Oxide Activated Carbon for Seawater Desalination Using Solar Energy

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Overview

- Introduction
- Objectives
- Methodology
- Results
- Conclusion
- Acknowledgment

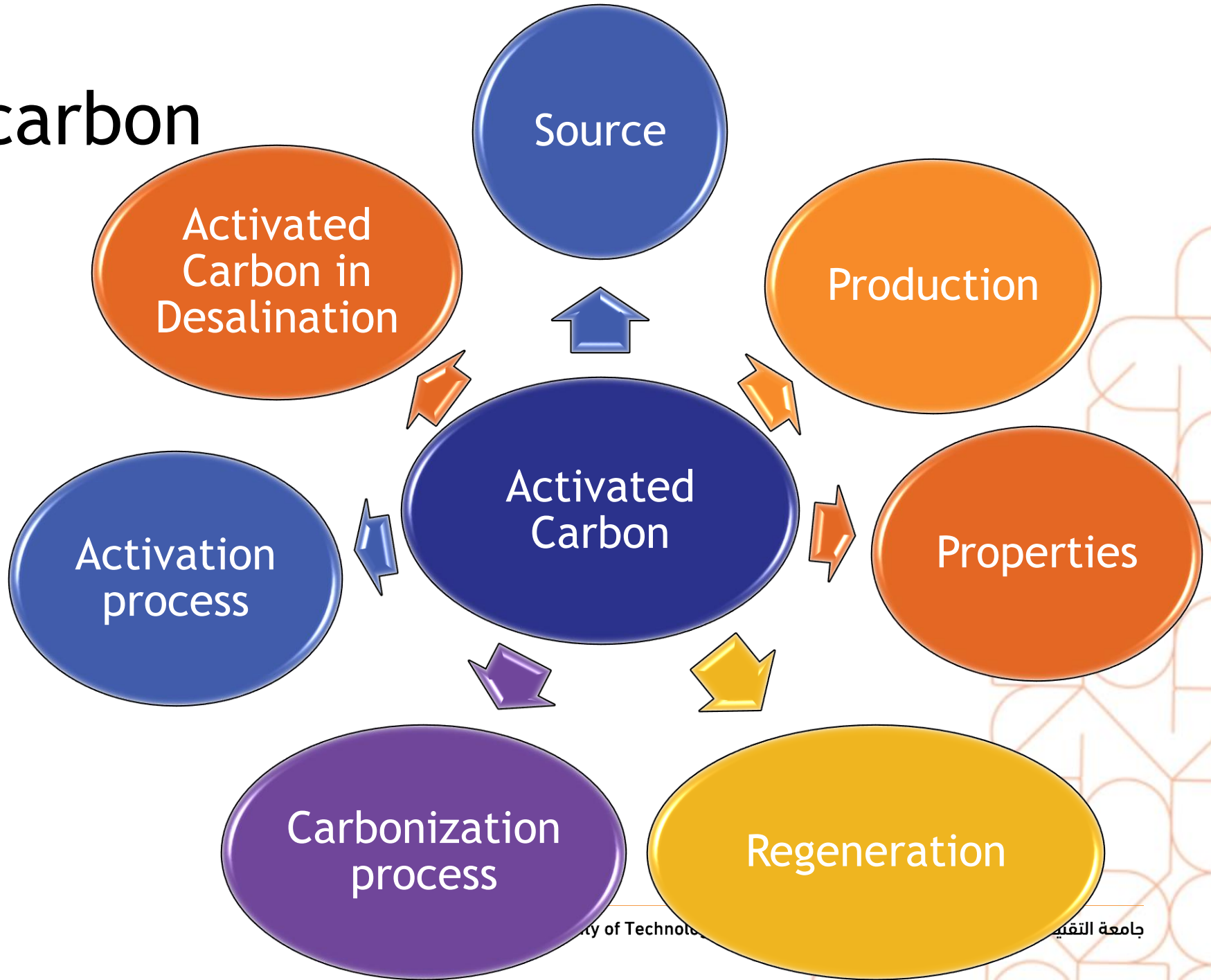
1. Introduction

- Desalination
  1. Types of desalination

- Desalination and water treatment in Oman
  1. Desalination Technologies in Oman
  2. Desalination membrane processes

- Desalination environmental impact.

Activated carbon



2. Aim and Objectives

- **The aim of this project is to To investigate the production of large amount of pure water with less energy consumption by environmentally friendly method using activated carbon prepared from agricultural waste.**

The objective of this study:

- preparation of activated carbon with physiochemical activation.
- analysis and characterize the activated carbon using FTIR, SEM & EDX.
- 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.

3. Methodology

Stage 1

Preparation of Activated Carbon (AC)

from Agricultural Waste

by using physiochemical activation method

Stage 1: Preparation of Activated Carbon (AC)

Approximate 100 g of waste powder was used in each batch and it was placed in an electric furnace (Carbolite reactor).

The heating rate was run about 10°C / min in N_2 flow (150 ml / min) to 700 °C for two hours.

Carbonized char was impregnated with KOH at ratio of 1:3 and it was dissolved with DDW. Solution kept in oven overnight.

The dried char was employed with same condition before and after reach 700°C, the N_2 gas was switched to CO_2 gas

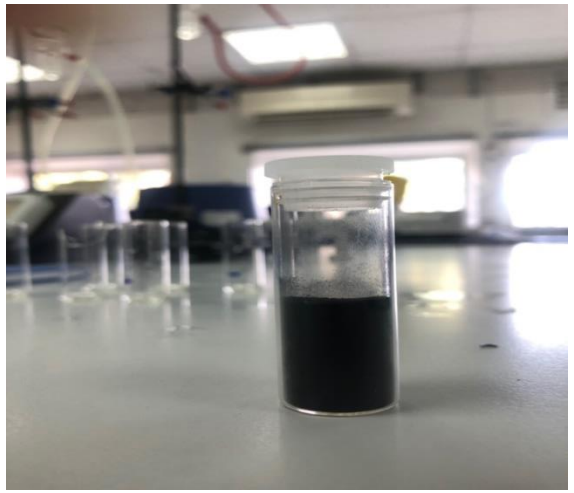
Wash AC with HCl and DDW until reached to neutral pH

The activated carbon was characterized by send it for analysis by EDX & SEM.

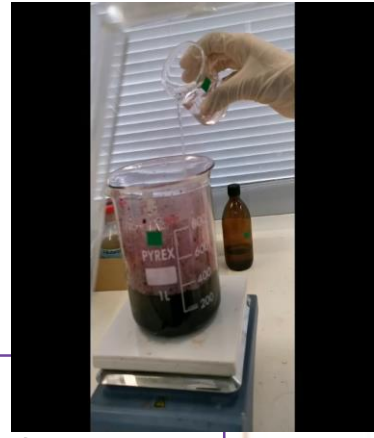
Reference: Azam, T., Hameed, B. and Ahmed, A. (2009) Batch adsorption of phenol onto physiochemical-activated coconut shell. Journal of Hazardous Materials, 161, 1522-1529

Stage 2

Preparation of Oxide Activated carbon (O-AC) using Hummers method



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



React AC with a mixture of H_2SO_4, $NaNO_3$, and $KMnO_4$.

