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# Electric lantern using sea water battery

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***Abstract*---**In this study cathode material is used in the electrochemical process of seawater to suggest a rechargeable saltwater battery system for electric lanterns. Sodium is created from saltwater during battery charge , and oxygen of sea water helps to discharge the battery. As well stand as oxidants to energy production. Hence sodium and cathode can be brought from the sea water. During this procedure it shows the success of 72 percent as the involvement of Sodium and evolution of $Cl2$ in the presence of $O2$. This has been increased to 82 percent with a cycle of 40.

***Keywords*---**lithium-air, sodium air, sea-water battery, energy storage system, renewable energy.

## Introduction

Seawater is the world's most plentiful resource, including a wide range of chemical species emitted by the Earth's crust and living creatures. Sodium is the most abundant chemical component in saltwater (Na and chlorides). As a result, we presented a rechargeable battery cell that employs saltwater as anode and cathode materials. The non-aqueous liquid electrolyte in the seawater battery was

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made up of Na/non-aqueous liquid/solid electrolyte/.1 M NaClO4 in ethylene carbonate: diethyl carbonate (1:1 volume ratio). The NASICON-type (NASICON: Na super ion conductor) Na3Zr2Si2PO12 solid electrolyte, which has a good and rapid Na ion conductivity of >7.0 tens of S cm-1 at room temperature, prevented one to one contact between the salty water of sea with positive and the battery electrolyte with -ve electrode.

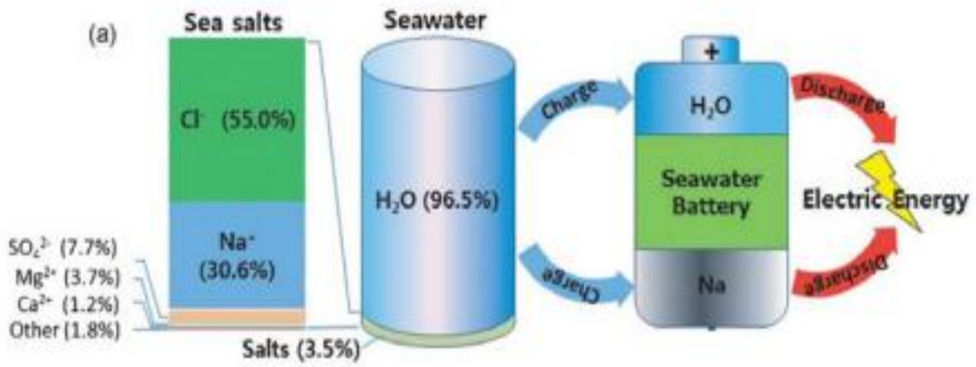

Figure 1. Chemical constituents of seawater

A collection of three of multi-phase electrolyte/electrode components such as liquid/solid electrolytes and liquid/solid/liquid (or gas) electrodes have enabled the creation of innovative battery cell topologies such as Li–Air, Li–liquid, Na–air[2], and Li–polysulfide batteries. Various fascinating electrochemical reaction pairs are suggested and tested based on these battery designs that were not previously explored owing to the limits of traditional battery cell design. We recently looked at the viability of employing seawater as an electrode material in a unique rechargeable battery system.

## Objective

In heavily inhabited locations, a high volumetric energy density would be the best choice for energy storage[1], [4], but in distant places where the size of systems can be readily extended, cheaper systems might become more competitive. As a result, it's critical to have a robust portfolio of battery systems in order to deliver the best possible options. The mechanism of the seawater battery is illustrated in this paper, based on the aforesaid novel cell design. Figures 1 and 2 depict schematic schematics of sodium-ion movement and probable chemical reaction pathways in the cell during the charge and discharge operations.

