The 2nd African Membrane Society International Congress (AMSIC-2) 2018

hosted by

The University of South Africa College of Science, Engineering and Technology Florida, South Africa

On

29 July – 1 August 2018

"Inventing a better future filled with knowledge sharing, economic growth and prosperity in Africa using membrane and filtration technologies"

UNISA
Science Campus
Florida Park

Edward Nxumalo
edwardnxumalo@gmail.com

Editorial by:

Edward Nxumalo
Congress chair
University of South Africa

Dear AMSIC-2 delegate,

On behalf of the Executive Organizing Committee (EOC) of the 2nd African Membrane Society International Congress (AMSIC-2), I have great pleasure in welcoming you to this beautiful campus. I welcome all our special guests and delegates descending from various parts of the world. With about 120 participants from at least 15 countries, I consider this a truly amazing event of a great international standing.

The AMSIC-2 congress with a theme “Inventing a better future filled with knowledge sharing, economic growth and prosperity in Africa using membrane and filtration technologies” focuses on the front-line areas of membrane science and technology.

This international congress aims to capture key technological advances in fields heavily dependent on membrane filtration systems such as water, air quality, biomedical sciences, microelectronics, biopharmaceuticals, chemical manufacturing, energy and mining, oil, gas and power generation. From an educational perspective, this meeting will examine new synthetic routes of membrane and filtering materials formation. It will reflect on new approaches of merging academic and industrial research together without compromising the quest for basic scientific advances. From a socio-economic perspective, AMSIC-2 will determine how filtration technologies can tackle more effectively practical challenges associated with better access to clean water, improved air quality, the processing of industrial and biopharmaceutical fluids by adopting environmentally friendly practices, and improved healthcare and patient protection.

I invite you to participate in two highly specialized workshops which are a critical component of this important meeting: (i) the Air-filtration Workshop which is continuing concurrently with the technical proceedings and (ii)the Post-Conference Workshop on Membranes for Water, Energy and the Environment which will take place in the last two days of the week. Your esteemed presence during these sessions will enrich the scientific deliberations at the Conference and I don’t doubt that you will find this conference intellectually stimulating.

I would like to thank the Vice Principal: Research Postgraduate Studies, Innovation, and Commercialisation and the Executive Dean of the College of Science, Engineering and Technology as well as the President of AMSIC for gracing this occasion. I also acknowledge our plenary and keynote speakers and all presenting delegates. We thank you for choosing AMSIC-2 as your preferred platform to present your ground-breaking research work on this important subject of membrane technology which is at the heart of our development.

I would like to also recognize the people who worked so tirelessly to ensure that this congress become a success, including EOC members, the staff and students of the NanoWS Research Unit, Marketing Department, and the various committees and structures, including the AMSIC-2 Board, Scientific Committee, International Advisory Board and the Student Committee comprising of various students from the University. To our sponsors and partners, we thank you for the generosity you have shown. I invite all participants to visit the exhibition houses in the Exhibition Hall during breaks and to interact with our sponsors and exhibitors.

It is of noteworthy importance that we have now formulated the South African Membrane Society. I strongly believe that the incorporation of this South African Chapter will contribute greatly towards bringing all membrane technologists, researchers, industrialists and legislators together as we share knowledge and work collectively towards finding solutions to South Africa's most critical challenges such as water scarcity and energy shortage using membrane technologies.

Finally, it is a great privilege for me to serve as the Chair for AMSIC-2. Evidently, our week is packed with stimulating brain storming sessions and I do hope that you will find the content and the context of the conference relevant. I am very sure that at the end, we will all return to our home institutions and home countries academically provoked and fired up at the same time.

Please do enjoy the amazing scenery of our campus and our beautiful city!

Edward Nxumalo
AMSIC-2 Chair

Dr. Abdoulaye Doucouré
On behalf of the African Membrane Society

President message of African Membrane Society

The African Membrane Society International Congress (AMSIC) aims to bring together experts in membrane/filtration sciences, sustainable water treatment and energy processes, as well as decision-makers seeking to improve the well-being of communities thanks to Science, Technology, Engineering and Mathematics.

AMSIC was formally established in August 2014 and located its headquarters at the *Ecole Nationale d'I*ngéni*eurs Abderrahmane Baba Touré*, in Bamako, Mali. It counts nearly one hundred members with 80 percents residing in Africa and 20 percents living in North America, Europe and Asia. It is an international, pan-African and culturally diverse organization that is actively engaged in studying and implementing filtration processes in strategic sectors such as Water, Health, Energy and Environment. Our vision is to train and educate a critical mass of experts on the African continent that can engage stakeholders from the academia, industry and government to build technological and economic growth derived from membrane and filtration sciences.

AMSIC-2 participants are given the opportunity to enjoy a comprehensive program offering plenary and keynote lectures, oral presentations, posters, university facility visits, an industrial exhibition and an introductory workshop on air filtration. Further, following the congress, colleagues from the University Technology of Malaysia have kindly arranged to host a two-day training session on membrane science and its applications at the University of South (UNISA).

Our first international congress (AMSIC-1) organized two years ago in TUNISIA was a successful event thanks to the leadership of professor Raja Ben AMAR - May 3rd - 5th, Sfax 2016. Today our community feels humbled and honored to hold its second congress in SOUTH AFRICA during the centennial of Nelson Mandela. We are grateful to UNISA and the City of Johannesburg for hosting AMSIC-2 at such an inspiring time.

The African Membrane Society would like to acknowledge the crucial contribution and leadership of (South Africa-based) AMSIC-2 Executive Committee for its sustained engagement and commitment to organize a high quality congress. We are indebted to our members and everyone who has devoted time for organizing a productive and successful venue. May the principles of Ubuntu (caring, sharing, reciprocity, co-operation, compassion and empathy) guide our steps during this gathering and as we are learning to build a community of experts all across the African continent.

AMSIC Website: http://www.sam-ptf.com/

AMSIC Board of Directors (fifteen members):

- President :
  Abdoulaye **Doucouré** (USA, France and Mali)

- Vice-President:
  Raja **Ben Amar** (Tunisia)

- General Secretary:
  Mady **Cissé** (Senegal)

- Treasurer:
  Arona **Coulibaly** (Mali)

- Directors of Science & Technology:
  Rachida **Chemini** (Algeria) and Tarik **Eljaddi** (France, Morocco)

-Director of Visual Content & Webmaster:
  Jim **Barry** (USA)

-Directors of Communication:
  Nachida **Kasbadji-Merzouk** (Algeria) and Gomotsegang Fred **Molelekwa** (South Africa)

- Directors of External Relations:
  Edward **Nxumalo** (South Africa) and Dessalegn **Dadi Olani** (Ethiopia)

-Director of Fundraising:
  Chimezie **Anyakora** (Nigeria)

-Director of Publication & Editing:
  Sidy **Ba** (Mali, Canada)

-Directors of Academy-Industry Partnership:
  Alexander **Anim-Mensah** (USA, Ghana) and Samuel Sowemimo-**Coker** (USA, Nigeria)

Objective of the Conference

This international congress aims to capture key technological advances in fields heavily dependent on membrane filtration systems such as water, air quality, biomedical sciences, microelectronics, biopharmaceuticals, chemical manufacturing, energy, and mining, oil, gas and power generation.

From an educational perspective, this meeting will review new synthetic routes of membrane and filtering materials formation. It will reflect on new approaches of merging academic and industrial research together and without compromising the quest for basic scientific advances.

From a socio-economic perspective, AMSIC-2 will seek to determine how filtration technologies can tackle more effectively practical challenges associated with better access to clean water, improved air quality, the processing of industrial and biopharmaceutical fluids by adopting environmentally friendly practices, and improved healthcare and patient protection.

Fields of Interest:

Advanced materials fabrication & processes

- Synthesis of Advanced Porous Materials: membranes and fibrous materials
- Composites and Nanostructures in Filtration
- Surface treatment of polymeric and inorganic membranes

- Nanofibrous materials
- Pressure-driven Membranes and Processes (MF, UF and NF)
- Reverse Osmosis and Pressure Retarded Osmosis,
- Depth Filter Media for Membrane Protection
- Catalytic Membranes and Membrane Reactors

Porous/fibrous materials & their applications

- Fibrous media for Water Treatment
- Fibrous media in Air Filtration & Air Quality
- Gas Separation
- Membrane for the Life Sciences (biomedical / biopharmaceutical fields)
- Membranes for Bio-fuel Applications and Sustainability
- Bioremediation and Analysis

Transport/filtration mechanisms - Hybrid & smart systems

- Membrane Fouling and Mechanisms
- Modeling/Theoretical Tools Applied to Membrane Formation and Transport Phenomena
- Hybrid Membrane Filtration Systems
- Pervaporation and Vapor Separation
- Membranes for Sensing and Electrochemical Applications
- Internet of Filtration Systems and Smart Materials

Figure 1 A section of AMSIC-2 conference delegates

Figure 2 Plenary and keynote speakers from L to R: Prof YuZhong Zhang, Prof Jas Pal Badyal, Prof Jianxin Li, NanoWS director Dr L. De Kock, CSET dean Prof Bhekie Mamba, African Membrane Society president Dr Abdoulaye Doucouré, Prof Rong Wang, Prof Mamadou Diallo, Prof Glenn Lipscomb, Prof Mathias Ulbricht, and Prof Lingam Pillay - at Moyo Zoo lake.

