Membrane based electrochemical technologies for sustainable energy production and minerals recovery

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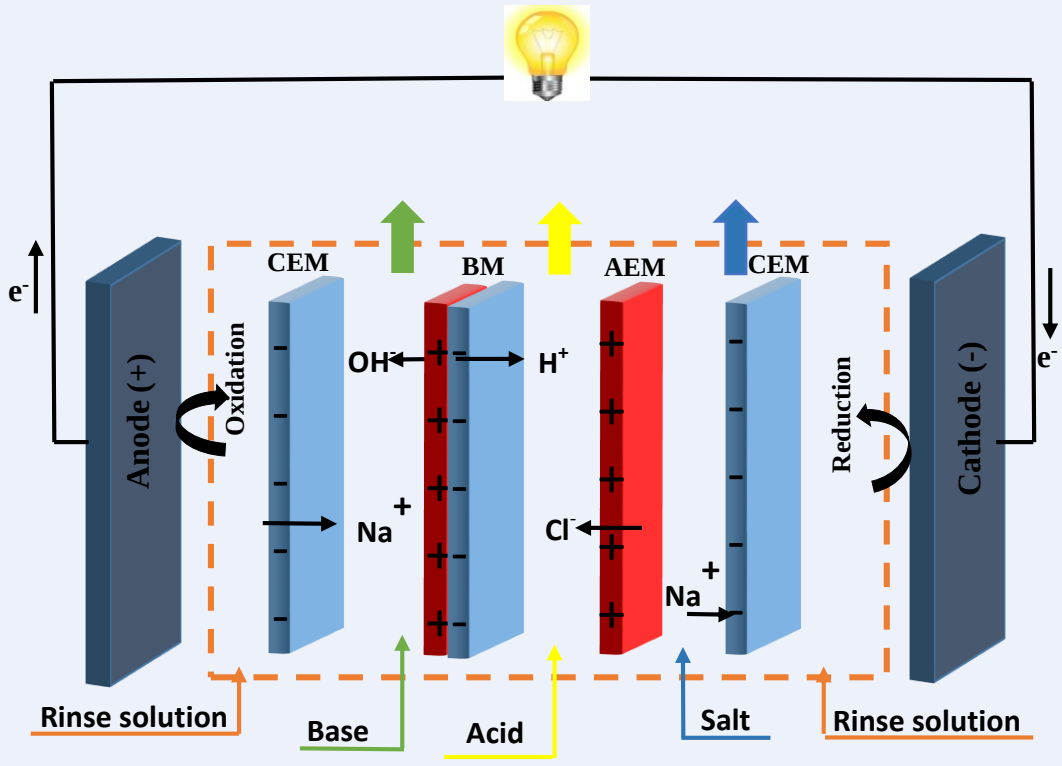
Electrodialysis and Reverse Electrodialysis

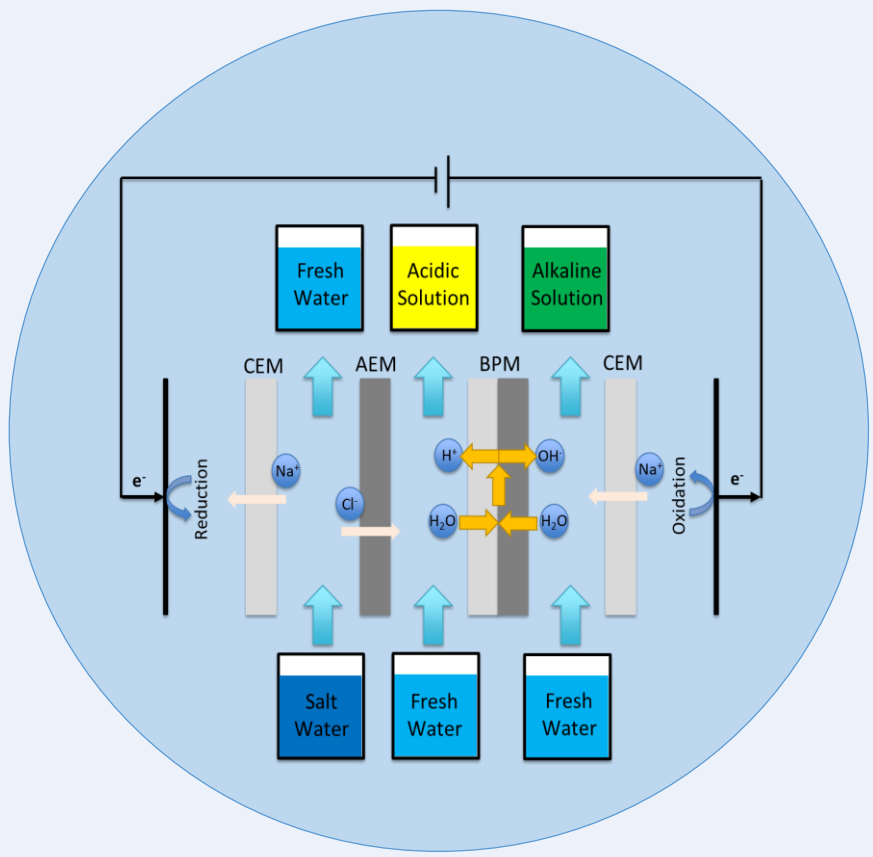
Humankind lives in an era of consuming a huge amount of energy due to technological development. A worldwide energy crisis, environmental pollution, and climate change caused by the process of energy obtaining are important issues for the global society. Therefore, we need to divert from fossil fuel energy resources toward renewable energy.

Also, zero discharge of high salinity solutions, such as industrial wastewater and brines generation from seawater desalination has become a hot topic due to its significance for environmental protection. The discharge of such effluents resulted in a very large impact on the environment and human life, such as groundwater contamination and water scarcity.

To overcome the above issues electro membrane technologies, such as electrodialysis (ED) and reverse electrodialysis (RED) have been widely proposed for salinity gradient power generation, wastewater treatment, and exhausted brines.
Salinity gradient power (SGP), also known as blue renewable energy can harvest via reverse electrodialysis technology (RED). RED is a rising technology for the production of electrical power from salinity gradient power generated on the mixing of two different salinities solution. The RED unit consists of an Ions exchange membrane (IEMs). The ions are passed through the IEMs from high concentration to low concentration solution generate an electrochemical potential. The resulting ionic flux is converted from chemical energy to electrical energy by a redox reaction occurring at the electrodes connected to an external circuit.
The EDBM technology has been developed as a sustainable approach to split an aqueous saline stream into its corresponding acid and base without any use of chemicals. EDBM is configured with a series of ion-exchange membranes (IEMs), including anion exchange membranes (AEMs), cation exchange membranes (CEMs), and bipolar membranes (BPMs). The BPM is composed of anion and cation exchange layers and split water into H+ and OH- ions. Under an electric field, the H+ ion migrates toward acid channels and OH- toward base channels. Thus, the high salinity waste stream in the feed chamber is desalted to provide treated water that can be reused or discharged directly. The corresponding acid/base solution is produced in the acid/base chambers, respectively.



Schematic representation of the RED



Schematic representation of the EDBM

Research objectives

1. Generation of HCl (1M) and NaOH (1M) solution from exhausted brines via EDBM technology.
2. Production of clean water.
3. Renewable energy production from waste brines via RED technology.