Oxide Activated Carbon for Seawater Desalination Using Solar Energy

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ABSTRACT

Desalination of seawater is the efficient process and a viable solution for water shortage problem. One of the latest possible solution with less energy consumption is the use of activated carbon for the desalination process. In this work activated carbon was produced from palm trees trunk. The preparation of the activated carbon was done by two steps process. The first step was the pyrolysis for two hours at 700 °C under nitrogen gas flow of 150 ml/min. The next step was the physiochemical activation using potassium hydroxide (1:1) under nitrogen and carbon dioxide gas flow of 150 m/min for two hours. The prepared activated carbon was analyzed using SEM, EXD and XRD to study the surface area, the porosity and the chemical composition. The application of the activated carbon in the desalination process was done by initially oxidizing the AC to use it for the reduction of the boiling point of the seawater followed by the desalination. This was supported with the use of a solar panel to provide the required energy for evaporation. The prepared activated carbon in this study was used to produce fresh water by the desalination of seawater based on environmentally safe and lower energy cost method, which is a promising technique that can overcome the shortcomings of the current used technologies.

INTRODUCTION

- Fresh water under very fast exhaustion because of the overdrawing and the leak of seawater in water stressed regions.[1]
- Seawater desalination methods is increasing everyday which in return made this technology becoming a cost-competitive technique in comparison with other methods to produce useable fresh water that can solve the growing needs for water in this region.[2]
- Solar cell has been used to replace fossil fuel to provide these plants with the required energy.[3]
- Activated carbon is characterized as a carbonaceous material with an expansive inside surface region and exceedingly created permeable structure coming about because of the handling of crude materials under high temperature responses.[4,5]

AIM AND OBJECTIVES

To develop a desalination process that does not consume high amount of energy and environmentally friendly using oxide activated carbon prepared from agricultural waste.

❖preparation of activated carbon with physiochemical activation.

❖analysis and characterize the activated carbon using FTIR.

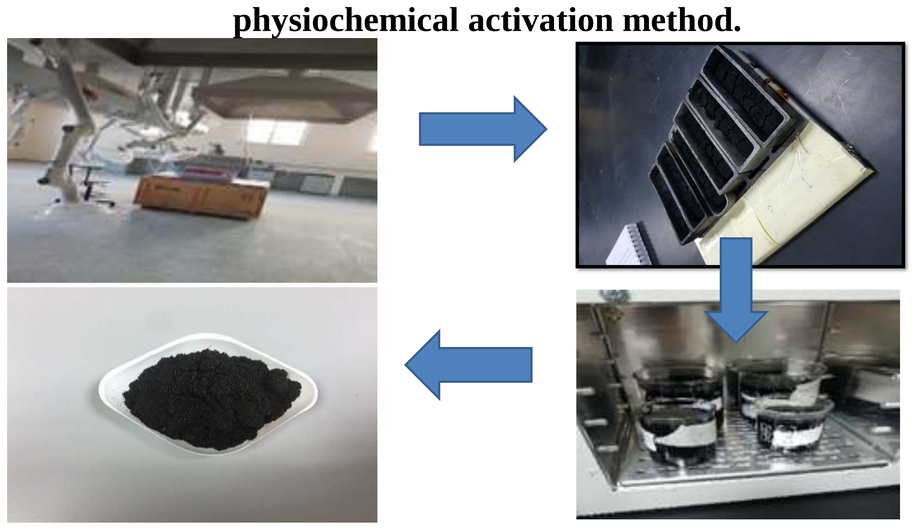
❖preparation of O-AC to lower the boiling point.

❖ preparation the pellets from O-AC.

❖ Using pellets in the desalination process supported with solar panel.

METHODOLOGY

1: Preparation of Activated Carbon (AC) from agricultural waste (palm waste) by physiochemical activation method.



2: Preparation of Oxide Activated Carbon (O-AC)

Preparation of mixture of O-AC using Hummer's method

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Centrifugation

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Washing with DDW for many times

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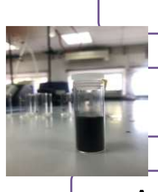

Drying.

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Analysed using FTIR instrument

Formation of homogeneous gel

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Placed in a freezer for 24h.

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Placed in a DDW bath for 4h.

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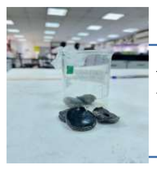
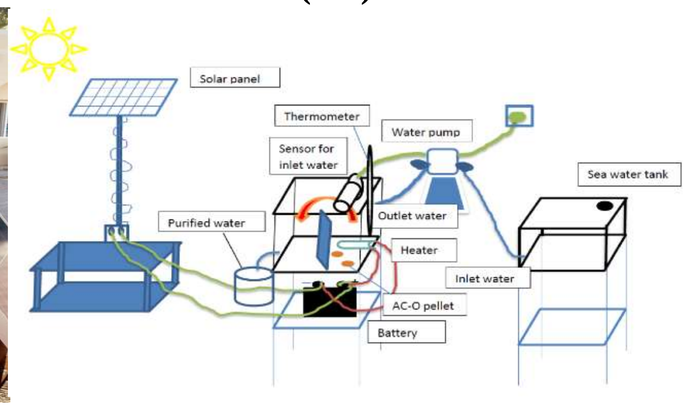


Pellets were annealed in water for 15 minutes at 85°C .