About 60 ml H_2SO_4 (at 4 °C in an ice bath) then 3.5 g $NaNO_3$ and 7 g AC were added into the H_2SO_4 solution under continuous stirring.

After 2 hr, 21 g of $KMnO_4$ were gradually added

322 ml DDW was slowly added. Then,70 ml H_2O_2 was added.

The O-AC were centrifuged and washed with 5% HCl and DDW twice, and the collected O-AC gels were further rinsed by ethanol

Finally the O-AC materials were obtained by drying the gels at 40 °C for 24 hr and send to the SEM analysis.

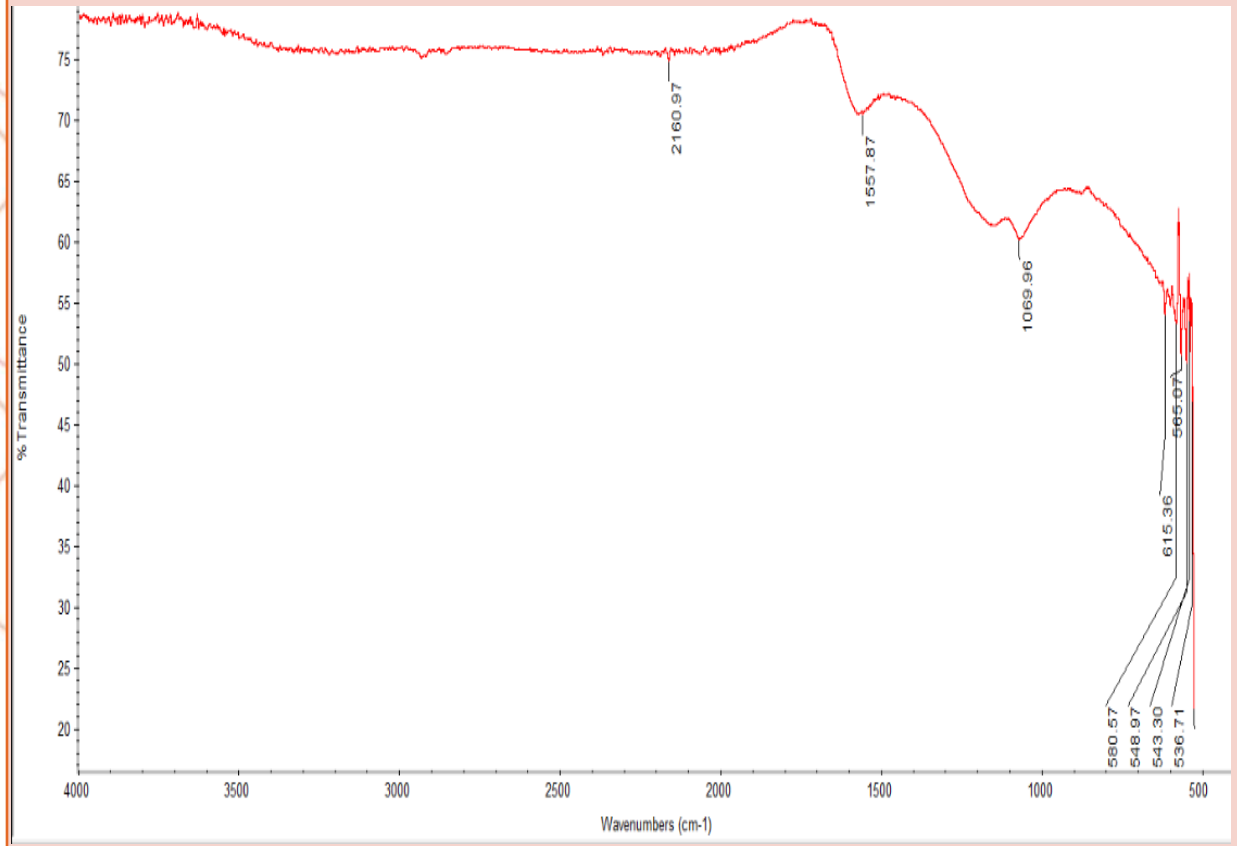
Reference:
Jun, Y., Guocheng, Z. and Baolin, D. (2016) Graphene oxide (GO) enhanced polyamide (PA) thin-film nanocomposite (TEN) membrane for water purification. Desalination, 379, 93-101

