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Current Advances in Desalination Battery: An Overview

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Abstract

The study has been depicted the current advances in desalination batteries considering the understanding of concept of desalination batteries. Secondary data collection method has been used in this study based on peer reviewed journals and thematic data analysis process has been conducted in this study. Seawater desalination has been conducted with the implication of desalination batteries including the different methods such as reverse osmosis, membrane process, micro grid process has been highlighted here. PBAs implication regarding the longevity of the desalination batteries also has been discussed over here. Purification of water according to the demand of water considering the increasing population has been depicted here to analyze the process of seawater desalination. Environmental sustainability along with business sustainability also has been focused by the sweater desalination including use of desalination batteries. Advantages of the desalination batteries use have been highlighted in the study to determine the objectives of the study.

Keywords

Desalination Batteries, PBAs, Water.

INTRODUCTION

Desalination battery is a component that helps to extract sodium and chloride ions from seawater using electrical energy input to generate fresh water. Basically, in water treatment desalination batteries are used to purify the water considering natural and unnatural contaminants. Drinking water of ships and in many arid regions are using this battery to desalinate seawater or in water in which the sodium is high in quantity [1]. Electro dialysis is the main characteristic of the desalination concept. The features of desalination can be used in thermal desalination. The benefits of desalination procedure are to enhance the safety of drinking water by providing clean and fresh drinking water along with serves to the agriculture field with enhanced quality water for cultivation. Tried and tested technology also has been impacted with the desalination process considering the sea water desalination.

The tools used for sea water desalination have used the desalination battery to extract the chloride and sodium ions from salty water. Beside this thermal distillation including multi effect distillation, multi stage flash desalination and vapour compression along with solar desalination also have been used the desalination battery. Capacitive deionization is the basic characteristic of a desalination battery that helps to generate electricity for furthermore uses [2]. Small consumption of energy used in the desalination process that helps to accelerate the purification of water in a large quantity. The entire process has been driven by the desalination battery that highlights the strengthening potential of the battery. The composition of the desalination battery is $Na_{2-x}Mn_5O_{10}$ nanorod positive electrode and Ag/AgCl negative electrode. This battery capacity has the efficiency to reduce 25% of salt from seawater as it is the most efficient technique in present days. The study also has highlighted the extraction of the lithium materials from the sea water that helps in manufacturing the batteries. New advanced technologies used in seawater desalination accelerate the scope of generating renewable energies for future. Solar wind combined device for the electric supply to the seawater desalination considering the use of diesel generators and desalination of batteries has been focused in the study. Importance of the desalination battery in seawater desalination including creating drinking water has been briefly discussed over here.

Objectives

The study aims to desalination battery to provide specific knowledge about recent advances.

- To understand the concept of desalination battery.
- To analyse the process of desalination of salt water using the battery.
- To evaluate the energy storage capacity of the desalination battery.
- To identify the impact of desalination batteries in concurrent energy generation and water desalination.

MATERIALS AND METHODS

The study has executed the secondary data collection process based on the peer reviewed journals. The reliability and authenticity of peer reviewed journals enhance the quality of the study. Secondary data collection method is quite cost effective and a time saving approach [3]. The study has used the thematic data analysis process considering the secondary data collection. Thematic data analysis also has

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been influenced by the peer reviewed journals that can be considered as the reliable sources for collecting the information. The writer can use the independent thought process highlighting the realistic observation in secondary thematic data analysis. Themes are developed relevant to the subject of the study and using the peer reviewed journals. Objectives of the study also have been focused by the study to develop the themes focused to meet the goal of the study.

Desalination battery and its impact on daily curricular activities have been discussed in the study considering the themes developed in the study based on secondary collected data. On the other hand, there are more options to collect more secondary data to justify the study with a realistic observation aspect. Themes are also developed with flexible consequences to meet the study objectives with informative justification. Reliability and validity of the secondary data analysis enhance the trustworthiness of the readers that helps to enhance the quality of the study [4]. Both process secondary data collection and thematic data analysis helps to save time and reach the final destination of the study in a short period of time. Observation capacity of the study considering the realistic society has been highlighted in the study to mitigate the urge of the study to meet the objectives with proper justification.