Edition & Publishing team:

Chief Editor
Nachida Kasbadji Merzouk,
Senior researcher at 'Unité de Développement des Equipements Solaires UDES/Centre de Développement des Energies Renouvelables'
Professor at 'Département des Energies Renouvelables, Université de Blida1', Algéria.

(In alphabetic order)

Sidy Ba, Mali
Raja BenAmar, Tunisia
Rachida Chemini, Algeria
Mady Cisse, Senegal
Ablo Doucoure, USA
Tarik Eljaddi, Morocco
Abaynesh Yihdego Gebreyohannes, Belgium
Soraya Malinga, South Africa
Edward Nxumalo, South Africa

Executive committee (Local)

Edward NXUMALO (Chair) UNISA, South Africa
Sabelo MHLANGA (Co-Chair) UNISA, South Africa
Mokgadi BOPAPE Tshwane University of Technology, South Africa
Gomotsegang Fred MOLELEKWA Tshwane University of Technology, South Africa
Soraya MALINGA University of Johannesburg, South Africa
Nozipho GUMBI UNISA, South Africa
Alex KUVAREGA UNISA, South Africa
Shivani MISHRA UNISA, South Africa
Brian CHABALALA UNISA, South Africa
Machawe MOTSA UNISA, South Africa
Thereza BOTHA (Secretary) TechnoScene, South Africa

International scientific committee

Scientific Committee (Alphabetical Order)

Edward NXUMALO, University of South Africa, Johannesburg – South Africa, Chair
Saad ALAMI YOUNSSI, Fac. Sciences de Mohammedia, Morocco
André AYRAL, Institut Européen des Membranes, Montpellier, France
Sidy BA, University of Sherbrooke, Canada
Jas Pal S. BADYAL, Durham University, United Kingdom
Mihail BARBOIU, Institut Européen des Membranes, Montpellier, France
Roger BEN AIM, Institut Filtration & Techniques Séparatives, France
Raja BEN AMAR - Faculté des Sciences de Sfax, Tunisia
Merlin BRUENING, University of Notre Dame – USA
Sudip CHAKRABORTY, University of Calabria, Italy
Corinne CHARCOSSET, Université de Lyon, France
Rachida CHEMINI, University Science & Technology H. Boumedienne, Algeria
Mady CISSE - Université Cheikh Anta Diop, Sénégal
André DERATANI, Institut Européen des Membranes, Montpellier, France
Abdoulaye DOUCOURE, Hollingsworth & Vose, USA
Ludovic DUMEE, Membrane Society of Australia
Sana GASSARA, Institut Européen des Membranes, Montpellier, France
Nachida KASBADJI MERZOUK, UDES/ CDER, Algeria
Soraya MALINGA, University of Johannesburg, South Africa
Sabelo MHLANGA, University of South Africa, Johannesburg – South Africa
Edward NXUMALO, University of South Africa, Johannesburg – South Africa
Gilbert RIOS, Chaire de l'UNESCO-SIMEV, France
A. SZYMCZYK, Université des Sciences Chimiques de Rennes, France
Volodymyr TARABARA, Michigan State University, USA
Bart VAN DER BRUGGEN, Université de Louvain, Belgium

International Committee

Prof. Bhekie Mamba, Director of the Nanotechnology & Water Sustainability Research Unit. University of South Africa
Prof. Arne Verliefde, Dept. of Analytical & Physical Chemistry, Ghent Univ., Belgium
Prof. Bart Van der Bruggen, Dept. of Chemical Engineering, KU Leuven, Belgium
Dr. Chris Swartz, Institute of Municipal Engineering, South Africa

African membrane society representatives

Dr Sidy Ba, sidy.ba@usherbrooke.ca
Mr. Jim Barry, jimbarry.7@gmail.com
Prof. Raja Ben Amar, benamar.raja@yahoo.com
Dr Abdoulaye Doucouré, ablodoucoure@hotmail.com
Prof. Mady Cissé, mady.cisse@ucad.edu.sn
Dr Nachida Kasbadji Merzouk, nkmerzouk@gmail.com

Figure 3 AMSIC-2 participants (main auditorium) during the Opening Ceremony

Figure 4: The six award Winners in the oral and poster presentations holding certificates (from Left to right): C. Chukwuati, S.K. Nzaba, K. Kothlao, F. Maziya and N. Gumbi) with the CSET Dean , judges, AMSIC-2 conference char and African Membrane Society President.

Sunday, 29 July 2018	
ARRIVAL OF DELEGATES & REGISTRATION	
ALL DAY	ARRIVAL OF DELEGATES: SHUTTLE SERVICE FROM OR TAMBO AIRPORT TO HOTELS
14:00 – 18:00	Registration at the Link Area (Thamsanqa KambuleAuditorium) UNISA Science Campus
18:00 – 19:00	Welcome Evening

Monday, 30 July 2018		
07:30 – 08:30	**REGISTRATION**	Link Area (Thamsanqa Kambule Auditorium)
	OPENING CEREMONY	Thamsanqa Kambule Auditorium
08:30 – 08:40	**Opening Remarks by AMSIC-2 Conference Chair: Prof. Edward Nxumalo**	
08:40 – 08:45	**Address from AMSIC-2 President: Dr. Abdoulaye Doucouré**	
08:45 – 09:00	**Address from the Dean of the College of Science, Engineering and Technology (CSET), UNISA: Prof. Bhekie Mamba**	
09:00 – 09:30	**Address from Vice-Principal: Research, Postgraduate Studies, Innovation and Commercialisation, UNISA: Prof.Thenjiwe Meyiwa**	
09:30 – 10:30	**PL1: Prof. Glenn Lipscomb** *Department of Chemical Engineering, University of Toledo, USA* **Spacers for spiral wound modules**	
10:30 – 11:00	**TEA BREAK & GROUP PHOTO**	Link Area

Symposium	Session 1 Desalination and Drinking Water	Session 2 Fabrication and Surface Modification	Session 3 Catalytic Membranes and Membrane Bioreactors
Venue	Thamsanqa Kambule Auditorium	Council Chambers	GJ GerwelC 3-01
Session Chair	Prof. Rong Wang	Prof. André Deratani	Dr.R Vijayakumar
11:00 – 11:30	**KN1: Prof. Raja Ben Amar** *Faculté des Sciences de Sfax, Tunisia* Development of new ceramic membranes from low-cost materials: application to wastewater treatment and water desalination	**KN2: Prof. Mamadou S. Diallo** *Korea Advanced Institute of Science & Technology, South Korea* New directions in mixed matrix membranes	**KN3: Prof. Lingam Pillay** *Stellenbosch University, South Africa* Energy reduction in membrane bioreactors-some novel findings
11:30 – 11:50	**OP1: Dr. Ahmad Al-Sairafi** *Kuwait Institute for Scientific Research, Kuwait* Hydrophobically modified PVDF nanocomposite membranes for seawater desalination via direct contact membrane distillation	**OP5: Ms. Nozipho Gumbi** *University of South Africa, South Africa* Fabrication of macrovoid-free polyethersulfone/sulfonated polysulfone/o-MWCNT support UF membranes with improved mechanical strength, antifouling and performance properties	**OP9: Dr. Alex Kuvarega** *University of South Africa, South Africa* Catalytic mixed matrix PVDF membranes based on in-situ generated PAMAM dendrimer microparticles
11:50 – 12:10	**OP2: Ms. Mokgadi F Bopape** *Tshwane University of Technology, South Africa* Modification of polyether sulfone-based membranes with novel nanocellulose crystal powder NCC for purification of potable water	**OP6: Prof. Yuzhong Zhang** *Tianjin Polytechnic University, China* Development of novel membranes	**OP10: Ms. Koketjo M Shaku** *University of Johannesburg, South Africa* Photocatalytic membrane embedded on hyperbranched polyethyleneimine host and bismuth vanadate nanoparticles for the removal of organic pollutants in water
12:10 – 12:30	**OP3: Mr. Machodi Mathaba** *University of Johannesburg, South Africa* Effect of chitosan on the heavy metal removal efficiency of chitosan-modified polyether sulfone (PES) membrane during treatment of acid mine drainage	**OP7: Ms. Charmaine Tshangana** *University of South Africa, South Africa* Study and synthesis of modified electrospun membranes for application in novel solar-driven water purification system.	**OP11: Dr. Abaynesh Gebreyohannes** *KU Leuven, Belgium* Membrane bioreactors: in microalgae harvesting, in-situ fouling degradation and bioethanol production
12:30 – 12:50	**OP4: Dr. Rajesh Kumar** *Kuwait Institute for Scientific Research, Kuwait* A pilot scale study of forward osmosis desalination system for Arabian Gulf seawater desalination	**OP8: Ms. Kate Kotlhao** *University of Johannesburg, South Africa* Evaluation of Ag-ZnO modified polyamide thin-film composite membranes for removal of 2,4-dichlorophenol from water	**OP12: Mr. Lwazi Ndlwana** *MINTEK/University of Johannesburg, South Africa* Towards Pd@Fe@HPEI/PMAA-PES and Pd@FeAg@HPEI/PMAA-PES nano-multicatalytic composite membranes for the rapid degradation of methyl orange in water
12: 50 – 14: 00	**LUNCH BREAK**		Exhibition Hall