1. Examination of activated carbon using FTIR

Results and Discussion

FTIR of activated carbon sample and oxide activated carbon

Activated carbon



Oxide activated carbon

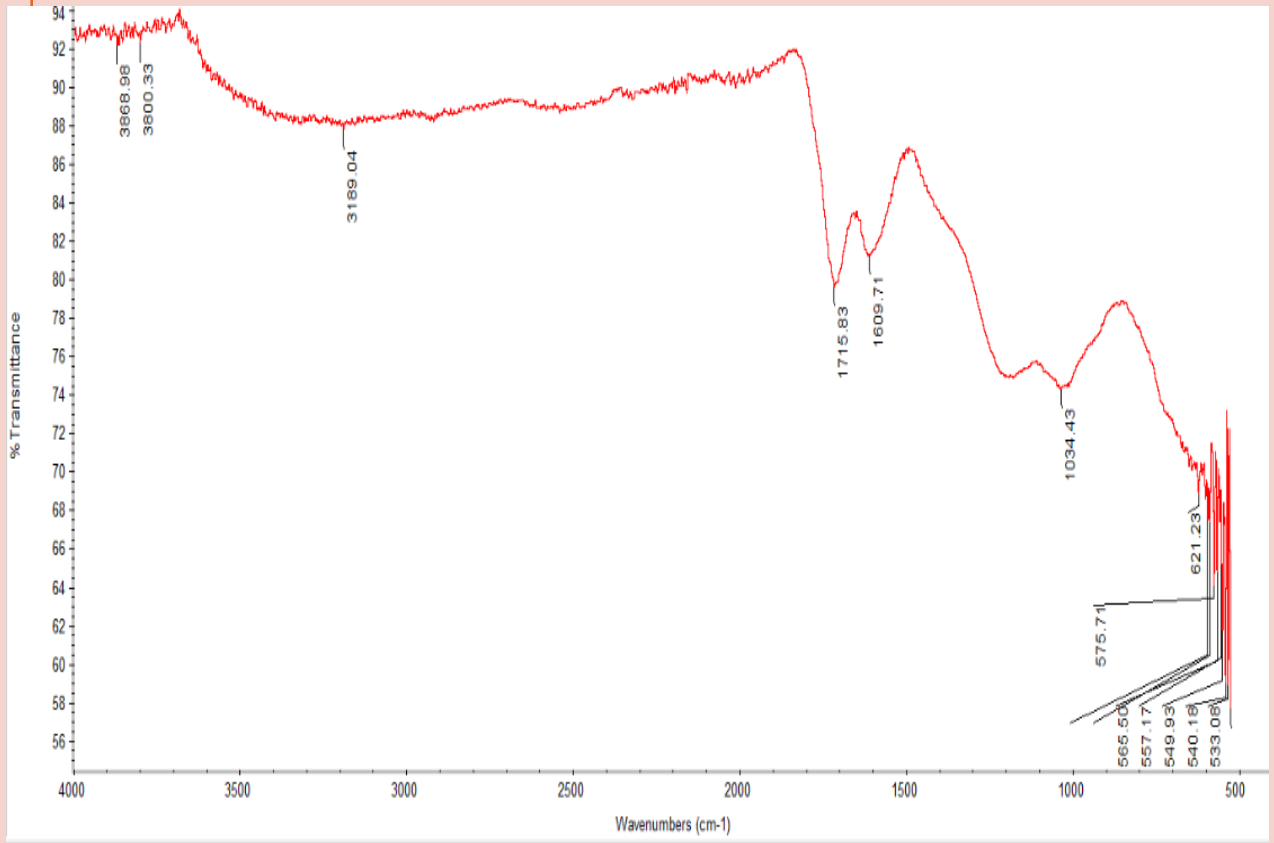
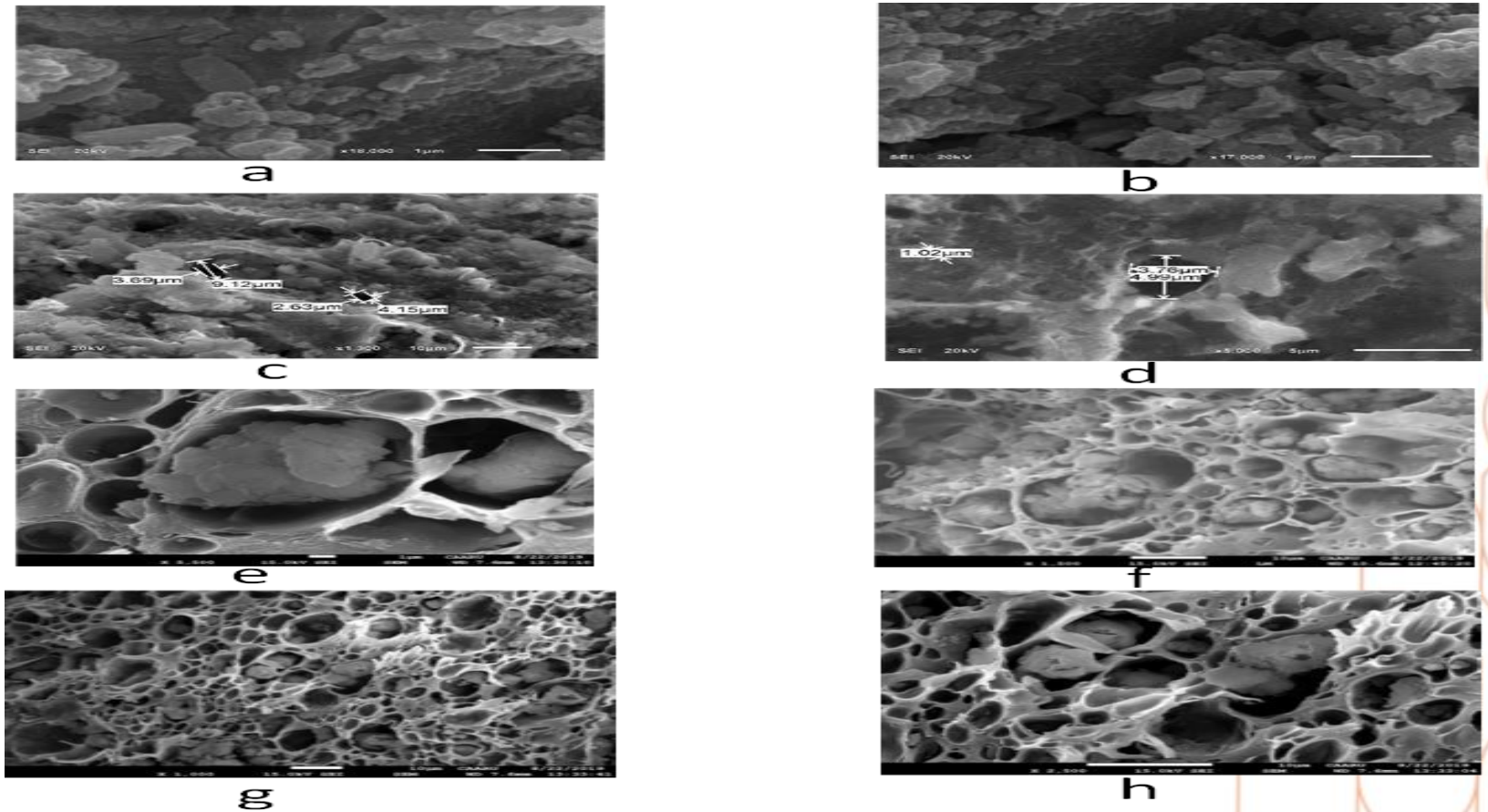


Table 1 FTIR result of both O-AC and the activated carbon

Result of: AC and O-AC from SEM (Scanning Electron Microscope)