RESULTS

Increasing demand for energy consumption has focused on the utilisation of renewable energies. Renewable energies considering the solar, water and wind power can create sustainable sources of energy along with helping to reduce the environmental pollution. The concept of desalination battery can be followed by oxidation of chloride ions considering the TEMPO catholyte and beside this; sodium ions are reduced to produce the FMN Na anolyte [5]. The NaCl salt has been removed by this process including electric energy generation in the water. “4-hydroxy-2”, “2,6,6-tetramethylpiperidin-1-oxyl (TEMPO, 97%)” and “riboflavin-5’-phosphate sodium salt dihydrate (FMN-Na)” were bought from Sigma-Aldrich. “Nicotinamide (99%)” and “sodium chloride (99.5%)” act as the reagent for the desalination of seawater to produce purified water. Ion exchange membranes are also engaged in the process of electricity generation by desalination battery.

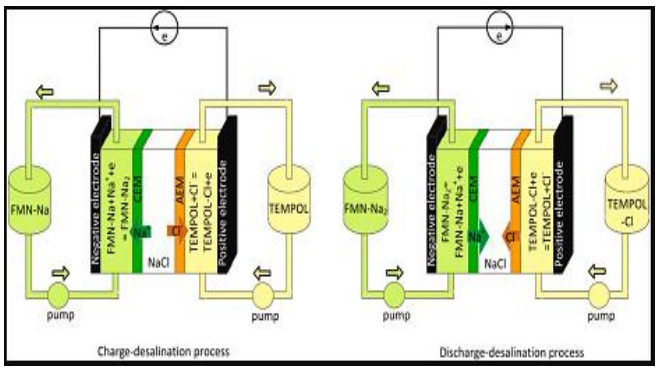

Figure 1: Concept about desalination battery

The organic flow of the desalination battery has been explained in the above graph. ORFDB is enforces the cost-effective renewable storage considering the electrochemistry of organic modules. The redox flow batteries have the capacity to store electricity on a large scale. Electro active species outside the battery is itself a container for storing electricity. The RFBs are divided into positive and negative electrolytes which have separated by the membrane [6]. Charge and discharge of catalysts have been explained in figure 1 to understand the entire process of organic flow of desalination batteries. In the organic flow batteries, the seawater desalination process gets integrated that helps to maintain the environmental sustain ability. The batteries stand for Ph neutral considering aqueous organic redox flow that includes three electrolytes channels such as acolyte channel, catholyte channel and centre salt water channel. Integrated energy storage chemical stable reaction and employing low cost are the prior features of organic flow desalination batteries.

The cell delivers 79.7% efficiency to store energy which has a more competitive advantage than reverse osmosis technologies. Water stressed countries are adopting the desalination of seawater to accelerate the process of purification of water. Membrane processes considering the desalination of seawater have been too expensive in cost along with high energy requirement of the process creates difficulties to use the process [7]. Therefore, the study has focused on the rechargeable desalination batteries used in the desalination process of seawater that has an extra advantage of storing additional energy. Reverse osmosis system analysis model has been optimised for the seawater desalination to achieve lowest energy consumption while executing the process of desalination. The results reflect on the satisfactory performance of seawater batteries that successfully dissolve 72 to 82% of chloride and sodium ions from seawater.

Growing population increases the demand for fresh and clean water and scarcity of water takes place in a global aspect. Among all the technologies reverse osmosis process has been mostly used for the desalination of seawater. The expensiveness of the RO system and high consumption of energy are the disadvantages of the process [8]. Therefore innovation of seawater batteries that can store energy on a large scale can integrate the process of desalination of seawater. Hence desalination batteries are highly prioritised by the process to apply the actual plant in seawater desalination. Strategic implication of seawater batteries in the process of desalination has been highlighted in the reverse osmosis analysis model that accelerates the desalination process in a cost-effective manner including increasing the energy storage capacity of the desalination batteries. According to the demand for water, there is a need to purify water from the oil and gas extracted.