Session Chair	Prof. Raja Ben Amar		Thamsanqa Kambule Auditorium
14:00 – 15:00	**PL2: Prof. Jas Pal Badyal** *Department of Chemistry, Durham University, UK* **Scalable smart surfaces for water harvesting and purification**		
Symposium	**Session 4** **Desalination and Drinking Water**	**Session 5** **Fabrication and Modification**	**Session 6** **R&D, Composites and Hybrid and Integrated Processes**
Venue	Thamsanqa Kambule Auditorium	Council Chambers	GJ Gerwel C3-01
Session Chair	**Prof. Raja Ben Amar**	**Prof. Mamadou S. Diallo**	**Dr. Richard Moutloali**
15:00 – 15:30	**IN1: Dr. André Deratani** *Université de Montpellier, France* Desalination performance of PV powered stand-alone OSMOSUN® unit under intermittent operating conditions	**OP16: Prof. Titus Msagati** *Nanotechnology and Water Sustainability Research Unit, University of South Africa, South Africa* Novel MWCNT-PVDF membranes for desalination by membrane distillation: Effect of solvent composition	**IN2: Prof. Chris Buckley** *Pollution Research Group, University of KwaZulu-Natal, South Africa* Implementation of membrane R&D - A retrospective view
15:30 – 15:50	**OP13: Mr. Christopher Chukwuati** *University of Johannesburg, South Africa* The effect of PEI component on PES/GO/PEI/Ag NPS nanocomposite membranes for the treatment of organic dyes and removal of heavy metals in water	**OP17: Mr. Simanye Sam** *University of Johannesburg, South Africa* Cadmium(2) removal from water using carbon nanodots embedded on polyethersulfone membrane and detection using anodic strippingvoltammetry	**OP20: Sina F Torbati** *Tarbiat Modares University, Iran* Investigations of the effect of incorporation of TiO_2 on the performance of PES ultrafiltration membranes for oily water treatment
15:50 – 16:10	**OP14: Jingshi Wang** *Deakin University, Australia* Ultra-thin semi-permeable polymer alloy membranes for low cost desalination	**OP18: Mr. Sinethemba Xabela** *University of Johannesburg, South Africa* Grafting of PSBMA on graphene oxide surface for modification of cellulose acetate membranes for water treatment	**OP21: Mr. Nyiko M Chauke** *University of Johannesburg, South Africa* Intrinsic features of ZSM-22 zeolite/polyethersulfone composite as support membrane
16:10–16:30	**OP15: Dr. Machawe Motsa** *University of South Africa, South Africa* Surface modification of low pressure NF membranes via LBL-assembly: characterization and application in brackish water treatment	**OP19: Ms. Azile Nqombolo** *University of Johannesburg, South Africa* Poly(m-phenylineisopthalmide) ultrafiltration membrane incorporating graphene oxide-metal organic framework with improved water flux and antifouling properties	**OP22: Dr. Gomotsegang Molelekwa** *Tshwane University of Technology, South Africa* Uptake of membrane technology by the public sector in South Africa
16:30 – 17:00	**TEA BREAK**		Link Area
17:00 – 18:00	**POSTER SESSION**		Exhibition Hall
18:00 – 20:00	**Welcome Cocktail**		**Struben venue, Roodepoort Theatre**

Tuesday, 31 July 2018

07:30 – 08:00	**ARRIVAL**		
08:00 – 08:10	**ANNOUNCEMENTS**		Thamsanqa Kambule Auditorium
Session Chair	**Prof. Lingam Pillay**		
08:10 – 09:10	**PL3: Prof. Dr. Mihail Barboiu** *Institut Européen des Membranes, Université de Montpellier* **Rubbery organic frameworks-molecular control of CO_2 capture with elastomeric membranes**		
Symposium	**Session 7** **Ultra/Microfiltration**	**Session 8** **Membrane MaterialCharacterization**	**Session 9** **Air Filtration and Gas Separation**
Venue	Council Chambers	GJ Gerwel 301	GJ Gerwel 06-085
Session Chair	**Prof. Lingam Pillay**	**Mr. Simon Sibiya**	**Dr. Rachida Chemini**
09:10 – 09:40	**KN4: Dr. Abdoulaye Doucouré** *Hollingsworth & Vose Company, USA* A Roadmap for advancing the field of membrane and filtration sciences in Africa	**KN5: Prof. Mathias Ulbricht** *University of Duisburg-Essen, Germany* Increasing separation performance by integration of tailored functional polymeric layers in established filtration membranes and modules	**IN3: Dr. Richard Moutloali** *DST/MINTEK Nanotechnology Innovation Center – UJ Water Research Node, South Africa* Modulating membrane selectivity: A comparative study
09:40 – 10:00	**OP23: Ms. Thollwana Makhetha** *University of Johannesburg, South Africa* Ultrafiltration Membrane Composites Tailored by ZIF@GO with highly improved organic dye rejection performances	**OP25: Mr. Itumeleng Block** *Anton Paar, South Africa* Use of zeta potential measurement to monitoring membrane fouling and enhance membrane separation performance	**OP27: Prof. Michael Daramola** *University of Witwatersrand, South Africa* Nanocomposite sodalite/ceramic membrane for pre-combustion CO_2 capture from integrated gasification combined cycle (IGCC)
10:00 – 10:20	**OP24: Dr. Sana Gassara** *Université de Montpellier, France* Physicochemical properties monitoring of UF hollow fiber membrane during fabrication and aging	**OP26: Mr. Majid Jahdi** *University of South Africa, South Africa* Photocatalytic TiO_2 co-doped nanomaterials for water treatment applications	**OP28: Dr. Neil Stacey** *Institute for the Development of Energy for African Sustainability (IDEAS), UNISA, South Africa* Reduction in greenhouse water usage through inlet CO_2 enrichment
10:20 – 10:50	**TEA BREAK**		Link Area

Symposium	Session 10 Hybrid and Integrated Processes	Session 11 Nanotechnology and Membranes / Membrane Modelling	Session 12 Workshop on Air-filtration
Venue	Council Chambers	GJ Gerwel301	GJ Gerwel 06-085
Session Chair	**Prof. Mathias Ulbricht**	**Prof. Jas Pal Badyal**	**Dr. Abdoulaye Doucouré and Prof Sabelo Mhlanga**
10:50 – 11:10	**OP29: Mr. Simon M Sibiya** *Rand Water, South Africa* Ultrafiltration for potable water production-pilot plant experiences at Rand Water	**OP34: Dr. Neil Stacey** *Institute for the Development of Energy for African Sustainability (IDEAS), UNISA.* Novel graphical design methods membrane separations systems	**OP39: Xin Feng / Dr. R Vijayakumar** *China Academy of Building Research, China* A novel long-life air cleaning unit and its continuous operation performance analysis
11:10 – 11:30	**OP30: Dr. Ludovic Dumée** *Deakin University, Australia* Ultra-thin and high adsorption capacity composite nanofiber membranes for virus removal	**OP35: Mr. Sakhile Dube** *University of Johannesburg, South Africa* Synthesis and characterization of hyperbranched polyethylineimine multiwalled carbon nanotube incorporated with Fe-Cu bimetallic nanoparticles for water treatment	**Workshop on Air-filtration** **Dr. R Vijayakumar** Introduction to air filters
11:30 – 11:50	**OP31: Prof. Efrem Curcio** *University of Calabria, Italy* Salinity gradient power generation by reverse electrodialysis: System performance using natural feed streams	**OP36: Prof. Seyed S Hosseini** *Tarbiat Modares University, Iran* Improvement in efficiency of electroplating wastewater treatment through development and modification of PAN nanofiltration membranes	
11:50 – 12:10	**OP32: Prof. Lingam Pillay** *University of Stellenbosch, South Africa* Low energy, low maintenance membrane systems for developing economies-recent developments	**OP37: Ms. Ngozi Enemuo** *University of the Witwatersrand, South Africa* Nickel and cobalt-modified nanocomposite polysulfone membranes and their leaching studies	
12:10 – 12:30	**OP33: Dr. Bhekani Mbuli** *University of Johannesburg, South Africa* Adsorption-desorption of Pb (II) heavy metal ions from water using antifouling pH-responsive PA-TFC membranes	**OP38: Dr Michael Daramola** *University of the Witwatersrand, South Africa* Synthesis and application of carbon nanotube-infused polymer membrane (CNT/PSF/PVA) in the treatment of phenol-containing refinery wastewater	
12:30 – 13:40	**LUNCH BREAK**		Exhibition Hall

