

DEVELOPMENT OF GRAPHENE OXIDE MEMBRANES FOR ITS USE IN REVERSE ELECTRODIALYSIS SYSTEMS

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INTRODUCTION

Reverse electrodialysis (RED) is a sustainable technology used for different purposes: energy generation and water treatment 1. In RED systems, ion exchange membranes are an important component, however, the membranes currently used are polymeric, which have important performance limitations since they degrade under saline environments and suffer of bioincrustation. It is for these reasons that there is a need to develop membranes capable of resisting the degradation and biofouling in marine environments.

Graphene oxide (GO) is a ceramic material resistant to environments with high salinity and has biocide properties, therefore, are suitable for the production of membranes (MGO). Additionally, MGO can be designed to be selective towards specific ions and nanometric thicknesses. The thickness of the membranes plays an important role in the RED systems, since the thickness is a function of the electrical resistance, and the electrical resistance of the membranes is directly related to the power output or the power consumption of the RED systems 2.

The structure of the MOGs is developed by stacking sheets of OG, which forms a wide network of channels. This type of structure allows the MOG to be thinner, maintaining diffusion lengths similar to polymer membranes, but with greater capacity for ion exchange and density of fixed charges.

AVAILABLE BACKGROUND INFORMATION & DATA

In this work, GO membranes were developed with different degree of oxidation, through the solvent evaporation route. Some structural properties and elemental composition of the membranes were analyzed by XRD, MEB and XPS. The ion exchange capacity, the degree of swelling, the density of fixed charges, selectivity and electrical resistance were also analyzed.

The ion exchange capacity (IEC) was determined by titration, according to the methodology proposed by Dluglecki (2008). The degree of swelling (SD) of the membrane was determined by weight difference, dry and hydrated. The density of fixed charges was calculated from equation 1.

$$C_{fix} = IEC/SD \quad (1)$$

On the other hand, the permselectivity was determined using a static membrane potential measurement and the electrical resistance was determined using the 4-point method.

BRIEF STATE OF THE ART

The thickness of commercial ion exchange membranes varies between 34-764 μm 3. In general, these membranes are made of polymeric materials, which are not good electrical conductors. For this reason, as an alternative to reduce the electrical resistance of the membranes, it was proposed to reduce the thickness and / or use better conductor materials.

These improvements can be developed using materials such as graphene and graphene oxide, which have stood out for their excellent properties (electrical, terminations, etc.), which are compatible for the development of selective ion exchange membranes.

SUMMARY

The electrical resistance, the ion exchange capacity and the selectivity of the membranes are determining properties of the performance of the reverse electrodialysis systems, which were determined for graphene oxide membranes with different degree of oxidation.

REFERENCES

Dlugolecki, Nymeijer, Metz, Wessling (2008): Current status of ion Exchange membranes for power generation from salinity gradients, *Journal of Membrane Science*, ELSEVIER, vol. 10, pp. 214-222

Galama, Vermaas, Veerman, Saakes, Rijnaarts, Post, Nijmeijer (2014): Membrane resistance: The effect of salinity gradients over a cation Exchange membrane, *Journal of Membrane Science*, ELSEVIER, vol. 467, pp. 279-291.

Lou, Abdu, Wessling (2018): Selectivity of ion exchange membranes: A review, *Journal of Membrane Science*, ELSEVIER, vol. 555, pp. 429-454.

EXCEED - SWINDON Conference 2019

THE FUTURE OF WATER RESOURCES

October 13th - 16th, Mérida, Mexico



Programme and Book of Abstracts

PROGRAMME

Sunday, 13 th		Arrival	
19:00	-	21:00	Welcome cocktail

Monday, 14 th		Conference Day 1	
08:30	-	09:00	Registration
09:00	-	09:30	Opening Ceremony <ul style="list-style-type: none"> • Norbert Dichtl • Andreas Haarstrick • Rodolfo Silva • Local authority
09:30	-	10:00	Keynote speech <ul style="list-style-type: none"> • Norbert Dichtl
10:00	-	10:10	Break
Session 1: The impact/performance/role of SDGs Chairman: Valeria Chávez			
10:10	-	10:30	Exploring some ocean energy possibilities in Latin America (Jassiel Hernández)
10:30	-	10:50	Water energy nexus in the MENA region (Abbas Al-Omari)
10:50	-	11:10	Ocean energy and marine biodiversity affectations: a life cycle assessment review (Dora Ruiz-Méndez)
11:10	-	11:40	Coffee Break
Session 2: Water-Energy-Nexus (I) Chairman: Dwi Andreas Santosa			
11:40	-	12:00	Wastewater/waste to energy in MENA region: A review for opportunities (Zeinab Abou Elnaga)
12:00	-	12:20	Water-energy nexus in a wastewater treatment plant: Energy efficiency and recovery (Wang Hongtao)
12:20	-	12:40	From wastewater treatment plants to a resources recovery facility (Marcelo Nolasco)
12:40	-	13:00	Seasonal assessment of the energetic potential associated with salinity gradient: Champoton River, Mexico (Gregorio Posada Vanegas)
13:00	-	14:30	Lunch
Session 3: Water, ecosystem and socio-economic integrating aspects (I) Chairman: Germán Rivillas			
14:30	-	14:50	Decolourization and mineralization of acid green 25 dye through single and catalytic ozonation (Liliana Amaral Féris)

