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salgenx-saltwater-flow-battery-technology

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Salgenx

Saltwater Flow Battery Technology

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NaCl based flow battery technology. Electricity and thermal storage. Add on graphene production as part of process. Using artificial intelligence and supercomputers to formulate, assess, verify, and forecast self-assembling and self-healing flow battery electrodes.

PDF Version of the webpage (first pages)

https://salgenx.com/salgenx-saltwater-flow-battery-technology.html

Exploring the Feasibility of Chloride Salts in Saltwater Batteries

Saltwater batteries present an innovative approach to energy storage, leveraging the electrochemical properties of various chloride coesalts. By using a chlorinator to split the salts into chlorine gas, which is stored in oil, and metal ions that travel to the cathode, these batteries can harness a range of elements to generate power. This article evaluates the feasibility of different chloride salts in such batteries, including the number of electrons transferred during the electrochemical reactions. We use artificial intelligence and supercomputers to formulate, assess, verify, and forecast self-assembling and self-healing flow battery electrodes.

Common Chloride Salts

1. Sodium Chloride (NaCl)
• Electrons Transferred: 1 electron per sodium ion.
• Feasibility: High
• Explanation: Sodium chloride is abundant and cost-effective. The electrolysis process yields chlorine gas and sodium ions, which are compatible with various cathode materials. Sodium ions exhibit good ionic mobility, enhancing battery efficiency.

2. Potassium Chloride (KCl)
• Electrons Transferred: 1 electron per potassium ion.
• Feasibility: High
• Explanation: Potassium chloride is widely used in fertilizers and as a salt substitute. Electrolysis produces chlorine gas and potassium ions, which have high mobility and contribute to efficient energy storage.

3. Zinc Chloride ($ZnCl_2$)
• Electrons Transferred: 2 electrons per zinc ion.
• Feasibility: Medium to High
• Explanation: Zinc ions are effective in battery applications, providing high energy density. However, managing chlorine gas and potential formation of insoluble compounds presents challenges.

4. Calcium Chloride ($CaCl_2$)
• Electrons Transferred: 2 electrons per calcium ion.
• Feasibility: Medium
• Explanation: Calcium ions have lower mobility compared to sodium or potassium, potentially reducing efficiency. However, calcium chloride is commonly available and inexpensive.

5. Magnesium Chloride ($MgCl_2$)
• Electrons Transferred: 2 electrons per magnesium ion.
• Feasibility: Medium to High
• Explanation: Magnesium ions offer good conductivity and are widely available. The main challenge lies in managing the kinetics of magnesium ions in the electrolyte.

6. Ammonium Chloride (NH_4Cl)
• Electrons Transferred: 1 electron per ammonium ion.
• Feasibility: Low to Medium
• Explanation: Ammonium ions can complicate the electrochemistry due to the potential formation of ammonia and other reactive species. While feasible, this option presents significant complexity.

Less Common Chloride Salts

1. Aluminum Chloride ($AlCl_3$)
• Electrons Transferred: 3 electrons per aluminum ion.
• Feasibility: Low
• Explanation: Aluminum ions can form insoluble hydroxides, complicating their use in aqueous solutions. Handling and effective electrochemical performance are also challenging.

2. Iron(II) Chloride ($FeCl_2$) and Iron(III) Chloride ($FeCl_3$)
• Electrons Transferred: 2 electrons per iron(II) ion.
• Electrons Transferred: 3 electrons per iron(III) ion.
• Feasibility: Low to Medium
• Explanation: Iron ions can form various insoluble compounds, making them complex to manage in aqueous batteries.

3. Copper(I) Chloride (CuCl) and Copper(II) Chloride ($CuCl_2$)
• Electrons Transferred: 1 electron per copper(I) ion.
• Electrons Transferred: 2 electrons per copper(II) ion.
• Feasibility: Medium
• Explanation: Copper ions have favorable electrochemical properties, but managing chlorine gas and potential compound formation in the electrolyte is necessary.

4. Barium Chloride ($BaCl_2$)
• Electrons Transferred: 2 electrons per barium ion.
• Feasibility: Low
• Explanation: Barium ions form insoluble compounds like barium sulfate, reducing practicality. Handling and environmental concerns also decrease feasibility.

Specialized Chloride Salts

1. Mercury(II) Chloride ($HgCl_2$)
• Electrons Transferred: 2 electrons per mercury ion.
• Feasibility: Very Low
• Explanation: Mercury compounds are highly toxic, posing significant environmental and health risks, making this option impractical.

2. Lead(II) Chloride ($PbCl_2$)
• Electrons Transferred: 2 electrons per lead ion.
• Feasibility: Very Low
• Explanation: Lead compounds are toxic and pose environmental hazards, making this option impractical due to toxicity and disposal issues.