Session Chair	**Prof. Titus Msagati**		Thamsanqa Kambule Auditorium
13:40 – 14:40	**PL4: Prof. Jianxin Li** *State Key Laboratory of Separation Membranes and Membrane Processes, School of Materials Science and Engineering, Tianjin Polytechnic University, China* **Recent developments on membranes for water treatment and industrial separation**		
Symposium	**Session 13** **Modelling and Simulation**	**Session 14** **Air Filtration, Gas Separation and Solar Evaporation**	**Session 12** **Workshop on Air-filtration**
Venue	Council Chambers	GJ Gerwel 301	GJ Gerwel 06-085
Session Chair	**Prof. Dr. Mihail Barboiu**	**Dr. Sana Gassara**	**Dr. Abdoulaye Doucouré and Prof Sabelo Mhlanga**
14:40 – 15:00	**OP40: Dr. Amos Adeniyi** *Tshwane University of Technology, South Africa* Predictic the fouling tendency of RO/NF membranes using fractal analysis and membrane autopsy	**OP43: Ing. Katerina Setnickova** *Institute of Chemical Process Fundamentals of the Cas, v.v.i, Czech Republic* Novel membranes with ordered nanowell structure for gas separation	**Workshop continues**
15:00 – 15:20	**OP41: Dr. Rachida Chemini** *University of Science and Technology Houari Boumediene, Algeria* Simulation of water treatment plants in the petroleum industry	**OP44: Mr. Javad A Dehkordi** *Tarbiat Modares University, Iran* An investigation on the important role of porous support layer in the performance of gas separation membrane modules	
15:20 – 15:40	**OP42: Prof. Alexander Anim-Mensah** *Illinois Tool Works, USA* Relating key parameters in a membrane separation system and performance prediction (*via Video Conference*)	**OP45: Ms. Ellen Kwenda** *University of South Africa, South Africa* Carbon sphere-assisted solar evaporation of urine for the recovery of nutrients	
15:40 – 16:00	**KN6: Prof. Woei-Jye J Lau** *University Technologi Malaysia, Malaysia* Development of thin-film nanocomposite (TFN) membrane for water applications	**OP46: Ms. Palesa Menze** *Air Products South Africa, South Africa* Air Products in South Africa: Fundamentals and products	
16:00 – 16:30	**TEA BREAK**		Link Area
16:30	**TRANSFERS TO HOTELS**		
18:00	**TRANSFERS TO CONFERENCE DINNER**		

Wednesday, 1 August 2018		
	CLOSING CEREMONY	Thamsanqa Kambule Auditorium
07:30 – 08:00	**ARRIVAL**	
08:00 – 08:10	**Announcements**	
Session Chair	**Prof. Edward Nxumalo**	
08:10 – 09:10	**PL5: Prof. Rong Wang** *School of Civil and Environmental Engineering,Nanyang Technological University, Singapore* **Development of novel membranes for desalination and water reuse**	
09:10 – 09:30	**Dr. Lueta De Kock** *Nanotechnology and water Sustainability Research Unit, University of South Africa, South Africa*	
09:30 – 09:40	**Conference Awards**	
09:40 – 09:50	**CLOSING REMARKS: AMSIC President and Conference Chair**	
09:50 – 10:20	**UNISA Facility Tour**	
10:20 – 10:50	**TEA BREAK**	
10:50	**EXCURSIONS AND DEPARTURE**	

Note: **PL** – Plenary Lecture by Invited Speaker; **KN** – Keynote by Invited Speaker; **IN** – Invited Speaker; **OP** – Oral Presentation

Workshop on membrane technology for water, environment and energy

2 & 3 August 2018

Room 301, GJ Gerwel Building, UNISA Science Campus, Florida, South Africa

Presenters

Professor Dr Ahmad Fauzi Ismail
Associate Professor Dr Lau Woei Jye
Dr Goh Pei Sean
Dr Hasrinah Hasbullah

The 2-day workshop ***Membrane Technology for Water, Environment and Energy*** will be held after AMSIC-2. The workshop is sponsored by the Faculty of Chemical & Energy Engineering (FCEE), Universiti Teknologi Malaysia (UTM) with the cash award given by the Islamic Development Bank (IDB). FCEE won the 15th edition of IDB Science & Technology Prize (Category 2) in 2017.

During the 2-day membrane workshop, four members from the Advanced Membrane Technology Research Centre (AMTEC), UTM will be giving talks based on their research expertise. They are Prof Dr Ahmad Fauzi Ismail (Director of AMTEC), Assoc Prof Dr Lau Woei Jye (Research Fellow of AMTEC), Dr Goh Pei Sean (Research Associate of AMTEC) and Dr Hasrinah Hasbullah (Research Associate of AMTEC).

The workshop aims to provide basic principles of membrane and its industrial applications. Specifically, it will cover topics such as principles of membrane formation, membrane synthesis and characterization, membrane configuration and design, membrane process and the success story of membrane applications in Malaysia.

Figure 5 Group of participants and facilitators in the Membrane Technology for Water, Environment and Energy Applications workshop

Days program

	3 August 2018
Time	Lecture/Activity
	Morning Session
8.45 - 9.00	Registration
9.00 - 9.30	Introduction to Speakers, Universiti Teknologi Malaysia & Faculty of Chemical & Energy Engineering
9.30 - 10.00	Introduction to Advanced Membrane Technology Research Centre (AMTEC) - Higher Institution Centre of Excellence (HICoE)
10.00 - 10.30	Morning Tea Break
10.30 - 11.00	Module 1: Introduction to Membrane Technology
11.00 - 12.00	Module 2: Principle and Preparation of Membranes (Polymeric & Ceramic)
12.00 - 12.30	Module 3: Membrane Characterization
12.30 - 1.00	Q & A Session
1.00 - 2.00	Lunch
	Afternoon Session
2.00 - 2.30	Module 4: Membrane Separation Mechanisms
2.30 - 3.30	Special Talk: Fibrous Media for Solid-Liquid Separation (Dr Ablo Doucoure)
3.30 - 4.00	Afternoon Tea Break
4.00 - 5.00	Module 5: Membrane Configuration and System Design
	3 August 2018
Time	Lecture/Activity
	Morning Session
9.00 - 10.00	Module 6: Membrane Application: Water & Wastewater
10.00 - 10.30	Morning Tea Break
10.30 - 11.30	Module 7: Membrane Application: Environment & Energy
11.30 - 12.30	Special Talk: Membrane Research Development/Achievements in Africa (Prof Sabelo & Assoc Prof Dr Edward)
12.30 - 1.00	Q & A Session
1.00 - 2.00	Lunch

Sponsors Acknowledgement

AMSIC-2 had various sponsors including UNISA College Research Committee, NanoWS Research Unit. Others sponsors included Anton Paar, Institut Européen des Membranes, ANATECH, European Membrane Society, Ion Exchange Safic, Air Products and Mercedes Benz.

Table of Contents

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Photocatalytic Membrane: A new Frontier in Wastewater Treatment

Sudip CHAKRABORTY*, Stefano CURCIO, Debolina MUKHERJEE and Vincenza CAKABRO

University of Calabria, Italy

*Corresponding author: sudip.chakraborty@unical.it

Abstract

Industrial wastewater from various sources is causing great problem all over the world. To avoid the contamination of natural water bodies by residual pharmaceutical waste compounds, pretreatment to degrade these compounds in municipal and industrial effluents is needed before their release into the environment. Conventional physical and biological treatments generally fail to fully oxidize the spectrum of drugs found in wastewater.