AC

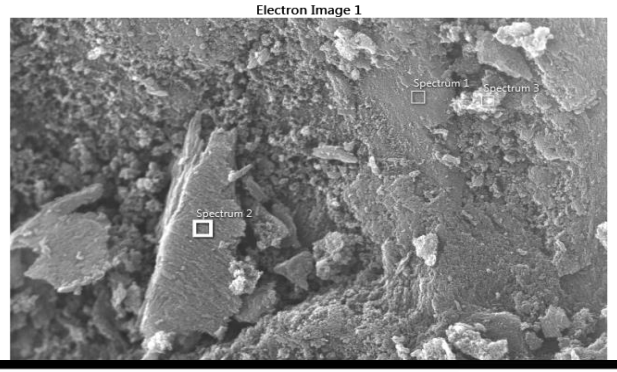
O-AC



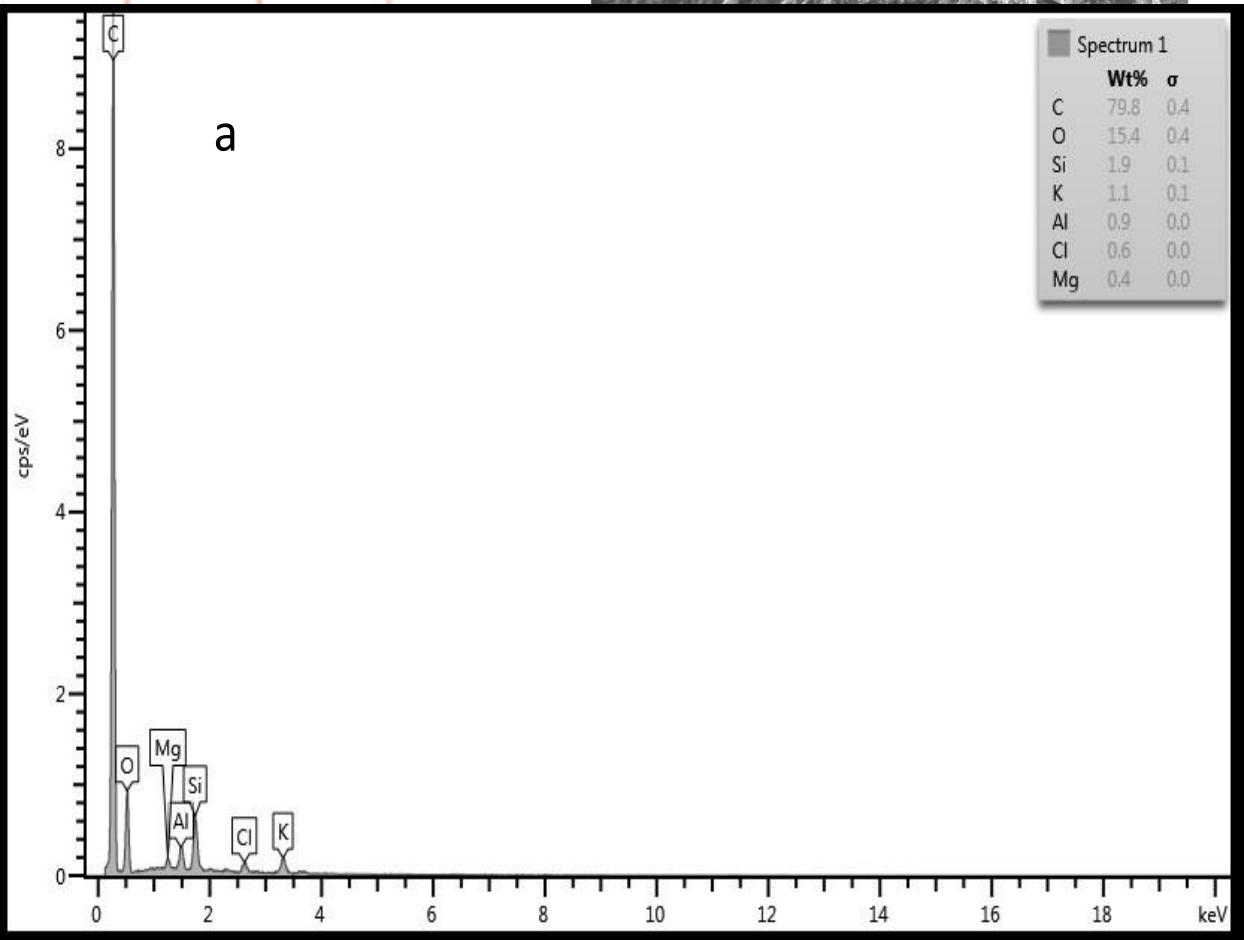
Results and Discussion

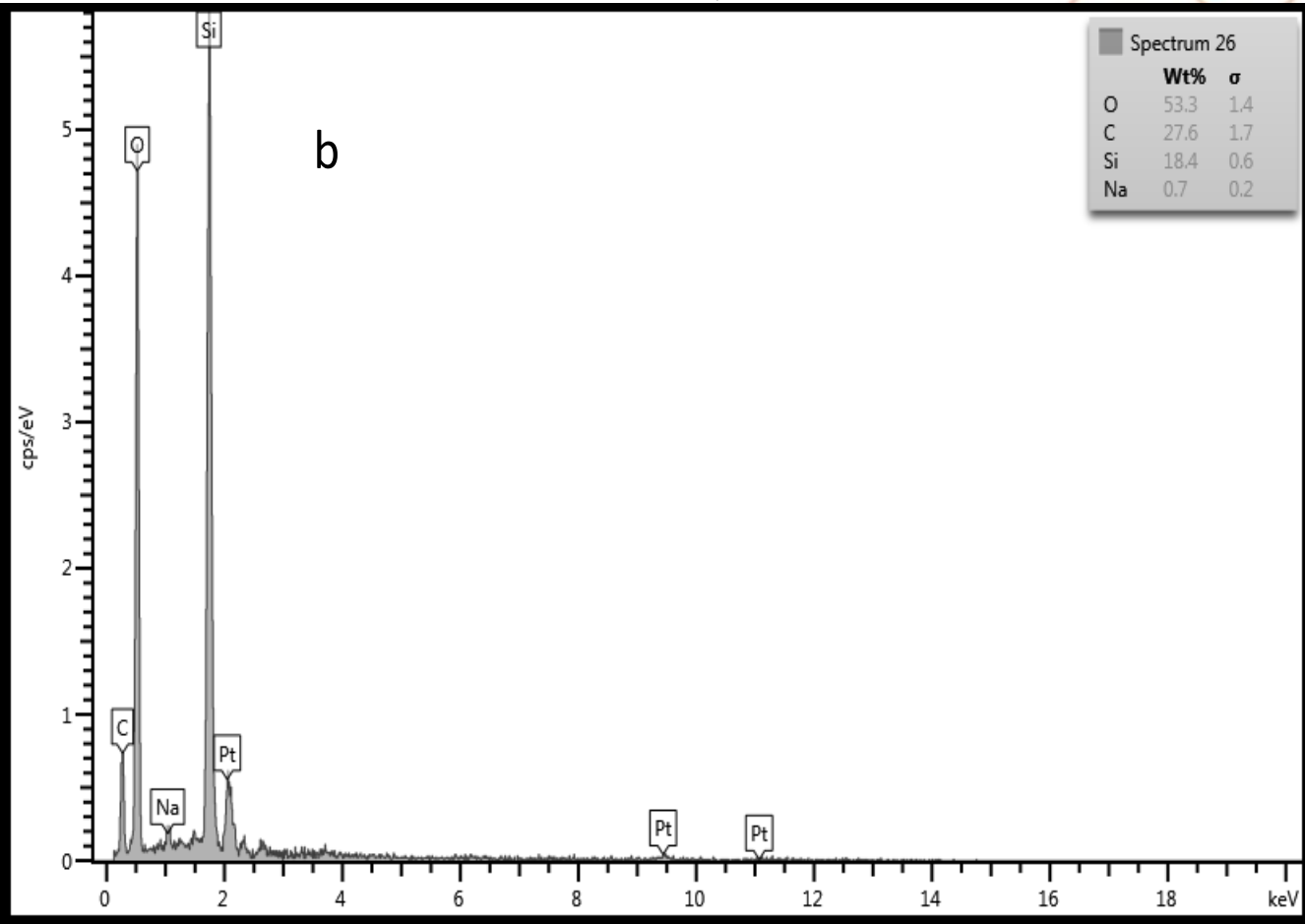
1. EDX Examination

Activated carbon



Oxide activated carbon





Stage 3:

Preparation of supporting material (Cellulose triacetate) for O-AC

1. About 0.92 g of maleic acid was dissolved by methanol

2. Acetone & 1,4-Dioxen also the cellulose triacetate & oxide activated carbon were added after and it was make homogenous gel and casting in glass.