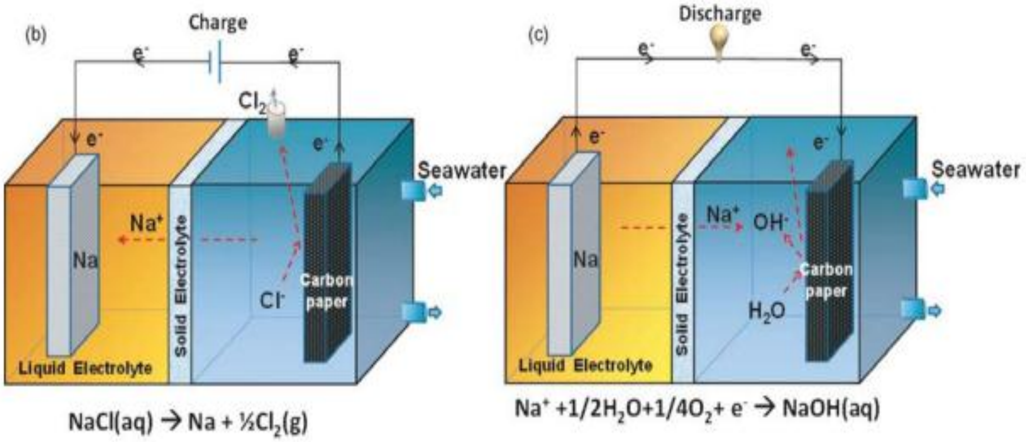

Figure 2. Chemical Reaction Mechanism during charging and discharging

**Methodology**

Toxic metals and solvents in Li-ion batteries can escape from buried cells and damage soil and groundwater. The novel seawater battery is ecologically beneficial since it uses benign seawater instead of the poisonous solvent used in conventional lithium-ion batteries. Lithium-ion battery solvents are currently flammable, posing a fire hazard if the batteries are damaged or overheated. When incorrectly disposed of in landfills, they can potentially cause fires. Because of its availability and possible use in deep-sea energy storage applications, seawater has been proposed as the battery electrolyte, or chemical medium that permits electrical charge to pass between anode and cathode. As a result, a sea-water battery outperforms others.

Under the same experimental circumstances, saltwater [0.1 M NaCl (aq)] was examined, and a 4.1 voltage is generated and compared (versus. Na+/Na0) with the salty water (4.0 V vs. Na+/Na0), as shown in Figure 3. From seat water sodium is separated and used in the negative electrode room during recharging, after which they were reduced to metallic Na at the negative electrode [Eq. (1)].
Electrode that is negatively charged:

->Na++e—>Na++e—>Na++e—>Na++ (s) (1)

## General Demonstration

Figure 3.General Demonstration of sea water battery

Clorine ion and water molecule are two important substance in sea water that can be oxidized at the positive electrode side, shown in the above figure and as reactions below [Eqs. (2) and (3)]

$2H_2O(l)\text{->}O_2(g) + 4H^+(aq) + 4e^-$ (2)
$2Cl^- (aq)\text{->} Cl_2(g) + 2e^-$ (3)

Therefore, two possible overall reactions can be considered during the charging process [Eqs. (4) and (5)]

$2\ NaCl(aq) + H_2O(l) \text{->} 2Na(s) + 2HCl(aq) + ½\ O_2(g)$ (4)
$2\ NaCl(aq)\text{->} 2Na(s) + Cl_2(g)$ (5)

In both chemical processes, gas evolve at the positive electrode, even though the voltages for the generation of O2 and Cl2 are slightly different (0.14 V). Although O2 evolution is thermodynamically preferable to Cl2 development, the measured charge voltage of the saltwater[3] may be linked to both Cl2 and O2 gas evolution reactions. The ratio of Cl2 evolution to O2 evolution is higher in general because the O2 evolution reaction has a higher overpotential when saltwater [NaCl (aq)] undergoes an electrolytic process (Figure 4). Sodium ions created by the Na metal at the negative electrode moved into the saltwater through the solid electrolyte during battery discharge. According to the half-cell reaction [Eq. (6)], the following chemical reaction happened at the negative electrode. :

2.71V = Na->Na+ + e- E0 (6)

Two hypothetical electrochemical processes which involves H2O and O2 which is dissolved in it [Eqs. (7) and (8)] can be studied at the positive electrode:

E0 = 0.40 V = 2H2O + O2 + 4e—>4OH- (7)

$E_0 = -0{:}83$ V $2H_2O + 2e \longrightarrow 2OH^- + H_2$ $E_0 = -0{:}83$V $2H_2O + 2e \longrightarrow 2OH^- + H_2$ $E_0 = -0{:}$ (8)

When the battery is drained, two different total chemical processes may be formed, as indicated below [Eqs. (9) and (10)]:

$E = 3.11$V $Na(s) + 1/2H_2O(l) + 1/4O_2(g) \rightarrow NaOH(aq)$ (9)
$E = 1.88$V $Na(s) + H_2O(l) \rightarrow NaOH(aq) + 1/2H_2(g)$ (10)

Figure 4. Model seawater battery-operated Lantern

The carbon–seawater complete cell has a discharge capacity of 115 mAh $g^{-1}$ at 0.1 mA $cm^{-2}$ and an average voltage of 2.1 V. The full-initial cell's cycle exhibited a Coulombic efficiency of 69 percent. The sodium ions originally gathered from seawater are consumed to produce a stable SEI layer on the surface of the hard carbon negative electrode, resulting in a 31 percent irreversible capacity. The measured voltage gradients of 2.5–3.5 V after the development of the SEI matched to sodium ion intercalation into the hard carbon structure. Furthermore, due to the constant supply of $O_2$ by flowing saltwater, the discharge voltage was maintained throughout the cycling process. After the first cycle, the full-Coulombic cell's efficiency increased, and excellent capacity retention was achieved (Figures 5.). The solid electrolyte in the seawater battery[5],[6], [7] system must be highly stable in the presence of water, and this solid electrolyte demonstrated good chemical stability during 40 cycles in contact with seawater. Further study is planned to analyze its long-term stability in saltwater and its impacts on electro-chemical performance, since its long-term stability in water is a concern.