In this research, the degradation by heterogeneous photocatalysis of two organic compounds using TiO2 nanoparticles immobilized on commercial hollow fiber ultrafiltration membranes was studied. Polymeric hollow ultrafiltration membranes were functionalized at room temperature with the aim of degrading CHD under simulated solar irradiation. The sol-gel coating protocol, never used before for this purpose, was employed to achieve the TiO2 coating. Polyether-sulfone (PES) and blended polyvinyl-chloride/polyacrylonitrile (PVC-PAN)) was chosen as a medium to immobilize the inorganic catalyst due to their chemical stability, mechanical resistance and superior specific surface area. The support as well as a selected inorganic catalyst was characterized by FT-IR, XRD, UV-DRS, FESEM techniques. The progress of the reaction was monitored by absorption studies and measuring the reduction in COD and TOC. The parametric variation has shown that alkaline pH, ambient temperature, low initial substrate concentration, high TiO2 loading were favorable, though at a certain concentration of TiO2 loading, photocatalytic degradation efficiency was found to be maximum. The adsorption study has shown good confirmation with Langmuir isotherm and during the reaction at initial stage; it followed pseudo-first-order reaction.

Finally, the present study confirmed that there is a significant effect of adsorption on photocatalytic degradation. The influences of pH and temperature have been explained with the help of surface charge distribution of reacting particles and thermodynamic point of view respectively. The membranes developed through sol-gel achieved a degradation of more than 63% and 60% Methylene Blue and Chlorhexidine digluconate, respectively, showcasing the potential of coated ultrafiltration membranes for purification of pharmaceutical wastewater.

Keywords: Photocatalysis; TiO2; Membrane; pharmaceutical wastewater; active components.

2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Development of Novel Membranes

Yuzhong ZHANG* and Hong LI

Tianjin polytechnic university, China

*Corresponding author: zhangyz2004cn@vip.163.com

Abstract

High performance hollow fiber membranes were developed, in which Polyvinylidene fluoride (PVDF) and Polyether sulfone (PES) were as basic materials. These membranes have been applied in water purification and reuse widely in domestic and industry. In order to solve the problems in bio-separation and environmental pollution new type functional membrane materials have been investigated in adsorptive membrane, smart membrane and gas separation. Micro-pattern membrane was fabricated by the method phase inversion with micro-pattern module. The membrane absorbers in MMMs were prepared to remove the heavy metal, sulfur, and N, P in water resource

Keywords: hollow fiber; UF; membrane adsorber.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Carbon Nanotube-Infused Thin Film Composite Membrane for Acid Mine Drainage (AMD) Treatment

Selaelo Kholofelo RAMOKGOPA[1]*, Keneiloe SIKHWIVHILU[2], Richard MOUTLOALI[3], Selby MAPHUTHA[1] and Kapil MOOTHI[1]

[1]Department of Chemical Engineering, Faculty of Engineering and the Built Environment, University of Johannesburg, Doornfontein 2028, Johannesburg, South Africa
[2]DST/Mintek Nanotechnology Innovation Centre, Advanced Materials Division, Mintek, Randburg, 2125, South Africa
[3]Department of Applied Chemistry, Faculty of Science, University of Johannesburg, Doornfontein 2028, Johannesburg, South Africa.

*Corresponding author : sly.kholo@gmail.com

Abstract

Acid mine drainage (AMD) is a huge environmental challenge which threatens water security and the ecosystem balance. There are various remediation techniques, such as ion exchange, bioremediation and neutralization, however membrane technology is a popular alternative to conventional wastewater treatment methods, particularly the treatment of AMD. In addition, thin film composite (TFC) membranes are ideal for use in AMD treatment as because they are able to reject multivalent ions.

Nonetheless, membrane fouling and concentration polarization limit the application of this technology. The inclusion of hydrophilic nanomaterials such as functionalized carbon nanotubes (CNTs) have been shown to be effective in reducing membrane fouling. In this study, the operating conditions of CNT-modified TFC membranes were investigated for the treatment of AMD. The Surface roughness, hydrophilicity, ion rejection, permeation and membrane flux will be presented. In addition, the effect of fouling on the membrane operability will be discussed.

Keywords: AMD; Carbon nanotube; membrane trématent; nanotechnologie.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Simulation of Wastewater Treatment Plants in the Petroleum Industry

Meryem KHELOUF, Rachida CHEMINI* and Zineb SALEM

University of Science and Technology Houari Boumediene, Algiers, Algeria

*Corresponding author : rachida_chemini@yahoo.fr

Abstract

The aim of the present paper is to simulate two different treatment units of wastewater resulting from the crude oil and gas production. Two effluents are considered, the first one is coming from separator center and the second from the de-oiling station.

The Water9 software is used to simulate and to optimize the treatment operations, in addition, it is used also to estimate different transfer and diffusion coefficients for each pollutant from the treated wastewater into air phase.

The results show that first settling pond built in separation center; gives the estimated efficiency of the API standard. The treatment of the de-oiling effluent is very well correlated.

Keywords: Industrial wastewater; treatment units; oil; Simulation.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

A Roadmap for Advancing the Field of Membrane and Filtration Sciences in Africa

Abdoulaye DOUCOURE

Board of Directors of the African Membrane Society Hollingsworth & Vose Company, Virginia 24091 – USA

Corresponding author: ablodoucoure@hotmail.com

Abstract

The African Membrane Society (AMSIC) stems from the efforts of motivated scientists, with expertise in filtration/ water/energy technologies, who met in Bamako in 2010 and recognized that membrane science needed much greater visibility on the continent. In 2014, meetings were held in Morocco and Mali and the association was created, establishing its headquarters at the Ecole Nationale d'ingénieurs A.B.Tdu Mali [1].

AMSIC mission is about inspiring individuals in Africa by promoting a culture of scientific and technological excellence all across the continent. The organization also seeks to demonstrate societal relevance by exploring how filtration sciences can be leveraged against challenges posed by climate change, fast growing demographics and densely populated cities [2].

This presentation will give an opportunity to discuss about AMSIC cultural diversity, its geographical presence around the word and to highlight its technical priorities/pillars including

i) Membranes and nonwoven/fiber materials;
ii) Filtration and treatment of liquids and air streams;
iii) Sustainable energy and water technologies.

Further, several examples will be analyzed to describe the current state of membrane and filtration technologies in Africa and elsewhere in the world. A proposal will be shared with a list of steps needed to build a vibrant and robust network of "filter" experts on the continent ready to advocate for more prosperous nations and an improved quality of life [3].

Keywords: Nonwoven and fibrous media; renewable energies; sustainability; African membrane society.

Reference

[1] A. Doucouré, AMSIC Newsletter, 1st edition, http://www.sam- ptf.com/newsletter.html, p1-2, 2015
[2] Special selection Urban Planet, Science, Rise of the city, p 906, 2016
[3] F. Sarr, Afrotopia, "L'Afrique n'a personne à rattraper. Elle ne doit plus courir sur les sentiers qu'on lui indique, mais marcher prestemment sur le chemin, qu'elle se sera choisi, Ed. Philippe Rey, ISBN 978-2-84876-502-0, 2017

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Introduction to Air Filters

R. VIJAYAKUMAR

Aerfil, 300 Cypress St. N. 41, Liverpool, N.Y. 13088, USA

Corresponding author: vijay@aerfil.com

Abstract

Air filters are the key active component in ensuring the cleanliness of air wherever clean air is required. This lecture will be a comprehensive review of the theory and practice of air filters made with fibrous filter media (membranes). The discussions will build upon the theory of particle removal and its central role in filter designs and testing. In an attempt to appeal to a broader audience, and to enable the presentation of information on a substantial number of topics, only concepts of the physics of the filtration rather than detailed mathematical derivations will be presented. The operating principles of the different test instruments commonly used for filter performance testing and their key differences will be addressed. An overview of the prevailing standards and their equivalence will also be presented.

The goal of this lecture is to provide both new and established professionals in the field with answers to common questions regarding filter media, filter design, filter testing, and filter selection and to clarify common misconceptions. The.

Keywords: Air filtration - Air quality - Filtration standards Air filter products - Nonwoven media.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Ultra-thin and High Adsorption Capacity Composite Nanofiber Membranes for Virus Removal

Ludovic DUMEE[1*], Riyadh AL-ATTABI[1], Julio RODRIGUEZ-ANDRES[2] and Yos MORSI[3]

[1]Deakin University, Institute for Frontier Materials, Australia
[2]The University of Melbourne
[3]Swinburne University

*Corresponding author : ludovic.dumee@deakin.edu.au

Abstract

Viruses can be spread and released into the environment via water and aerosols generating great risks of infection for exposed populations. The use of electrospun nanofiber membranes for virus removal is relatively new and promising due to nanoscale interconnected porous structure, small fiber diameter, high specific surface area, and the ability to demonstrate an active surface on the nanofiber. Nano-composite electrospun nanofiber membranes for the first time from TEOS and ATTM mixed with PAN were electrospun to produce defect-free and highly interconnected porous structure with high adsorption capacity for virus removal application. The impact of PAN/ATTM and PAN/TEOS solution concentration on final properties of the fabricated membrane was studied and correlated to their separation performance. The removal efficiency of the Semliki Forest virus (SFV) with the nano-composite electrospun based membranes were found to be largely related to the fibre surface morphology and roughness as well as to the surface energy of the materials. The membranes, with pore size distributions in the range of 100 to 450 nm and specific surface areas on the order of 75 m2/g exhibited virus removal efficiency in the range of 33.24 to 98.91. The morphology, mechanical properties, and wettability properties were also evaluated and the results suggested that this functional highly efficient membrane could be used as a promising membrane to meet the specific needs of air and water purification.