3. After it partially evaporated it was put in cooled water bath (1± 0.3°C) for 24 hours.

4. The pellets was taken out of the glass and kept it in DDW bath at room temperature.

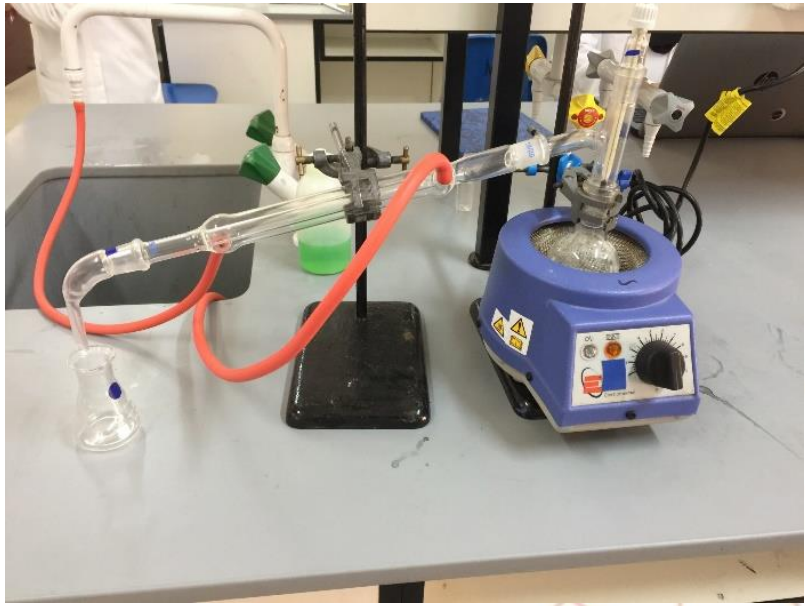
5. washed each 4 hours for 24 hours

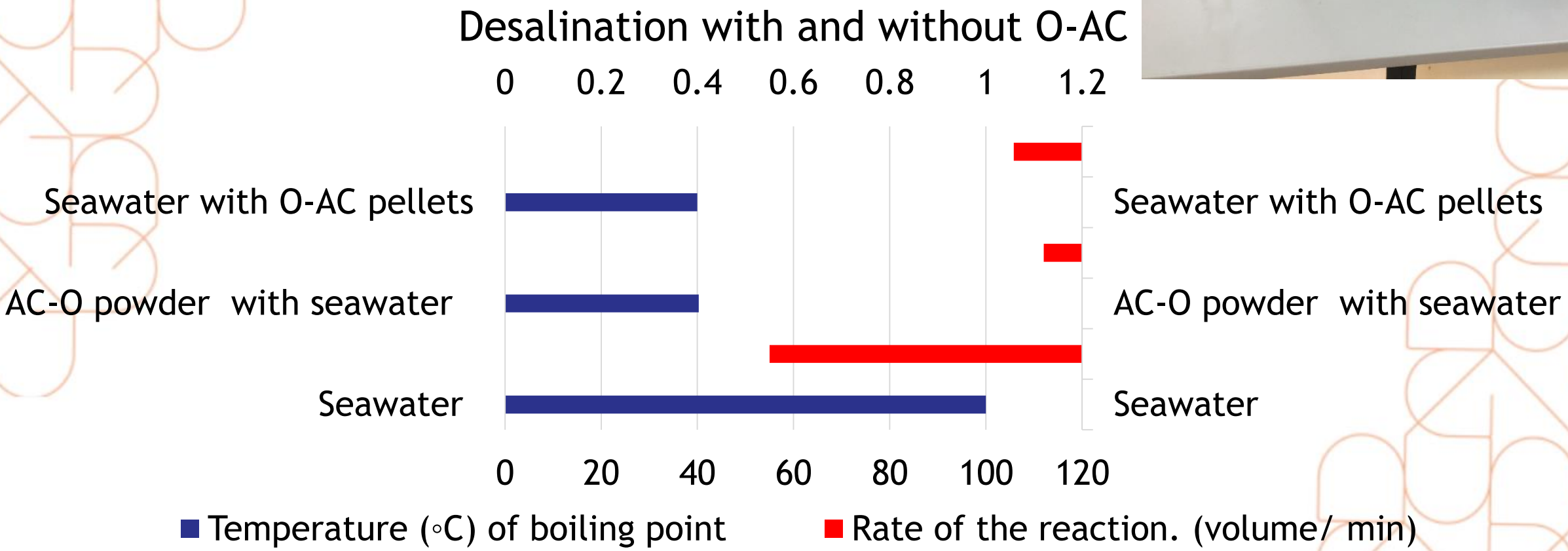
6. pellets was annealed for 15 min at 85°C in water before storing in DDW.

Nguyen, T.P.N., Yun, E.T., Kim, I.C., Kwon, Y.N., 2013. Preparation of cellulose triacetate/cellulose acetate (CTA/CA)-based membranes for forward osmosis. J. Memb. Sci. 433, 49–59.