Desalination technologies are highly concerned by the desalination process to develop the system for ultra filtration of water. After a critical research process using the advanced

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technologies including desalination batteries can automatically remove unnatural particles and slats and produce fresh drinking water. Higher water production also helps to develop the economic growth by increasing the saving capital and reducing energy use cost considering operational expenditure of the process. The target is to supply 6.4 million tons of water per day using a desalination process including a desalination battery to extract water from seawater [9]. Electrode preparation and electrochemical characterization of desalination batteries enhance the potential of the batteries to restore the energies considering electrical energy generation. Battery deionization has enhanced the next generation desalination process that helps to obtain high efficiency of restoring energies that can be applicable for the large ion storage capacity.

Salt concentration also has been regulated by the process of deionization of batteries. Redox flow battery desalination has followed by four channel cell architecture in different salinity levels. 70% and more earth surfaces are covered by water and human beings can utilise only 0.014% water [10]. However, the increased demand of water enforces the development of alternative fresh water resources. Aqueous batteries have a more comprehensive advantage than organic batteries due to the eco-friendly approach of the batteries. Low cost nature of the batteries simplifies the implication of the aqueous batteries and desalination batteries are now improvised with the features of aqueous batteries. Carrier ions of desalination batteries exhibit more hydrated radius in water electrolytes that helps to achieve the reversible insertion and extraction of cations. Therefore, Prussian blue analogues are prioritised in manufacturing desalination batteries. Open three-dimension framework and facile synthesis are the major characteristic of Prussian blue analogues.

Correlation ship of the electrochemical behaviours and structural characteristics of PBAs enforces the modification of desalination batteries to enrich the aqueous advantages. Monovalent batteries, multivalent batteries are the two dividends of desalination batteries. Considering the exploration of renewable resources, desalination of seawater helps to reduce the environmental pollution and improve the environmental responsibilities [11]. The aspects of volatilization, toxicity and flammability of organic electrolytes can create many safety problems and adverse impact on the environment; hence aqueous electrolytes are preferred for desalination of seawater. Energy storage efficiency potential in the aqueous electrolytes is much more than other devices. Considering the consequences, the seawater desalination used the PBAs components in desalination aqueous batteries to reduce energy consumption in the process and lowered the manufacturing cost of the operational process. Advantage of theoretical capacity acceptance, high stability and low cost integrate the efficiency of energy storing capability of desalination batteries.

Nano structured materials are generally used in the PBAs implication including co-precipitation method. PBAs also have been considered as the good carrier of both organic and aqueous electrolytes [12]. Mixed reactions of organic and aqueous have been integrated into the seawater desalination process. AxM[R(CN)6]·wH2O can be considered as the composition of the PBAs in which R, M are undergoing a reduction reaction that helps to release energy. At the same time, atoms of PBAs structure have created a reaction of oxidation to store energy. The simultaneous charging and discharging process helps to accelerate the desalination process considering aqueous batteries and ensure energy restoration on a large scale. After reaction completion hydrated ions become larger in size that gives structural stability of PBAs.

Cubical dimension chemical composition of PBAs adds an extra advantage in inserting ions in storing energies. Variations of aqueous batteries are influenced by the PBAs implication that integrated the process of desalination and meet the demand of ultra-filtered water. In Spite of PBAs desalination of batteries combining with Cu3[Fe(CN)6]2·nH2O as the Na-storage electrode with Bi as the Cl-storage electrode has enforced the membrane's free desalination that also accelerates the speed of the process and increases the quantity of desalinated water [13]. In current days thermal distillation and reverse osmosis are the most feasible approach of seawater desalination. Considering the desalination batteries combination of Na storage electrode and Cl storage electrode used in the removal and release of the sodium ions are not required the membranes that impacted the cost-effective approach of seawater desalination.