Conclusion

• High Feasibility: Sodium chloride (NaCl) and potassium chloride (KCl) are the most feasible options due to their availability, cost-effectiveness, and favorable electrochemical properties.
• Medium Feasibility: Zinc chloride ($ZnCl_2$) and magnesium chloride ($MgCl_2$) present viable alternatives but require careful handling of chlorine gas and potential ion mobility challenges.
• Low Feasibility: Calcium chloride ($CaCl_2$), ammonium chloride (NH_4Cl), iron chlorides ($FeCl_2$, $FeCl_3$), copper chlorides (CuCl, $CuCl_2$), aluminum chloride ($AlCl_3$), barium chloride ($BaCl_2$), mercury

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Why Salt Water may be the Future of Batteries

There’s no shortage of solutions to the world’s need for renewable energy storage, but there is a shortage of accessible and cheap resources to use for those solutions. Lithium and vanadium aren't limitless, so what about regular, run-of-the-mill salt? Redox flow batteries, or RFBs, can exploit the abundance of elements like sodium and iron. One U.S. company already has salt water batteries ready to go, with at least two others developing iron flow variations built to effectively run on rust. They promise to last longer and be far cheaper than the competition. So, what happens if we go with the flow?

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As a simultaneous Thermal Storage Device

Considered a hybrid between a standard flow battery and a thermal storage device, the battery provides simultaneous heat or cold liquid storage as well as electrical energy storage.

The Cogen Battery has a variety of applications which include:
-storage of thermal energy (heating or cooling) from unused thermal resources
-storage of electrical power for backup power and grid strength
-utility grid power rate mining opportunities to store off-peak low cost power for later use during demand (on-peak) hours
-storage of thermal energy for Organic Rankine Cycle (ORC) power production while simultaneously storing the electrical output from the turbine generator
-using off-peak low cost power to make heating and cooling for later use
-reducing peak demand utility rates by peak energy shaving

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Saline pool as energy storage or simultaneous Desalination Device

We can extend the applications for the saltwater battery to include making recreational pools a dual use for energy storage when not in use.
The saltwater battery in the ocean or brine pools can also be used to make fresh water simultaneously.
NID has a remarkable energy efficiency (0.74 kWh/m3 for seawater-level NaCl) with the possibility of a high water recovery rate (maximum: 95% water recovery - source acsomega.6b00526).

Using a heat pump for vapor distillation or using battery process. For SWB-D system, sodium ions are solidified on the anode and chloride ions migrate to the cathode compartment to maintain charge neutrality while partial energy used during desalination is stored in the SWB anode. Unlike LIB (Lithium Ion Battery) or SIB (Sodium Ion Battery), SWB (Seawater Battery), and SWB-D (Seawater Battery Desalination) have an open-cathode compartment. In addition, sodium super-conducting separator (NASICON) is used for SWB and SWB-D, whereas a separator is used for LIB or SIB.

Turn Brine Pools into Batteries

Salton sea.
Ocean water.
Oil and gas producer water.
Brine remediation.
Powerplant cooling tower brine pool and boiler effluent use.
Reverse osmosis (RO) and ion exchange waste/reject streams.
Chlor-alkali and chemical plant waste.
Acid rock and mine drainage.
Food preservation and manufacturing waste streams.
Desalination waste from potable water creation.
Farming irrigation runoff.

Heat Pump

A heat pump is almost exactly like a ORC (Organic Rankine Cycle) system, which uses phase change to provide work to produce heat or cooling.

In the case of a ORC system, the pressure reducing valve is replaced with an expander which mechanically rotates a electrical generator to make power.

A heat pump has a high COP (Coefficient of Performance - is defined as the relationship between the power (kW) that is drawn out of the heat pump as cooling or heat, and the power (kW) that is supplied to the compressor) when compared to resistance heating.

We have also been able to have a high COP with our cavitating discs in liquids that cavitate (water, CO_2, and refrigerants).

The advantage of a heat pump is that you can use off peak power to produce heating or cooling into a liquid, and then use that thermal resource during the on peak hours for huge cost savings. We term this utility grid price arbitrage.

Saltwater Battery

The Salgenx saltwater battery is a flow battery system, which requires two large tanks that hold fluid electrolytes. One tank is dedicated to salt water (add NaCL to water). The saltwater tank may be used for thermal storage.
Fluids are circulated through electrodes, which regulate the input and output of electricity from the battery.
The battery does not use a membrane, which is common on a redox flow battery.
The absence of the membrane saves huge up front purchase costs, maintenance, and consumable expenses.

The amount of electrolyte flowing in the electrochemical stack at any moment is rarely more than a few percent of the total amount of electrolyte present (for energy ratings corresponding to discharge at rated power for two to eight hours). Flow can easily be stopped during a fault condition. As a result, system vulnerability to uncontrolled energy release in the case of RFBs is limited by system architecture to a few percent of the total energy stored.

The energy capacity is a function of the electrolyte volume and the power is a function of the surface area of the electrodes.