Stage 4

- **Examination of boiling point of sea water with oxide activated carbon.**

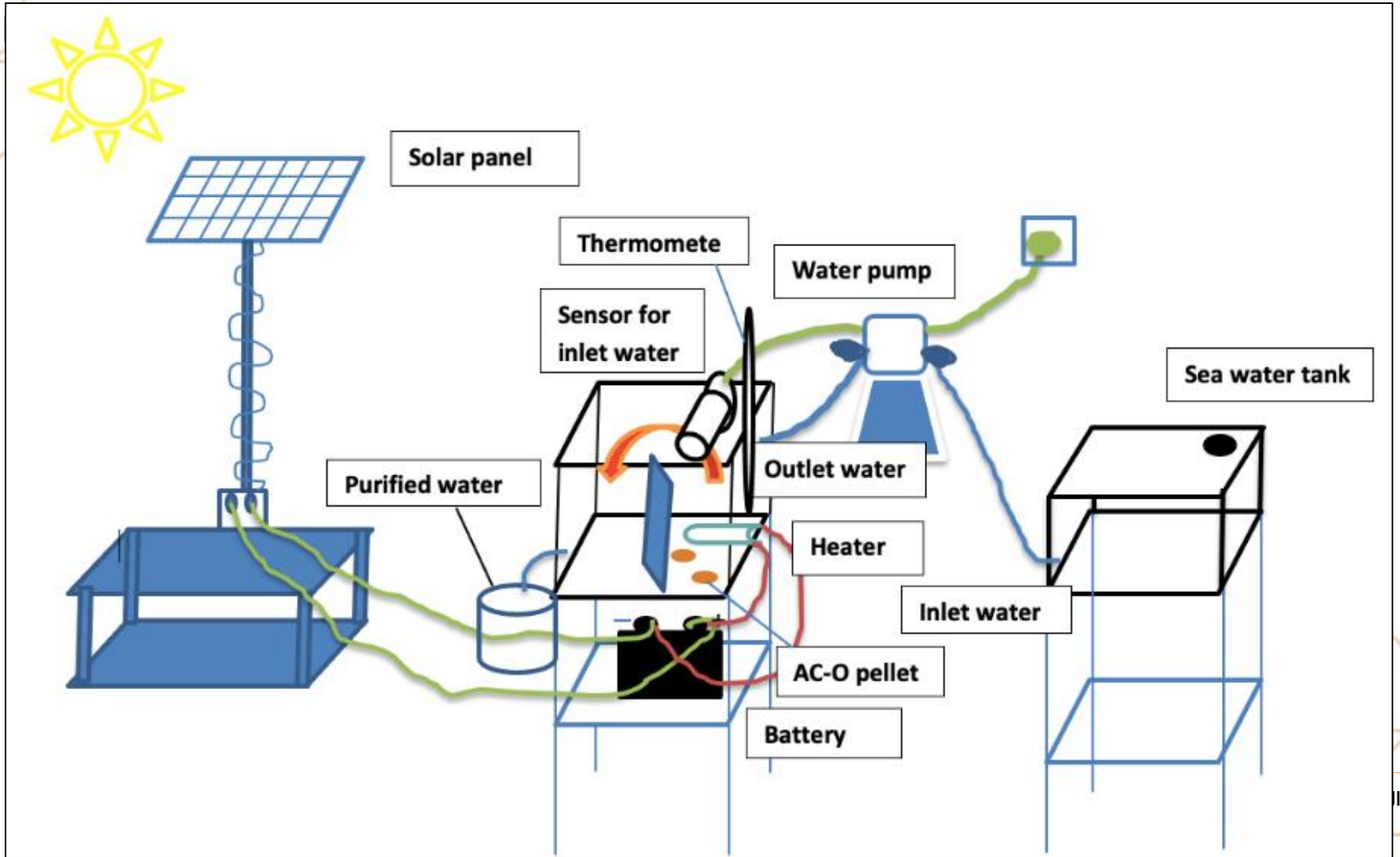




Stage 5

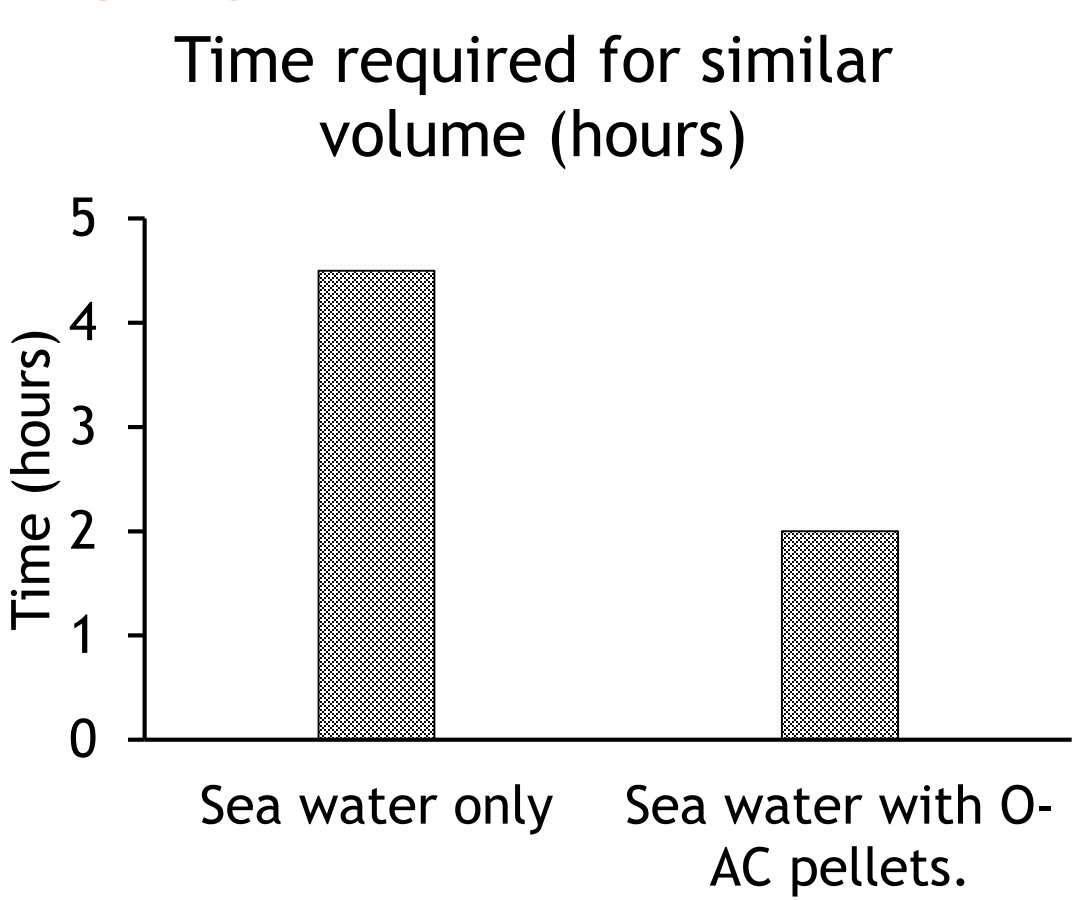
Solar Desalination of seawater with Activated Carbon

- Making a new set-up for the desalination process and smart parts with a program for controlling the temperature, water level, and the amount of Ene



- Making a new set-up for the desalination process and smart parts with a program for controlling the temperature, water level, and the amount of Energy used.