Membrane fouling and replacement also can be avoided by the application of Na and Cl electrodes in the desalination process. Batteries of the desalination process are also following the combination of composition of Na and Cl electrode. Synthesis and characterization of the Cu3[Fe(CN)6]2· nH2O (CuHCF) as a Na-Storage Material as a Na material have simplified the membrane free desalination that helps to enhance the process in positive ratio [14]. Bi can serve as a more effective Cl storage electrode considering the electrochemical conversion. Effectiveness of membrane free desalination also has been reflected on the operational cost of seawater desalination. Operational optimization for micro grids in the desalination batteries has been prioritised to increase the longevity of the battery’s life.

Reliable and safe power supply has been influenced by the micro grid operation optimization. Considering the micro grid operational optimization sweater desalination can better the volatility of renewable energy that helps to meet the goal of clean energy. Island micro grid operations have an important realistic significance that considers the seawater desalination [15]. Comparing the central system, the micro grid operational system is more efficient as it uses a minimum amount of hydrogen and oxygen. The economic optimization also has been driven by the micro grid operations considering the lifespan of batteries.

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Transformation of renewable energies also has adopted the non-dominated sorting genetic algorithm to enhance the protection and utilisation of desalination batteries.

Development of wind solar combined batteries that have accelerated the process of desalination of seawater. Pluripotent coupling reverse osmosis seawater desalination devices considering the wind solar complementary power generation that helps to reuse the energy again and again with a cost-effective approach. Desalination batteries help to generate the power to integrate seawater desalination [16]. Power generation operation including combination of solar and wind helps to operate the diesel generator and desalination batteries to supply flawless electric generation that can better the quality of water purification in a large quantity. The superior action of the solar and wind energy generation assures the water and electric supply to the rural and remote island areas. The container of this kind of device also carries out the water in case of emergency requirements. Rapid demand and supply can be balanced by using the device. Energy storage devices seawater desalination also has been influenced by this kind of device that also impacted the process of electric energy restoration in a simple way.

Emerging desalination technologies in seawater desalination also develop the water purification process with an environmental aspect that reflects on reducing environmental pollution along with industrial pollution. Environmental sustainability including business sustainability both have been impacted with the implication of desalination batteries in seawater desalination. Lithium extraction by the seawater desalination also can be integrated into the process of material storage that helps to manufacture the desalination batteries [17]. Considering the progression of different countries, the implication of new advanced technology has aimed to harness energy from the desalination process. Sodium ion desalination has been prioritized by the process of seawater desalination as the salt extraction and water purification both have been accumulated by this process. Considering all consecutive aspects, desalination batteries are the most important tool for purification of seawater and generating fresh and clean drinking water.

DISCUSSION

The results of evaluation of the importance of desalination batteries have been discussed over here to meet the objectives of the study. The chemical reaction of the desalination batteries composition has been presented here considering the ionization of Na and Cl ions. Organic flows of desalination batteries also have been focused here including effectiveness of electrodes. Redox flow and its impact on seawater desalination has widened the scope of seawater desalination. Beside this, methods used in seawater desalination have been discussed over here. Energy restoration processes along with generating renewable energies have been highlighted in this study to analyze the efficiency of desalination batteries in the seawater desalination process. Chemical reaction of seawater desalination has been depicted here. Increasing demand of drinking water following the population desalination batteries accelerates the process of water desalination that ensures the supply of safe and pure drinking water in the remote island also.

Environment sustainability also has been passively maintained by the desalination batteries by producing electricity energy without any pollution. Future restoration of renewable energies also has been accumulated by the implication of desalination batteries. Prussian blue analogue procedure for the seawater desalination process considering manufacturing the desalination batteries also has been focused here to depict the importance of seawater desalination. PBAs implication in the sweater desalination process has created the stability, accountability and cost integrated efficiency that enforces the process to generate the drinking water. Different types of batteries such as monovalent, multivalent batteries are highlighted in this study to ensure the efficiency of the desalination batteries.