Keywords: adsorption capacity composite; mechanical properties; wettability properties.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Novel Membranes with Ordered Nanowell Structure for Gas Separation

Katerina SETNICKOVA[1*], Hongta YANG[2], Tomas STRASAK[3], and Petr UCHYTIL[3]

[1]Institute of Chemical Process Fundamentals of the Czech Academy of Sciences, Czechia.
[2]National Chung Hsing University, Department of Chemical Engineering, Czechia.
[3]Institute of Chemical Process Fundamentals of the Czech Academy of Sciences, Czechia.

*Corresponding author: *setnickova@icpf.cas.cz

Abstract

Due to environmental, operational and economic impacts of acid gases such as CO2, H2S, NOx and SOx, development of new separation technologies with enhanced efficiency and low capital cost is an emerging demand in the near future. Membrane separation processes are considered as promising for gas removal and recovery owing to reasonable cost, good selectivity and low environmental impact. The development of innovative membranes having both high gas permeance and selectivity becomes very important. The aim of the presented work was to test a self-assembled hemispherical nanowell array in a new membrane design for gas separation. Highly permeable polymer was used for the preparation of controllable size nanowell structure, representing support layer of membrane. The separation efficiency was achieved by the deposition of separation layer (1) ionic liquid or (2) different type of polymer, having preferential solubility for some gases (especially carbon dioxide) on the nanowell structure support. Moreover, the mechanism of the gas transport through novel membranes as well as the possible interactions between polymer matrix and ionic liquid were investigated in this study.

Keywords: gas separation; membrane process; ionic liquids.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Ultra-Thin Semi-Permeable Polymer Alloy Membranes for Low-Cost Desalination

Jingshi WANG[1]*, Zhiqiang Frank CHEN[1], Nick MILNE[2], Lingxue KONG[1] and Ludovic FRANCIS[1]

[1]Institute for Frontier Materials, Deakin University, Waurn Ponds, VIC 3216, Australia
[2]School of Engineering, Deakin University, Waurn Ponds, VIC 3216, Australia

*Corresponding author: wangyv@deakin.edu.au

Abstract

A novel desalination membrane fabrication pathway based on plasma polymerization is proposed here. This study aims to reveal the correlation between plasma polymerization conditions, the physicochemical properties of the plasma polymerized separation layers and membrane performance.

The plasma polymerization applied onto ultrafiltration (UF) poly(sulfone) (PSf) membranes allows for controlled and versatile modification of the membranes, altering both pore size and surface charge simultaneously 1. Monomers such as 1-vinyl(imidazole) (VIM) and acrylic acid (AA) were introduced into the plasma system individually or as a mixture to generate either homogeneous materials or polymer alloys (heteropolymer). Plasma polymerization experiments were carried out in an inductively coupled radio frequency (RF, 13.56 MHz) plasma reactor. Typically, the plasma glow was run at a power in the range of 10 to 50 W and for a chamber pressure at 0.1 mbar over 1 to 15 min of duration. The impact of the different plasma conditions was assessed by evaluating the thin film deposition morphology, chemistry, and surface charge. Specifically, the morphology was characterized by scanning electron microscopy (SEM) and atomic force microscopy (AFM) measurement. The surface energy of the membranes was assessed by water contact angle measurements and streaming potential analysis over a range of pH conditions [1-2]. Furthermore, Fourier transforms infrared (IR) spectroscopy and X-ray photoelectron spectroscopy were used to evaluate alterations of surface chemistry.

Particularly, the homogeneity of the plasma polymerized thin films can be evaluated using Synchrotron micro-attenuated total reflectance (microATR)-infrared micro spectroscopy (IRM) at the micro and sub-micron scale. Last, the ability of the membranes to reject different salt solutions (i.e., sodium chloride and magnesium sulfate, 2000 ppm) [3-5] and organic dyes was examined in a cross-flow filtration system. Therefore, the membrane performance can be related to the physicochemical properties of the plasma thin films upon plasma polymerization.

Keywords: membrane modification; plasma polymerization; membrane material characterization; membrane desalination.

2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Adsorption-Desorption of Pb (II) Heavy Metal Ions from Water Using Antifouling pH-Responsive PA-TFC Membranes

Kgolofelo I MALATJIE, Bhekani MBULI*, Richard MOUTLOALI and Catherine NGILA

University of Johannesburg, Doornfontein 2028, Johannesburg, South Africa.

*Corresponding author : +bhekanimbuli@yahoo.com

Abstract

pH responsive polyamide thin film composite (PA-TFC) membranes modified with acrylic acid and zinc oxide nanoparticles were prepared by using an in-situ interfacial polymerization approach. For the modified membranes, adsorption of Pb (II) cations was more favorable at pH 11, while desorption was more favorable at pH 3. This was because of the ionisable functional groups from incorporated acrylic acid (-COOH) and ZnO nanoparticles (-OH) possessed adsorption capabilities that enabled them to adsorb at more basic pH conditions, since they ionized and become negatively charged at basic pH levels.

Hence, cationic species such as Pb (II) ions could be easily bound to the negatively charged side chains. At lower pH, the bound heavy metal ions are desorbed because of the hydrogen bonding that favored proton (H+) ions over heavy metal ions. For example, the membranes modified with 0.50:1.00% ZnO/AA had significantly higher affinity towards Pb (II) cations with the highest adsorption capacity of 79.45±1.63 mg/g. The unmodified PA-TFC membranes had the lowest maximum adsorption capacity of 9.56±1.42 mg/g. Other modified membranes had their maximum adsorption capacities ranging between 65.29±1.53 mg/g and 68.19±0.59 mg/g. The adsorption data favored the Langmuir isotherm, with the adsorption kinetics following the pseudo-second order. This suggested that the adsorption mechanism occurred as a monolayer coverage adsorption. The modified membranes showed improved desorption than unmodified membranes, suggesting higher a regenerability of the modified membranes by simply changing the pH conditions of the feed-water.

Therefore, these AA hydrogels and ZnO nanoparticles modified membranes showed improved pH responsiveness when compare to unmodified membranes. This performance behavior occurred as a result of the pH-switch protonation-deprotonation of the -COOH functional groups from the acrylic acid hydrogels and the “gate effect” mechanism.

Keywords: Adsorption-desorption; membrane.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Ultra-Porous Superhydrophobic PVDF Nanofiber Membranes for Efficient Desalination of Brackish Water

Sabelo MHLANGA[1*], Lebea NTHUNYA[1] and Arne VERLIEFDE[2]

[1]University of Johannesburg, South Africa
[2]Belgium Ghent University

*Corresponding author : mhlansd@unisa.ac.za

Abstract

Membrane distillation is an efficient desalination process that is receiving enormous attention. However, this process is affected by wetting of membrane pores and the low porous nature of membranes, which lead to lower rate of water recovery. This study sought to address these problems by fabricating highly porous and super-hydrophobic polyvinylidene fluoride (PVDF) nanofibre membranes modified with organically functionalized silica (Si) nanoparticles (NPs). The highly porous nanofibre membranes were synthesized using an electrospinning technique. The membranes were found to be highly rough, strong, and porous as demonstrated on the atomic force microscopy, small angle X-ray scattering and porosity measurements.

Addition of the organically modified Si NPs to the electrospinning solution resulted in the formation of super-hydrophobic membranes. These membranes were tested for their salt rejection and water fluxes. They were found to reject the salt ions from water at high efficiencies (> 99%) with water fluxes ranging from 55–64 liters per hour indicating their capacity to produce high purity water in large quantities.