Desalination process with and without oxide activated carbon (O-AC)



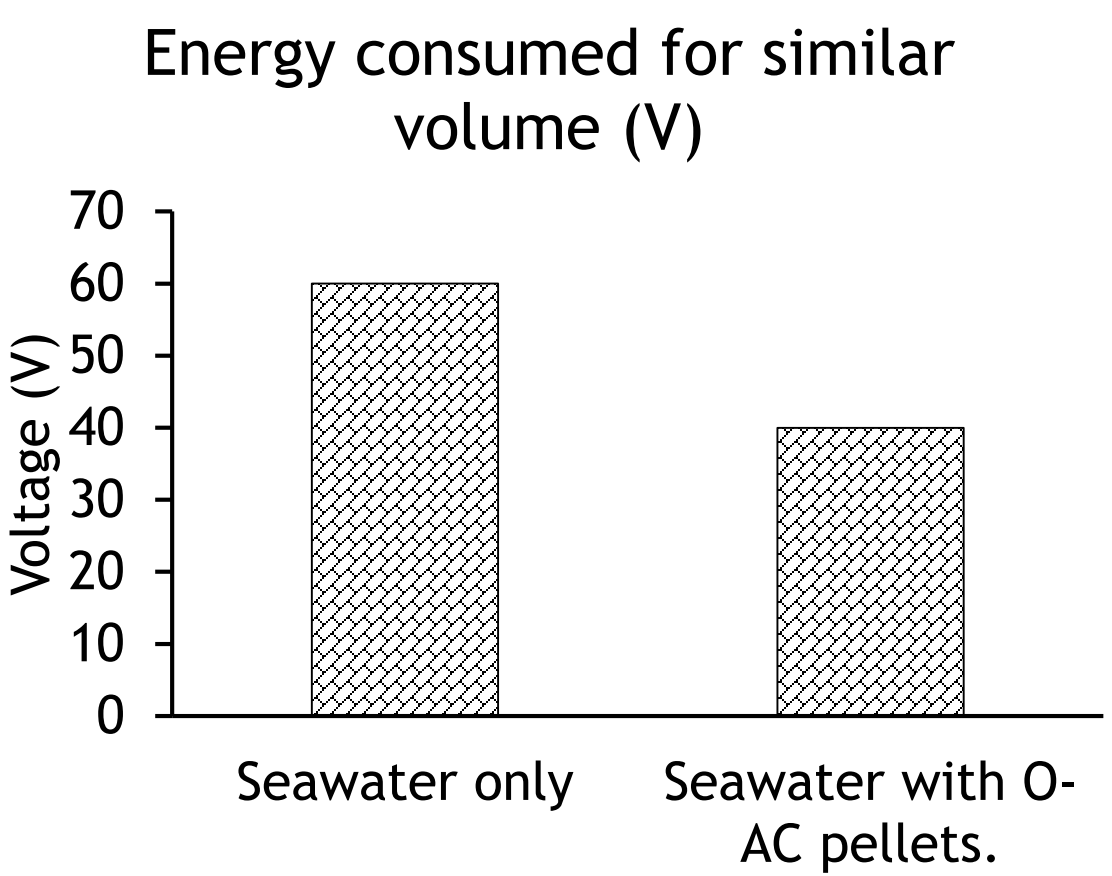


Table 1: Elemental Concentrations (mg/L) of Standard World health Organization (WHO) and desalinated seawater using ICP-OES instrument for seawater sample.

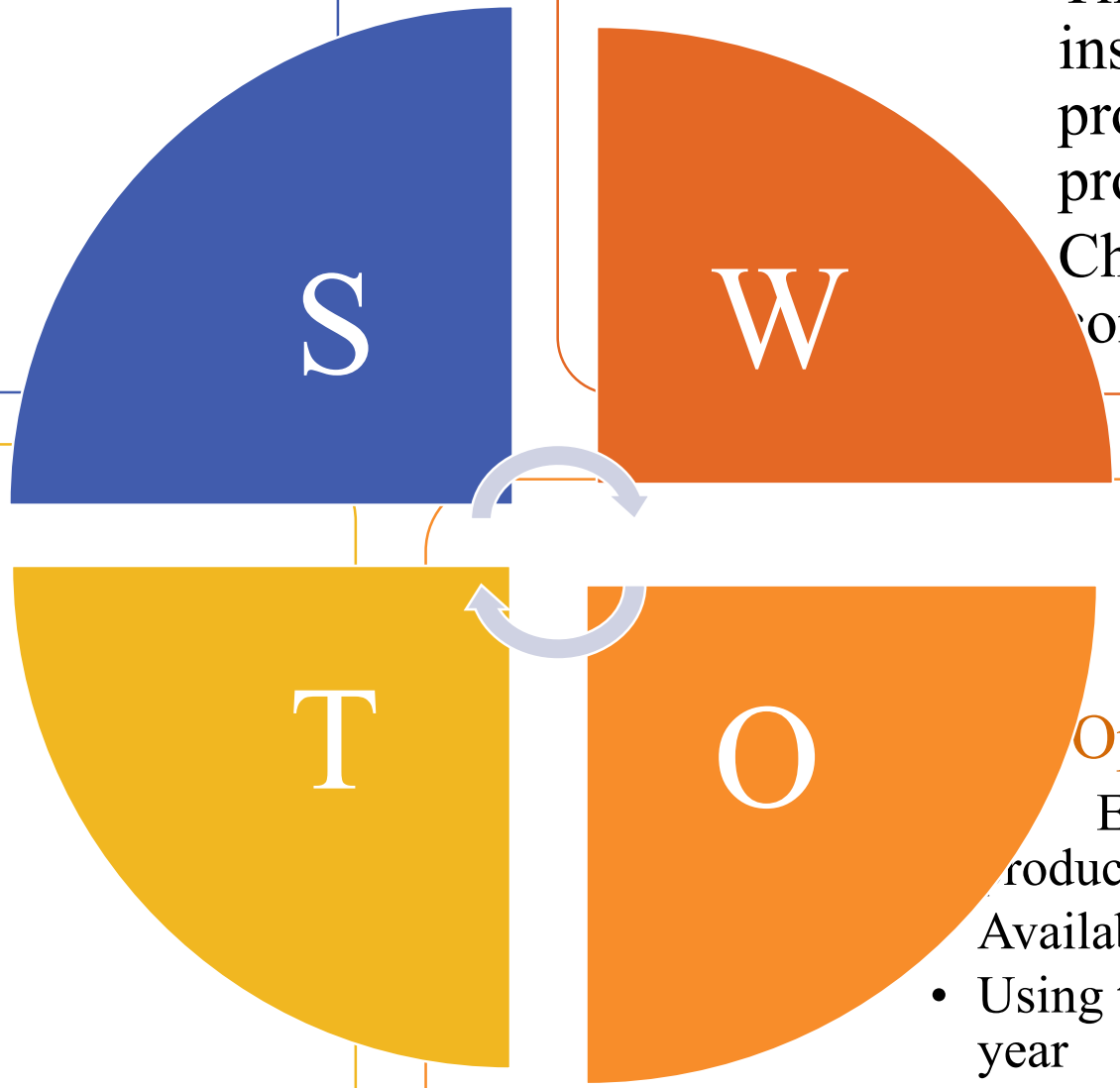
Elements (mg/L)	Standard element based on WHO	seawater	Desalinated water with O-AC pellets (DS-WP)
Na	22.6	2392.43	5.77
K	3.4	948.58	0.79
Mg	7.5	701.0	0.19
Ca	17.2	2340.06	0.45

4- Conclusion

- The aim of the project was achieved and this method is economically benefits, cost less energy and environmentally friendly.
- Activated carbon recycled from agricultural waste through KOH–CO_2 physiochemical activation.
- The SEM images shows different pore sizes. The EDX results showed the carbon combustion was the highest (32%).
- Activated carbon converted into oxide. The SEM and EDX showed the increase of the oxygen percentage to 37.5%. which indicates the oxidation of the activated carbon.
- activated carbon has the ability to reduces the poling point and increase the evaporation rate.
- activated carbon reduce the energy consume with high collected volume.
- The concentration of the element is within the range of standard value of WHO.