Harnessing Magnetohydrodynamic Drive in Saltwater Flow Batteries for In-Situ Flow Enhancement

The world's growing energy demands and the imperative shift towards cleaner, more sustainable technologies have spurred intensive research into innovative energy storage solutions. Among these, flow batteries have gained attention for their potential to offer scalable, long-duration energy storage. One intriguing development in this realm is the incorporation of magnetohydrodynamic (MHD) drives into saltwater flow batteries. This integration presents a fascinating approach to enhancing in-situ flow and improving the overall efficiency of these energy storage systems.

Summary of Tesla Megapack Lathrop Production Facility as of November 2023

In a November 16, 2023 interview on the Randy Kirk YouTube channel, Bradford Ferguson provided an update on Tesla's Megapack manufacturing. He visited Lathrop, California, and observed the production rate of Megapacks. In March 2023, he counted about 10 Megapacks produced per day. On a recent visit, he noted an increase to 27 per day, but estimated the actual rate to be around 18-19, occasionally dropping to 10 per day. The production capacity is believed to be 27 units per day, equating to 4 GW hours.

Ferguson identified the primary production limitations as the availability of batteries and power electronics, specifically silicon carbide. Power electronics are crucial for converting DC to AC power and include devices like gallium nitride FETs and power diodes. The cost of batteries in each Megapack is around $300,000, with the total price of a 3 MWh Megapack being approximately $1.9 million.

The interview concluded that with the resolution of battery and power electronics supply chain issues, Tesla could adopt a rapid expansion model for Megapack factories worldwide, potentially producing between 10,000 to 20,000 units annually. At full capacity (27 units per day), the output could reach 9,855 Megapacks (30 GWh) annually, yielding $18.725 billion in revenue and $9.362 billion in net profit.

Aqueous Zinc Flow Battery using Pair Dancing Proton Transfer

Salgenx is now investigating a ultra high rate (comparable to supercapcitors) battery combination based on recent research results from a study in China that has a 1000 C (400 A g-1) and 200,000 cycles.

Our interest is specifically to try new Faradaic electrodes and cathode materials while incorporating the technology into our flow battery.

The result may be a high power and long life closed loop flow battery with less weight and materials.

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Progress and Applications of Seawater-Activated Batteries

Nearly 50 percent of the world's population lives by the sea. Of the 17 largest cities in the world, 14 are located near the coast, and they consume most of the electricity. The required electricity is transmitted from long distances, increasing costs and reducing energy efficiency. Recently, renewable energy technologies such as solar, wind, wave, and tidal energy generators have been deployed offshore and by the sea to reduce energy transmission distances. However, large-scale EES systems are necessary to provide stable electrical energy, and rechargeable seawater-activated batteries can be a better option for large amounts of electrical energy storage. It is expected that offshore and waterfront deployments of rechargeable seawater-activated batteries may be very easy, since they operate in seawater as the main battery component. (reference article below)

Energy Density Chart:
Vanadium 22-43 Wh/L
Zinc Bromine: 60-70 Wh/L
Saltwater Flow Battery: 125 Wh/L
Lithium 90-160 Wh/kg
Lithium Ion: 140-160 Wh/kg
Magnesium Flow Battery: 300-500 Wh/L
Magnesium-Air Battery (MAB) with Nanostructured Polymeric Electrodes: 545 Wh/kg
Magnesium Metal H2 Peroxide Seawater Activated Battery: 100-500 Wh/kg

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Liquid Electrode

Under development is using centrifugal adhesion and flow dynamics to contain catalyst as an alternative to plating solid, porous, or flow-through electrodes.

This method is a game changer since little to no electrode manufacturing or preparation is needed. Maintenance free and easy to replace. Coded material can be time referenced for born-on and expiration or replacement date.

Almost any catalyst can be used. This is perfect for just-in-time experimentation and battery manufacturing since there is no time lag if preparing electrodes from a supplier.

We first used this to make a proof-of-concept to make hydrogen (H2) in water electrolysis. H2 production was actually increased using this process, compared to standard electrode and electrochemistry.

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Exfoliated Graphene

Under development using electrochemistry as a spinoff of this flow battery is making graphene.

There are many similarities and the use of sodium (Na) to exfoliate graphene from graphite.

We are also experimenting with electrostatic pulling to harvest layers of graphene from graphite.

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Salgenx Lift Pump System

The Salgenx Lift Pump System is design to pump saltwater and viscous fluids.

For the saltwater flow battery application, it has piping and fixtures which are electrolyte material compliant to resist corrosion from environmental conditions from saltwater.

Each bulk liquid electrolyte tank will have a pump.

Features: Each pump has a E-stop, Variable frequency Drive (variable flow depending on liquid), and sensor platform for manual and automated operation. The cart is a Infinity Caster Beam System with standard bolt-together assembly (by human or robot). The disc pump is a Patented modular block design driven by a magnetic coupling and stainless steel washdown motor. The pump is a modular bolt-together design for ease of maintenance and can be T-rack mounted for easy lift-in, lift-out servicing. The U manifold allows multi-port input/output/recirculation/services/sensor functions. The cart can easily be tipped slightly to transform into a hand cart for ease of movement through any standard door, hallway, or elevator. The unit can be mounted to any standard container.

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