Keywords: Nanofibre membranes; Super-hydrophobic; Membrane distillation.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Fabrication of Macrovoid-Free Polyethersulfone/Sulfonated Polysulfone/O- MWCNT Support UF Membranes with Improved Mechanical Strength, Antifouling and Performance Properties

NoziphoN. GUMBI[1]*, Bekhie MAMBA[1], Edwards NXUMALO[1] and Jianxin. LI[2]

[1]Nanotechnology and Water Sustainability Research Unit, College of Science, Engineering and Technology, University of South Africa Science Campus, Roodepoort 1709, Johannesburg, South Africa
[2]State Key Laboratory of Separation Membranes and Membrane Processes, School of Materials Science and Engineering, Tianjin Polytechnic University, Tianjin 300160, PR China

*Corresponding author : noziphongumbi@gmail.com

Abstract

The performance of pressure driven membranes in water treatment is limited by membrane fouling; a phenomena in which foulants are deposited on the membrane surface or within the membrane pores [1]. Increasing hydrophilicity of membrane surfaces has been found to remarkably minimize fouling due to the creation of a strong hydration layer that prevents the attachment of foulants [2]. In the quest to improve hydrophilicity, hydrophilic polymers or nanomaterials are added to membrane matrices. However, due to their hydrophilic nature, a membrane sublayer with finger- like structures and macrovoids is generated, which tends to diminish the mechanical strength properties of the membrane. Herein, we report on the synthesis of a hydrophilic, macrovoid-free membrane substrate with improved mechanical strength and other performance properties. The support membrane substrates were prepared by water-induced gelation phase separation method [3, 4], using a mixture of polyethersulfone/sulfonated polyethersulfone (PES/SPSf) with oxidized multi-walled carbon nanotubes (O-MWCNTs). Increase in O-MWCNT content led to an improvement in membrane hydrophilicity as alluded from contact angle measurements (from 67.6± 1.130 for PES/SPSf to 47.2± 0.430 for 0.1wt% PES/SPSf/O-MWCNT). Analyses by scanning electron microscopy (SEM) revealed that an increase in O- MWCNT content maintained the sponge-like morphology of the membrane PES/SPSf substrate (Figure 1). This morphology was essential in improving mechanical strength properties of PES/SPSf/O-MWCNT membrane, in the presence of hydrophilic O- MWCNTs. Fouling studies carried using BSA as a model protein foulant revealed that the presence of hydrophilic O-MWCNTs water improved the antifouling capacity of PES/SPSf membranes as revealed by pure water flux recovery of > 85% for all PES/SPSf/O-MWCNT membranes.

These PES/SPSf/O-MWCNT membranes display attractive features for use as supports for fabrication of thin-film composite nanofiltration membranes for use in brackish water desalination. PES/SPSf/O- MWCNT UF membranes prepared display attractive features for use as supports for fabrication of thin-film composite nanofiltration membranes for use in brackish water desalination.

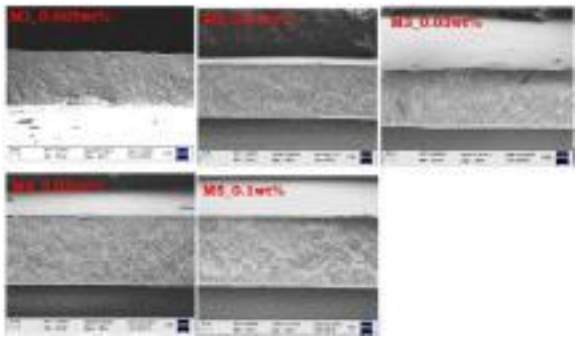


Figure 1. SEM cross-section images of PES/SPSf membranes containing different contents of O- MWCNTs.

Keywords : macrovoid-free ; sulfonated polysulfone ; oxidised-multi walled carbon nanotubes ; antifouling

References

[1] Matsuura T., Surface modifications for antifouling membranes, Chemical reviews, 110 (2010) 2448-2471.
[2] Tiraferri A., C.D. Vecitis, M. Elimelech, Covalent binding of single-walled carbon nanotubes to polyamide membranes for antimicrobial surface properties, ACS applied materials & interfaces, 3 (2011) 2869-2877.
[3] Li S., Z. Cui, L. Zhang, B. He, J. Li, The effect of sulfonated polysulfone on the compatibility and structure of polyethersulfone-based blend membranes, Journal of Membrane Science, 513 (2016) 1-11.
[4] Zhang L., Z. Cui, M. Hu, Y. Mo, S. Li, B. He, J. Li, Preparation of PES/SPSf blend ultrafiltration membranes with high performance via H2O-induced gelation phase separation, Journal of Membrane Science, 540 (2017) 136-145.

.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Photocatalytic Membrane Embedded on Hyperbranched Polyethyleneimine Host and Bismuth Vanadate Nanoparticle for the Removal of Organic Pollutants in Water

Koketjo M SHAKU[1], Soraya P MALINGA[1]* and Langelihle N DLAMIN[2]

[1]University of Johannesburg, South Africa
[2]Belgium Ghent University

*Corresponding author : smalinga@uj.ac.za

Abstract

With increased production and usage, the recurring accumulation of pharmaceutical and personal care products in various water bodies has attracted significant attention amongst the public and scientists (1). Classified as new emerging pollutants, these pharmaceutical and personal care products ultimately accumulate and contaminate several water bodies through several pathways.

Although reported to be found at very low concentrations, exposure to these emerging organic pollutants have adverse effects to humans such as being carcinogenic and disruption of the endocrine system. Conventional methods are reported to partially degrade the new emerging pollutants. Therefore, it is of importance to explore effective and innovative methods for the complete degradation of the new emerging pollutants.

In this study, a photocatalytic-membrane consisting of bismuth vanadate (BiVO4) nanoparticles, hyperbranched polyethyleneimine (HPEI) and polyethersulfone (PES) will be used in the degradation of selected emerging organic pollutants. BiVO4 is an n-type semiconductor with excellent properties such as lower band gap and visible light active. However, it has drawbacks such as agglomeration and having lower surface area. Hyperbranched polyethyleneimine will be used as a dispersing agent for the BiVO2 photocatalyst as this polymer has been found to be an excellent template/host for the production of monodispersed and uniform size particles. HPEI can also induce hydrophilic properties on the membrane thus alleviating fouling.

Characterisation techniques such as X-ray powder diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), transmission electron microscopy (TEM), Raman spectroscopy and atomic force microscopy (AFM) will be used to characterise both the pristine BiVO4 and the nanocomposite membrane. LC-MS will be used to monitor the extent of the photocatalytic activity of the membrane on the selected emerging organic pollutant. It is expected that the nanocomposite membrane will be effective in the degradation of organic pollutants in water due to properties induced by the HPEI and BiVO4 nanomaterials.

Keywords: Bismuth vanadate; Hyperbranched polyethyleneimine; polyethersulfone membrane; triclosan.

Reference

[1] Zhao, W., Wang, B., Wang, Y., Deng, S., Huang, J. and Yu, G., 2017. Deriving acute and chronic predicted no effect concentrations of pharmaceuticals and personal care products based on species sensitivity distributions. Ecotoxicology and environmental safety, 144, pp.537-542.

2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Immobilization of Silver Nanoparticles Decorated on Dendritic Polymer Nanofibrous Membrane for Antibacterial Properties

Khona MAZIYA, Soraya MALINGA+, and Bhekisisa DLAMINI

University of Johannesburg, Doornfontein 2028, Johannesburg, South Africa.

*Corresponding author : mhlansd@unisa.ac.za

Abstract

The concern over water contamination has become a critical issue due to population growth, water pollution and climate change. Microbial contamination by bacteria such as E.coli, Vibrio, Salmonella, Shigella and Staphylococcus species has been detected in South Africa water systems and linked to fecal contamination. Ingestion of bacterial contaminated water leads to a number of health-related issues such as gastrointestinal infections and can lead to death if left untreated. Immobilization of silver nanoparticles on a polymeric membrane for water treatment applications has emerged as a promising technique in the removal of bacteria in water. In this study, the synthesis of a nanofibrous membrane was carried out through electrospinning of a polymer blend containing hyperbranched polyethyleneimine (HPEI) and silver nanoparticles on a commercial membrane. HPEI assisted in the production of Ag nanoparticles that are uniformly dispersed, narrow size and further confer hydrophilicity to the PES membrane. Moreover, the Ag nanoparticles introduces biocidal properties to the membrane through production of free radicals that trigger oxidative stress towards bacteria thus causing cell damage and further anchoring on bacterial cells via electrostatic interaction resulting in the disruption of the cellular membrane structure.

The synthesized HPEI/Ag/PES nanofibrous membrane was characterized using scanning electron microscopy (SEM) coupled with energy dispersive X-ray (EDX), Transmission electron microscopy (TEM), correlative light electron microscopy (CLEM), contact angle analysis and water flux measurement. The performance of the membrane in the removal of bacteria was evaluated using both quantitative and qualitative assays such as bacterial plating tests, membrane inhibition test, and flowcytometric analysis.

Keywords: Nanofibres membrane; Ag nanoparticules; Bacteria; HPEI.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Fabrication of Hyperbranched Polyethyleneimine Blended with Multiwalled Carbon-Nanotube Composite Membranes for the Removal of Pb (II) from Water

Edward Rorisang MASENYE, Soraya P MALINGA* and N MABUBA

Department of Applied Chemistry, University of Johannesburg, Doornfontein Campus, P.O. Box 17011, Doornfontein 2028, Johannesburg, South Africa.