- Strength
  - An effective and unique product
  - Environmentally friendly product
  - Save time in desalination process

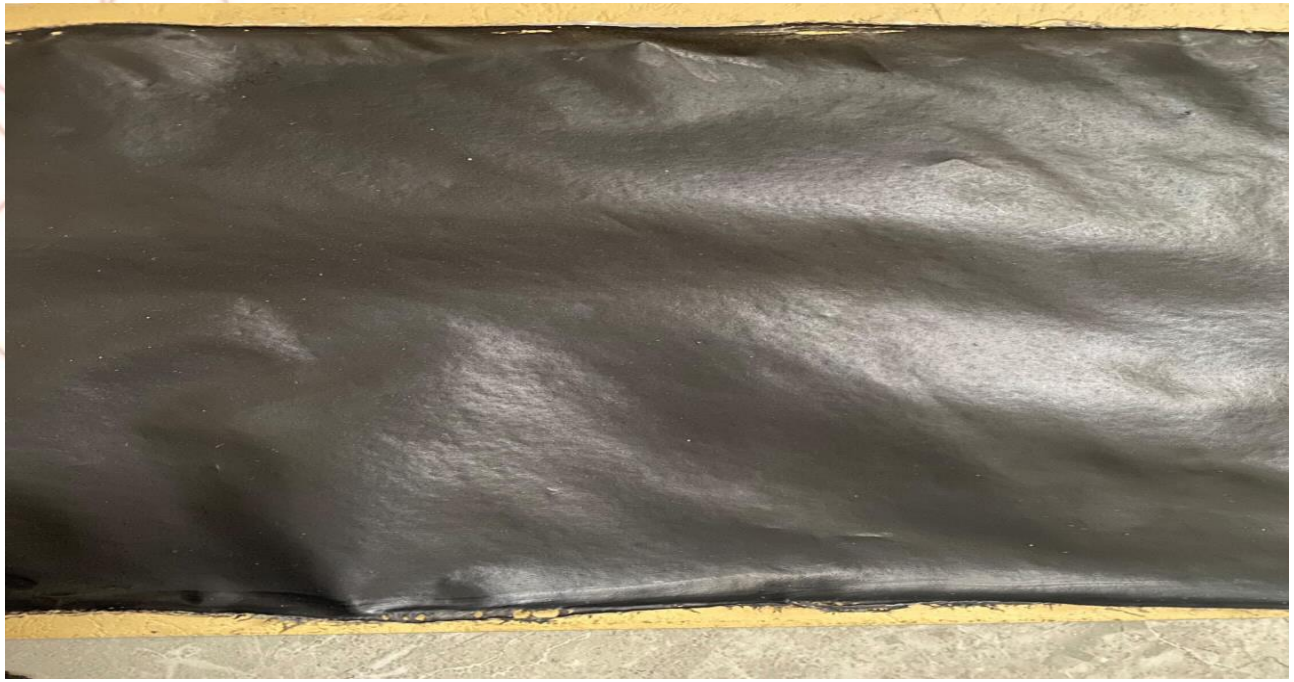
- Weakness
  - The availability of the instruments used in the product preparation process for large scale.
  - Changing weather condition (solar energy)



- Threats
  - The extent to which consumers accept the product
  - A competing product is available

- Opportunities
  - Environmentally friendly product
  - Availability of the investors
  - Using the product throughout the year
  - A solution for the salinization in agricultural areas

- ***Other Applications of the Prepared AC***
  - Adsorption
  - Increase the surface area of O-AC by making a membrane.



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Adsorptive removal of chromium(VI) using Cu/Fe impregnated activated carbon prepared from solid sludge

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ABSTRACT

Chromium(VI) can be introduced to the environment from different industrial activities. This study focuses on the removal of chromium(VI) using activated carbon. In this work, solid sludge obtained from a treatment plant in Nizwa, Oman was used to prepare the activated carbon. The preparation was done following two processes. The first one was pyrolysis of dried solid sludge for 2 h at a temperature of 700°C under nitrogen gas flow of 150 mL/min. The second process was physiochemical activation using potassium hydroxide with an impregnation ratio of 1:1 under a mixture of nitrogen and carbon dioxide gases with a flow of 150 mL/min for 2 h. The morphology and chemical composition of the prepared carbons were characterized using scanning electron microscopy-energy-dispersive infrared spectroscopy. The prepared carbons were used for Chromium(IV) removal and the removal was performed at different dosages, metal concentrations, and pH at a temperature of 30°C for 6 h. Chromium levels were analyzed using flame atomic absorption spectroscopy (FAAS). The highest removal of chromium(VI) was found to be 23% at 1.5 g of activated carbon (AC) dosage and pH 3. The influence of impregnating the prepared activated carbon with Fe(III) and Cu(II) metals on Chromium removal was investigated. The treated activated carbon with copper achieved the highest removal efficiency of 94.5% at pH 3. Therefore, addition of Cu(II) metal to sludge AC is efficient in enhancing the removal of chromium(VI).

Keywords: Adsorption; Chromium(VI); Activated carbon; Sludge; Removal

Project future plan

The future objectives of the endeavor comprise the following:

- The production of activated carbon oxide in substantial quantity from solid waste and agricultural waste
- The acquisition of financial backing or funding for the procurement of a reactor or furnace for the fabrication of Activated Carbon at the University of Technical and Applied Sciences
- The identification of investors for the undertaking to launch the business
- The marketing of the product and the pursuit of companies to finance the project of establishing some water cultivation facilities
- The application for the international patent following the granting of the national patent
- The manufacturing of the product in commercial quantities and the establishment of a marketing strategy to promote it.

Team Members

- Dr. Wafa Al Rawahi, Dr Amal Al Rahbi, Nada Abdullah Al-tubi, Reham Abdul Rahim Al-Abhani ,Belqis Ali AL-Hadramiya , Maryam Saud al-hashimiya, Marwa Yahya Al-riyamiya and Hanadi Ahmed Al-Amriya
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THANKS

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Ministry of Higher Education,
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