14:50	-	15:10	Adsorption of naphtholate-as dye in wastewater of batik industry using green synthesized zn layered hydroxyl salts (Sri Juari Santosa)
15:10	-	15:30	Adsorption of hexavalent chromium in coal beneficiation tailing in fixed bed column (Liliana Amaral Féris)
15:30	-	15:50	Kinetics of the adsorption of anionic and cationic dyes in aqueous solution by low-cost activated carbons prepared from sea cake and cotton cake (Ibrahim Tchakala)
15:50	-	16:10	Distribution of microplastics in water and sediment in a Biosphere Reserve (Cecilia Enriquez)
16:10	-	16:30	Evaluation of microplastics contamination in the margins of the Patos Lagoon in south of Brazil (Eduardo Saldanha Vogelmann)
16:30	-	17:00	Coffee Break
Session 4: Water, ecosystem and socio-economic integrating aspects (II) Chairman: Rodolfo Silva			
17:00	-	17:20	Hydrodynamic modelling of the Huave Lagoon System, Oaxaca (María Fernanda González Amador)
17:20	-	17:40	Impact effects of hard infrastructure in Salamanca Natural Park (Juan Carlos Caez-Perez)
17:40	-	18:00	The decision-making in face to coastal squeeze, analysis between social and economic impacts: Case study of Campeche, Mexico (Debora L. Ramírez-Vargas)
18:00	-	18:30	Keynote speech • Elvis Carissimi
20:00			Dinner

Tuesday, 15th		Conference Day 2	
Session 5: Water, ecosystem and socio-economic integrating aspects (III) Chairman: Arwa Naser Damen Hamaideh			
09:00	-	09:20	Dispersion of submarine groundwater discharges in reef lagoons and associated environmental effects (Arlett Rosado Torres)
09:20	-	09:40	Salt intrusions into a freshwater spring in a tropical coastal lagoon, Yucatán, Mexico (Xaní Malagón)
09:40	-	10:00	Variability of the saline gradient in a hypersaline coastal lagoon (Brenda Natalia Fitch Geymonat)
10:00	-	10:20	Sedimentation and water quality status of lake Tana, the headwaters of the Blue Nile, Ethiopia (Seifu A Tilahun)
10:20	-	10:40	An innovative approach to mitigate risks on the existing iron tailings dams in Brazil (Jose Araruna)

10:40	-	11:00	Urban sustainable water management and water efficiency improvement for buildings – a case study for Istanbul (Ahmet Baban)
11:00	-	11:30	Coffee Break
Session 6: Water-Energy-Nexus (II) Chairman: Eduardo Saldanha Vogelmann			
11:30	-	11:50	Reverse electrodialysis for energy and water: coupled systems based in salinity gradients (Mateo Roldan-Carvajal)
11:50	-	12:10	Development of graphene oxide membranes for its use in reverse electrodialysis systems (Eddie López Honorato)
12:10	-	12:30	Development of graphene oxide based materials for water treatment (Ana Cecilia Reynosa Martinez)
12:30	-	12:50	Laboratory experiences on marine energy conversion devices for supplying electricity demand of remote coastal communities (Jassiel Hernández)
12:50	-	13:10	Plate type obstacles used for coastal protection and power generation (Luis Eduardo Pérez Paez)
13:10	-	14:40	Lunch
Session 7: Water, ecosystem and socio-economic integrating aspects (IV) Chairman: Thi Thanh Van Ngo			
14:40	-	15:00	Evaluating combinatorial water treatment by locally available materials (Chrispin Kowenje)
15:00	-	15:20	Desalination by capacitive deionization as a tool to provide drinkable water to small communities in the Brazilian semiarid (Luis Augusto Martins Ruotolo)
15:20	-	15:40	Fluoride ions removal from groundwater by alumina adsorption (Elvis Carissimi)
15:40	-	16:00	Bio-refineries: A new concept towards green energy production from agroindustrial wastewater (Víctor Alcaraz)
16:00	-	16:20	The importance of water and nutrients management in paddy fields as an effort to increase crop yields and producing an electrical energy through microbial fuel cells (Dwi Andreas Santosa)
16:20	-	16:50	Coffee Break
16:50	-	17:20	Keynote speech • Klaus Fricke
16:50	-	18:00	Panel discussion Moderators: Edmilson Santos de Lima and Norbert Dichtl
20:00			Gala dinner