## Results and Discussion

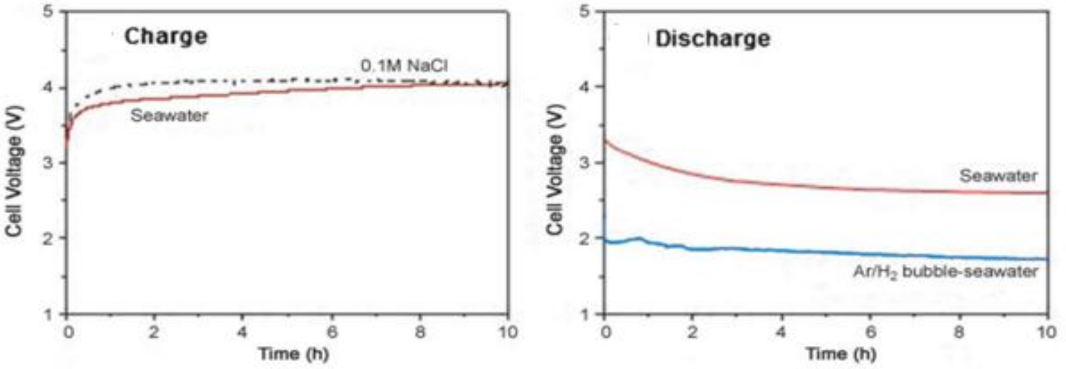

Figure 5 Charge and voltage discharge curve

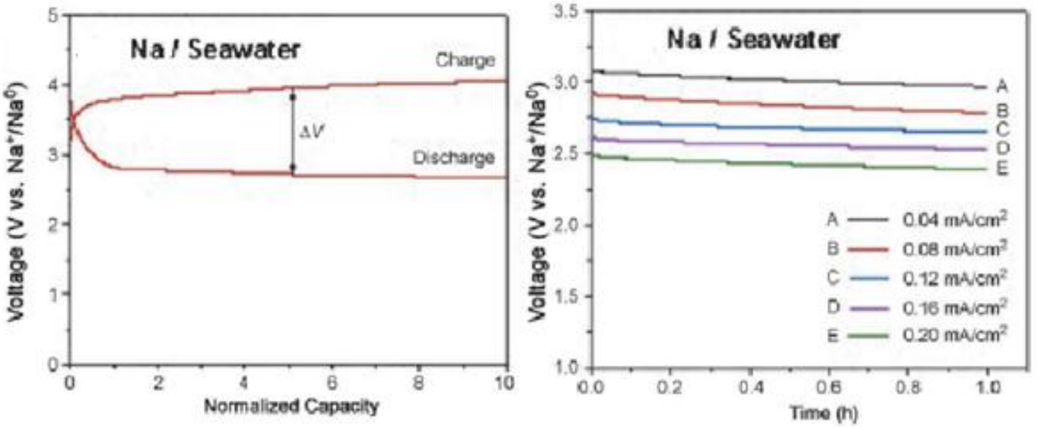

Figure 6: Charge and discharge voltage in Na/ Sea water

Our measured charge voltage (4.05 V) is somewhat higher than the estimated standard voltage for O2 development (3.94 V) and is comparable to the Cl2 evolution voltage (4.07 V). According to the literature, this finding implies that the observed charge voltage is more connected to Cl2 evolution than to O2 evolution. After charging, the amounts of Na and Cl in seawater reduced. The created battery's first discharge voltage was 2.9 V (vs. Na+/Na0), obtained at a rate of 0.1 mA cm-2, as illustrated in Figures 5 and 6. Sodium ions created by the Na metal at the negative electrode moved into the saltwater through the solid electrolyte during battery discharge. According to the half-cell reaction [Eq. (6)], the following chemical reaction happened at the negative electrode.

## Conclusion

The coastal portion of Andhra Pradesh, particularly the Konaseema region, is exposed to the Bay of Bengal, where the majority of SC and financially disadvantaged people struggle to obtain power, and in many cases do not have access to it. Fishermen who go out to sea take battery-operated lanterns with them. The electric lantern, which requires frequent charging and battery replacement, is costly. The seawater battery-powered electric lamp can meet their urgent needs. We will be able to give an electric light that is both affordable and environmentally friendly here. The electrochemical architecture of a rechargeable battery that uses saltwater to produce both negative and positive source materials is presented during cell charging and discharging. The discharge potential was 2.9 V with O2 participation in the discharge process, while the seawater exhibited 4.05 V with Cl2 development during charge. We also discovered that sodium ions in flowing saltwater intercalated reversibly into the hard carbon in the cell, resulting in high cycle performance. The research on this new battery is still in its early stages, and more design and performance enhancements are being worked on.

## Acknowledgment

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