3: Solar Desalination of seawater with Activated Carbon (AC)



RESULTS

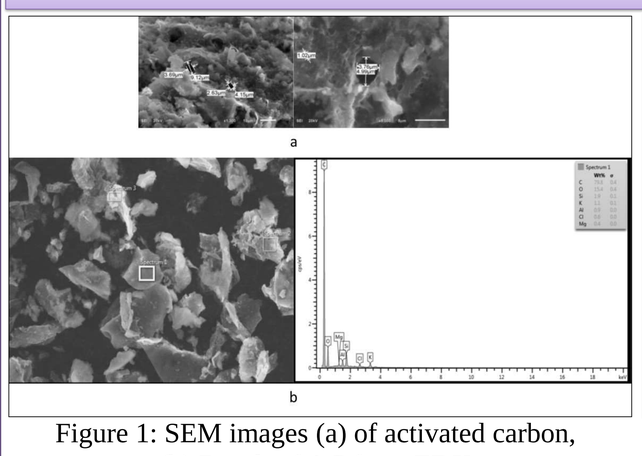


Figure 1: SEM images (a) of activated carbon, (b) Result of AC from EDX

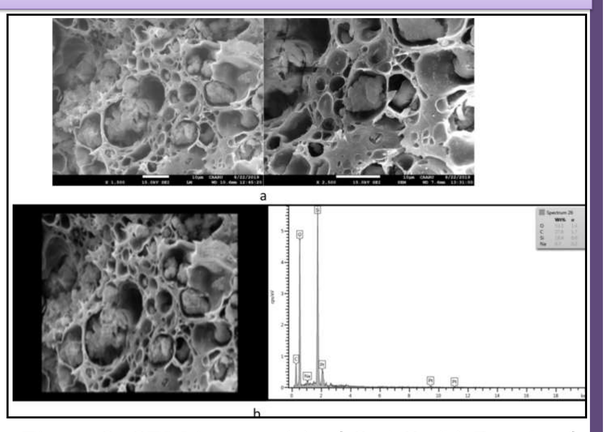


Figure 2: SEM images (a) of O-AC, (b) Result of O-AC from EDX

Sample	Average Time of starting the experiment	Temperature of boiling point	Average Time of stop dropping	Average Volume of collected sample in 50min/ml
Sea water	10:17 am	100°C	After 70 min	60ml
Sea water with O-AC (1)	10:17 am	45°C	After 70 min	64 ml

Table1 Examine the efficiency of oxide activated carbon that prepared from agricultural waste

No. of trail	Volume of DDW in 8 hours
Trail 1 seawater with out O-AC pellets	241 ml
Trail 1 seawater with O-AC pellets	353 ml
Trail 2 seawater with O-AC pellets	262 ml
Trail 3 seawater with O-AC pellets	262 ml
Trail 4 seawater with O-AC pellets	262 ml
Trail 5 seawater with O-AC pellets	212 ml

Table 2 Volume of DDW from desalination setup

concentration				
metals	sea water	D.W from sea water	D.W from O-AC Sample 1	WHO standard
Na	804500 ppm	72 ppm	80.2 ppm	200ppm
K	966.92 ppm	less than LOD	less than LOD	20ppm
Mg	1487.62 ppm	less than LOD	less than LOD	50ppm
Ca	567 ppm	0.048 ppm	1.54 ppm	100ppm
Zn	less than LOD	less than LOD	less than LOD	0.01-3ppm

Table3 Concentration of each metal in seawater, desalinated water sample without using oxide activated carbon (O-AC).

RESULTS & DISCUSSION

- The SEM images of the AC shows clearly the wrinkles with different pore sizes (Figure 1). The EDX results showed the carbon combustion was the highest (32%).
- The SEM and EDX showed the increase of the oxygen percentage to 37.5% (Figure 2) which indicates the oxidation of the activated carbon. This AC-O was then tested with the seawater. The reduction of the temperature of the boiling point and the increase in the evaporation rate of the seawater was noticed when the AC-O was added during the desalination process.
- The desalination was done in a setup made of two glass tanks containing copper coil and the AC-O membrane in the inner tank. The copper coil was connected to a solar panel with a monitor.
- The addition of the AC-O to the seawater showed increase in the evaporation rate and less consumption of the energy.
- The elemental analysis of the seawater showed the removal of the elements and the production of pure water due to the ability of the AC to hold these elements in their pores.

FUTURE WORK

- To produce more AC and try different methods of activation
- Use different membranes of the O-AC
- Find other agricultural waste to synthesis the O-AC
- Use closed system of desalination setup to save the heat and prevent the leakage of water vapored.

REFERANCES

1. Heidarinejad, Z., Dehghani, M. H., Heidari, M., Javedan, G., Ali, I., & Sillanpää, M. (2020b). Methods for preparation and activation of activated carbon: a review. In *Environmental Chemistry Letters* (Vol. 18, Issue 2, pp. 393–415). Springer. https://doi.org/10.1007/s10311-019-00955-0 .

2. Darre, N. C., Toor, G., Ma, L., & Inglett, K. (2017). *Desalination of Water: A Review M.S. Professional Student: Desalination of Water: A Review*.

3. Elsaid, K., Sayed, E. T., Abdelkareem, M. A., Baroutaji, A., & Olabi, A. G. (2020). Environmental impact of desalination processes: Mitigation and control strategies. *Science of the Total Environment*, *740*. https://doi.org/10.1016/j.scitotenv.2020.140125

4. Ahmed, F. E., Hashaikeh, R., Diabat, A., & Hilal, N. (2019). Mathematical and optimization modelling in desalination: State-of-the-art and future direction. In *Desalination* (Vol. 469). Elsevier B.V. https://doi.org/10.1016/j.desal.2019.114092

5. Ali Al-Jabri, S., Ahmed, M., Choudri, B. S., & Ali Al-Jabri Mushtaque Ahmed, S. (2015). *Uncorrected Proof Water Reuse and Desalination | in press.*