APPLICATION OF MEMBRANE DISTILLATION TECHNOLOGY FOR DESALINATION OF THE WATER ASSOCIATED WITH THE OIL FIELDS PRODUCTION, SIRTE BASIN, LIBYA

Submitted By
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B.Sc. of (Environment Science), Faculty of Engineering Sciences & Technology, Sabha University, Libya, 2009
Master in Environmental Sciences, Institute of Environmental Studies and Research,
Ain Shams University, 2014

A Thesis Submitted in Partial Fulfillment

Of

The Requirement for the Doctor of Philosophy Degree

In

Environmental Sciences

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2019

APPROVAL SHEET

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This Thesis Towards a Doctor of Philosophy Degree in Environmental Sciences Has been Approved by:

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2019

بسم الله الرحمن الرحيم

رَبِّ أَوْزِعْنِي أَنْ أَشْكُرَ نِعْمَتَكَ الَّتِي أَنْعَمْتَ عَلَيَّ

وَعَلَىٰ وَالِدَيَّ وَأَنْ أَعْمَلَ صَالِحًا تَرْضَاهُ

وَأَدْخِلْنِي بِرَحْمَتِكَ فِي عِبَادِكَ الصَّالِحِينَ

صدق الله العظيم

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النمل الاية ١٩

Acknowledgement

The author wishes to express her sincere gratitude and heart full thanks to the God for continuous and persistent supply with effort and patience to complete this thesis. I have been supported, assisted and accompanied by many people during this period of study. I would like to take this opportunity to express my gratitude to all of them.

*I would like to express my gratitude to my supervisors, **Prof. Dr. Mohamed Ghareeb El- Malky**, Professor of geophysics, Institute of Environmental Studies and Research for the great support, advice and guidance during my study.*

*I am glad to express my gratitude to **Prof. Dr. Abd El-Hameed M. Al-Aassar**, Prof. of water chemistry, Egyptian Desalination Research Center (EDRC), Desert Research Center for suggestions and supervising this work, for effective guidance and fruitful discussions his help to initiate and achieve this work.*

*Actually, I wish to express my deepest appreciation to **Dr. Adel Abd El-Ghany Saleh** Reservoir Engineering superintendent, AGOCO, Libya, for his help and valuable guidance, critical revision of the manuscript and encouragement.*

*I am greatly thankful for **Dr. Heba Isawi**, Hydrogeochemistry Dept., (EDRC), for her help, critical revision of the manuscript and encouragement and valuable guidance.*

*Special gratitude is expressed to Egypt Desalination Research Center **(EDRC)** and his team who helped me and facilitated all conditions to achieve this work.*

*I would like to express my gratitude and appreciation to **my father, my mother and all family** for their patience, encouragement, and motivation for me to move forward*

Osamah Mohammed Abdulsalam Shahlol.

Dedication

To My father & my mother

To My family (brothers & sisters)

To My uncles (Dr.Abdulhamid shahlol & Hassan shahlol)

To Mr . Najeeb Alaadly

I DEDICATED THIS WORK With Sincere Thanks And Appreciation

OSAMAH MOHAMED ABDULSALAM SHAHLOL

Abstract

Produced water is a very complex mixture and contains different compounds. It has a negative impact on the environment and considers an economic problem associated with oil and gas production. This study has evaluated the characteristics of produced water in Sarir oil field in Libya. The evaluation included physio-chemical parameters e.g. pH, total dissolved solids (TDS), the concentration of both cations and anions constituents. These parameters show a wide variation from well to another in the studied area. Direct contact membrane distillation (DCMD) process was used as one of an advanced techniques in water desalination laboratory unit was used for estimating the performances efficiency of the synthesized nano composite (NC) membranes via 60°C feed synthetic water (NaCl solution) and/or oil field produced water samples with different salinities up to 200,000 mg/L. All synthesized NC membrane produced a high salt rejection of 99.99%. On the other hand, the maximum permeate flux achieved in the order of single wall carbon nanotubes (SWCNTs) (20.91)> Al_2O_3 (19.92)> CuO (18.92)> multiple wall carbon nanotubes (MWCNTs) (18.20) (L/m^2.h) with nanomaterial concentration of 0.5, 0.75, 0.75, 0.1 wt.% at concentration of NaCl up to 20,000 ppm, respectively compared with 16% neat polysulfone (PSF) membrane. The optimum operational circumstances were investigated using the feed and permeate temperatures 60°C and 20°C, respectively. Material produced water with salinity 200.000 ppm its permeate flux was 5.97 L/m^2.h, via polysulfone /polyethylene glycol/single wall carbon nanotubes (PSF/PEG/SWCNTs) membrane with 0.5 wt.% of SWCNTs. Moreover, the membrane indicated sustaining performance stability during operation time 480 min continuous desalination testing, showing that the synthesized PSF/PEG/SWCNTs NC modified membrane may be of magnificent potential to be activated in DCMD procedure for water desalination.

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List of Abbreviations

Air Gap Membrane Distillation	AGMD
arabic gum	AG
AGOCO	Arabian Gulf Company
Attenuated Total Reflection – Fourier Transform Infra-Red.	ATR-FTIR
Billion barrels	pbbls
Carbon nanotube	CNT
chemical oxygen demand	COD
Desert Research Center	DRC
Dimethylformamide	DMF
dodecylamine	DDA
Dynamic mechanical analysis.	DMA
Electrical Conductivity.	EC
Electrocoagulation	EC
equilibrium water content	EWC
Forward osmosis	FO
freezing desalination	FD
Inductive Coupled Plasma.	ICP
liquid entry pressure	LEP
Mechanical properties analysis	MPA
Membrane Distillation.	MD
Microfiltration.	MF
Multi-effect distillation	MED
Multistage Flash Evaporation.	MSF
multi-walled carbon nanotubes	MWCNTs
nano composite	NC
Nanofiltration	NF
nanoparticles	NPs
oil and gas	O&G
Part Per Million	ppm
Polyethersulfone	PES
Polyethylene Glycol	PEG

Polysulfone	PSF
Polytetrafluoroethylene	PTFE
Polyvinyl Pyrrolidone	PVP
Polyvinylidenefluoride	PVDF
Porosity	ε %
prepare polyamide	PA
Pure Water Flux	PWF
Reverse Osmosis	RO
Scanning Electron Microscopy	SEM
Single-walled carbon nanotubes	SWCNTs
Sweeping Gas Membrane Distillation	SGMD
Temperature feed	T_f
Temperature permeate	T_p
Thermo-gravimetric analysis	TGA
Thin Film Composites	TFC
Total Dissolved Salts	TDS
total organic carbon	TOC
Ultrafiltration	UF
Vacuum Membrane Distillation	VMD
water contact angle	WCA
water-to-gas	WGR
water-to-oil	WOR
World Health Organization	WHO
X-ray diffraction	XRD