Reverse osmosis, membrane process, and membrane free process for desalination of seawater has been depicted here to analyze the most effective method for seawater desalination that accelerates the process of seawater desalination to generate a large quantity of water in minimum time. On the other hand, the cost effectiveness of desalination batteries including the time saving approach of it has been discussed over here to increase the process of seawater desalination. Longevity of the desalination batteries also has been concerned in this study that ensures the cost effectiveness of the sweater desalination process. Microgrid process of sweater desalination increases the reliability regarding production of the pure and clear drinking water that meets the demand of the water. Supply of the water has been influenced by the process of micro grid seawater desalination. Lithium extraction for the manufacturing batteries also has a significant characteristic of seawater desalination considering the desalination batteries.

Pluripotent coupling reverse osmosis seawater desalination devices use the solar and wind combination generating energy that ensures the continuous flow of electric energy supply to the seawater desalination process considering diesel generator and desalination batteries. Implication of advanced technologies in the sweater desalination process ensures the reduction of scarcity of water and simultaneously continuous flow of renewable energies. Most unique feature of the desalination batteries is to generate electric energy that maintains the continuous operational process of seawater desalination. Considering the reduction of water pollution, desalination batteries have an extra advantage to generate clean water in minimum time. Desalination batteries are considered as the energy generator in a cost-effective manner. Environmental sustainability and business sustainability both have been benefited by the implication of desalination batteries in the sweater desalination process. Central process desalination can be used in the seawater desalination which is less effective than

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the micro grid process.

Toxicity, volatilization and exploration of resources can be reduced by the process of desalination batteries considering the desalination batteries. Advantages of desalination batteries have been accelerated the process of seawater desalination that helps to reduce the scarcity of water and meet the global demand of the water supply. Environmental pollution also has been reduced by the use of desalination batteries as it helps to remove the lithium from seawater that helps to reduce the water pollution. Lithium extraction also has been used in the manufacturing of the batteries, however desalination batteries passively helps to generate raw materials. Removal of the salt from the sea water helps to restore the resources of minerals such as NA and Cl. Reverse osmosis procedure for seawater desalination is the most popular and cost-effective process that has been improvised with the implication of new technologies considering the desalination batteries. Considering all the consequences the study to some extent successfully discussed the result of evaluation of importance of desalination batteries.

CONCLUSION

The study has highlighted the importance of the desalination batteries for the storage of the renewable energies and purification of the water to reduce the scarcity of water. Different processes of seawater desalination have been discussed over here, prioritising the improvisation of desalination batteries. Organic flow of desalination batteries has been focused in this study. Objectives of the study have determined the evaluation of the desalination batteries impact on the water desalination including energy storage and generation. Secondary data collection method has been selected for the study to meet the objectives of the study. Thematic data analysis has been explored in the study to justify the subject of the study. Peer reviewed journals have been used in the study to make the study more reliable and validated. Concept of redox flow batteries and its chemical reaction also have been discussed in the study.

Membrane process, reverse osmosis process, membrane free desalination process has been discussed over here. Considering positive and negative aspects of the seawater desalination process, strategic implications of advanced technologies have also been depicted here. Analyses of alternative resources of energies also have been highlighted here considering the electric energy generation potential of desalination batteries. PBAs application in manufacturing batteries also has been discussed briefly in this study to depict the importance of restoration of the energies in a cost-effective way. Comparing the intrinsic and extrinsic capacity of different processes of desalination of seawater also has been highlighted here including prioritising the potential of salt removal from the seawater.

