time of seawater determine the CO_2 extraction yield. To increase the performance of the degasser and improve its design, a kinetic model of $CO_2(aq) \leftrightarrow CO_2(g)$ conversion (inside of the degasser) as well as $CO_3^{2-} \leftrightarrow HCO_3^{-} \leftrightarrow H_2CO_3$ conversion (inside of the BPMED stack) needs to be made [5,6]. $SeaO_2$ is looking for an intern student to build and verify such model. The project duration is 3-6 Months, with flexible starting day and remote working option.

Your profile

- Chemical engineering or similar background with B.Sc. or M.Sc degree.
- Familiar with electrochemistry and the carbonate equilibrium.
- Good English both verbally and in writing for generating reports.
- Good mathematics and modelling knowledge is a must. Familiarity with software such as Aspen, MINTEQ, PHREEQC, AutoCAD is a pre.

How to apply

Contact Rose Sharifian (Rose@seao2.nl), include your CV. Check at our website www.SeaO2.nl for more information.

References

1. S. Bouckaert et al. “Net Zero by 2050: A Roadmap for the Global Energy Sector”, (2021)
2. R. Sharifian et al. “Electrochemical carbon dioxide capture to close the carbon cycle”. In: Energy Environ. Sci. 14 (2 2021), pp. 781–814.
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