Optimization of micro grid operations to expand the desalination batteries life has been considered in this study. Impact of desalination batteries on the environment also has been focused in the study by stating the characteristics of the desalination batteries. Economic growth also has been influenced by the desalination batteries as it helps to reduce the cost of desalination operations and also save the time considering a large-scale production of fresh water. Working strategies of Na and Cl electrodes to electrolyte the process of desalination also has been discussed over here to reach the goal of the study. Importances of purification of water and restoration of renewable energies also have impacted the study with high quality.

REFERENCES

[1] Rashidi, Mohammad Mehdi, et al. "Applying wind energy as a clean source for reverse osmosis desalination: A comprehensive review." *Alexandria Engineering Journal* 61.12 (2022): 12977-12989.

[2] Vafakhah, Sareh, et al. "A review on free-standing electrodes for energy-effective desalination: recent advances and perspectives in capacitive deionization." *Desalination* 493 (2020): 114662.

[3] Ballard, David H., et al. "Medical 3D printing cost-savings in orthopedic and maxillofacial surgery: cost analysis of operating room time saved with 3D printed anatomic models and surgical guides." *Academic radiology* 27.8 (2020): 1103-1113.

[4] Kyngäs, Helvi, Maria Kääriäinen, and Satu Elo. "The trustworthiness of content analysis." *The application of content analysis in nursing science research*. Springer, Cham, 2020. 41-48.

[5] Liang, Mengjun, et al. "The progress and prospect of the solar-driven photoelectrochemical desalination." *Renewable and Sustainable Energy Reviews* (2021): 111864.

[6] Xiong, Ping, et al. "A Chemistry and Microstructure Perspective on Ion-Conducting Membranes for Redox Flow Batteries." *Angewandte Chemie International Edition* 60.47 (2021): 24770-24798.

[7] Ayaz, Muhammad, et al. "Sustainable seawater desalination: Current status, environmental implications and future expectations." *Desalination* 540 (2022): 116022.

[8] Ghaffour, N., et al. "Membrane distillation hybrids for water production and energy efficiency enhancement: A critical review." *Applied Energy* 254 (2019): 113698.

[9] Ayaz, Muhammad, et al. "Sustainable seawater desalination: Current status, environmental implications and future expectations." *Desalination* 540 (2022): 116022.

[10] Mocek-Płóciniak, Agnieszka, and Monika Skowrońska. "Water–an important element not only of the soil environment." *Soil Science Annual* 72.1 (2021): 134620.

[11] Ayaz, Muhammad, et al. "Sustainable seawater desalination: Current status, environmental implications and future expectations." *Desalination* 540 (2022): 116022.

[12] Yu, Yanxia, et al. "High-Voltage Rechargeable Aqueous Zinc-Based Batteries: Latest Progress and Future Perspectives." *Small Science* 1.4 (2021): 2000066.

[13] Nam, Do-Hwan, Margaret A. Lumley, and Kyoung-Shin Choi. "A desalination battery combining Cu3 [Fe (CN) 6] 2 as a Na-storage electrode and Bi as a Cl-storage electrode enabling membrane-free desalination." *Chemistry of Materials* 31.4 (2019): 1460-1468.

[14] Lee, D. K., et al. "An Introduction to Electrochemical Water Desalination and Solar Water Splitting." *Development of Electrode Materials for Electrochemical Desalination and Solar Water Splitting* (2020): 1.

e-ISSN: 2583-1968

[15] Wang, Wei, et al. "Research on capacity optimization and real-time control of island microgrid considering time-shifting load." *Energy Reports* 8 (2022): 990-997.
[16] Kotb, Kotb M., et al. "A fuzzy decision-making model for optimal design of solar, wind, diesel-based RO desalination integrating flow-battery and pumped-hydro storage: Case study in Baltim, Egypt." *Energy Conversion and Management* 235 (2021): 113962.
[17] Debruler, Camden, et al. "Integrated saltwater desalination and energy storage through a pH neutral aqueous organic redox flow battery." *Advanced Functional Materials* 30.24 (2020): 2000385.