*Corresponding author: smalinga@uj.ac.za

Abstract

Human activities associated with urban developments, agricultural productivity, and production from the mining industry introduce inorganic and organic pollutants into the environment which can trigger wastewater contamination [1]. Heavy metals such as Pb (II) are the source of unavoidable hazards to human health because they create undesirable diseases such as a potential rupture of the peripheral and central nervous system. Further, several types of heavy metals are linked to other serious health threats due to their carcinogenicity [2,3]. Hence this study seeks to fabricate an efficient membrane exhibiting the capability to reduce Pb (II) concentration levels in water below 10 ppb. A thin film composite membrane consisting of hyperbranched polyethyleneimine (HPEI) and multiwalled carbon nanotubes (MWCNTs) will be developed via interfacial polymerisation.

The functionalised MWCNTs will be characterised using Fourier-transform infrared spectroscopy (FTIR), Transmission Electron Microscope (TEM) coupled with EDX and Raman. The fabricated PES/MWCNT/HPEI membrane will be characterised using Scanning Electron Microscope (SEM), contact angle, and Atomic Force Microscope (AFM). Inductively coupled plasma, optical emission spectroscopy (ICP-OES), will be used to determine the concentration of Pb (II) in water following a filtration treatment by the new membrane.

Keywords: Hyperbranched polyethylenimine; Lead (II) as Pb(II); Interfacial polymerization; Polyethersulfone; Multiwalled carbon nanotubes

References

[1] Zhao, G., Li, J., Ren, X., Chen, C. and Wang, X., 2011. Few-layered graphene oxide nanosheets as superior sorbents for heavy metal ion pollution management. *Environmental Science & Technology*, 45, pp.10454-10462.
[2] Karr J.R., 1981. Assessment of biotic integrity using fish communities. *Fisheries,* 6, pp. 21-27.
[3] Gunatilake, S.K., 2015. Methods of removing heavy metals from industrial wastewater. *Methods*, 1, pp. 12-18.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Catalytic Mixed Matrix PVDF Membranes Based on In-Situ Generated Pamam Dendrimer Micro Particles

Alex KUVAREGA[1*], Madhusudhana KOTTE[2], Manki CHOI[2], Bhekie MAMBA[3] and Mamadou DIALLO[4]

[1]University of Johannesburg, South Africa
[2]Korea Advanced Institute of Science and Technology, South Korea
[3]UNISA, South Africa
[4]CalTech, United States

*Corresponding author: kuvarat@unisa.ac.za

Abstract

Nanotechnologies based on polymer embedded metal nanoparticles have recently found applications in a wide range of R&D niches with the focus on enhancing reactivity of the entrapped nanoparticles. Membrane reactors based on the combination of a membrane-based separation and a catalytic chemical reaction in one unit is a novel technique of ensuring process intensification in chemical manufacturing industry. A one-pot synthesis method for the fabrication of mixed matrix polyvinylidene fluoride (PVDF) membranes with in-situ synthesized poly(amidoamine) [PAMAM] particles is described. The in-situ generated PAMAM dendrimer microparticles were generated in the dope solutions prior to membrane casting using low-generation dendrimers with terminal primary amine groups (G0 and G1-NH2) as precursors and epichlorohydrin (ECH) as cross-linker. By using a combined thermally induced phase separation (TIPS) and non-solvent induced phase separation (NIPS) casting process, a new family of asymmetric PVDF ultrafiltration membranes with (i) neutral and hydrophilic surface layers of average pore diameters of 22−45 nm, (ii) high loadings (∼48 wt %) of dendrimer-like PAMAM particles with average diameters of ∼1.3−2.4 μm, and (iii) matrices with sponge-like microstructures characteristic of membranes with strong mechanical integrity were successfully prepared.

The new mixed matrix PVDF membranes showed high capacity Cu(II) and Pt(IV) recovery from aqueous solutions by ultrafiltration. In-situ reduction of the membrane adsorbed Pt (IV) led to a catalytic membrane with well dispersed Pt(0) clusters. The Pt loaded membrane can serve as a highly selective and recyclable catalytic media for the regioselective hydrogenation of alkenes and alkynes at room temperature under H2 atmosphere at room temperature and a pressure of 2 bars.

Keywords: dendrimer; mixed matrix membrane; metal sorption; phase separation.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Hyperbranched Polyethyleneimine-Multi Walled Carbon Nanotube (HPEI/MWCNTs) Polyethersulfone (PES) Membrane Incorporated with Fe-Cu Bimetallic Nanoparticles for Water Treatment

Sakhile T. DUBE[1], Richard M. MOUTLOALI[1,2] and Soraya P. MALINGA[1]*

[1]Department of Applied Chemistry, University of Johannesburg, Doornfontein Campus, P.O. Box 17011, Doornfontein 2028, Johannesburg, South Africa;
[2]DST/Mintek Nanotechnology Innovation Centre-UJ Water Research Node, University of Johannesburg, P.O. Box 17011, Doornfontein, 2028, South Africa.

*Corresponding author: smalinga@uj.ac.za

Abstract

The contamination of freshwater systems by pesticides such as 2.4.6-trichlorphenol (TCP), hexachlorobenzene (HCB), etc. is a key environmental problem. These compounds are stable and bio-accumulate in the environment, thus making their elimination impossible. Pesticides have been detected in South Africa's water supply systems, mainly from agricultural activities. In this study, a membrane composed of highly catalytic Fe-Cu bimetallic nanoparticles, hyperbranched polyethyleneimine (HPEI) and multi-walled carbon nanotubes (MWCNTs) will be used for the degradation of 2.4.6-Trichlorophenol.

HPEI is a highly branched cationic dendritic polymer. Its main role in this study was to assist in the dispersion of multi-walled carbon nanotube (MWCNTs) and Fe-Cu bimetallic nanoparticles. HPEI was covalently attached to MWCNTs via an amide bond to form HPEI-MWCNTs nanocomposite. Bimetallic Fe-Cu nanoparticles were incorporated via polyol process to form HPEI/MWCNTs/Fe-Cu. The asymmetric membrane sheet of HPEI-MWCNTsFe/Cu-PES was prepared via phase inversion by the induced immersion precipitation technique and applied in the degradation of TCP. Fourier transform infrared spectroscopy (FTIR) analysis confirmed the formation of a new bond at 1680 cm^{-1} attributed to an amide bond, which confirmed the success of HPEI-MWCNTs synthesis. Functionalized MWCNTs with thionyl chloride shown a diameter of 10.02 nm, were incorporated in the HPEI to provide mechanical robustness to nanocomposite polymer. The incorporation of bimetallic nanoparticles was confirmed by Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX) and X-ray diffraction spectroscopy (XRD). The degradation efficiency of TCP was found to be 99.4% in water. The liquid chromatography-mass spectroscopy (LC-MS) was used to determine the degradation efficiency of TCP and a 99.4% removal was obtained.

Keywords: Trchlorophenol (TCP), Hyperbranched polyethyleneimine (HPEI), Multiwalled carbon nanotubes (MWCNTs), Fe-Cu bimetallic nanoparticles

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Intrinsic Features of ZSM-22 Zeolite/Polyether-Sulfone Composite as Support Membrane

Nyiko M. CHAUKE[1*], James RAMONTJA[1] and Richard M. MOUTLOALI[1,2]

[1]Department of Applied Chemistry, Faculty of Science, University of Johannesburg, Doornfontein 2028, Johannesburg, South Africa.
[2]DST/Mintek Nanotechnology Innovation Centre, Research Node, University of Johannesburg, P. O. Box 17011, Doornfontein 2028, Johannesburg, South Africa.

*Corresponding author :jamesr@uj.ac.za

Abstract

Synthesizing new polymer materials is no longer a necessity due to the available opportunity to modify already existing polymers. The current research on polymeric membrane material and membrane technology focuses on membranes with intrinsic composite features [1, 2]. This new family of composite materials is based on polymer mixed matrixes, which are developed for different applications such as polymeric filtration. Zeolites have been used as additives in polymeric modification such as poly (imide siloxane), polypropylene, etc. [2-4]. Composite membranes are more effective and superior as well as prominent in producing membranes with enhanced diffusion and antifouling behaviour of different molecules [2, 3]. This study therefore, explores the synthesis, preparation and the applications of these combined zeolitic/polyethersulfone (PES) materials.

The influence of the ZSM-22 on the interactions between PES and ZSM-22 was determined by the activities of untreated and treated ZSM-22. The ZSM-22 zeolite was synthesised via hydrothermal approach to different Si:Al ratios. Depending on the Si:Al ratios and different silica sources, ZSM-22 zeolite with different crystal sizes, morphologies and crystallinities were produced. Characterisation of these materials with XRD, BET, FTIRT and SEM/EDS (Figure 1.) showed improved features of the ZSM-22/PES as compared to pristine materials. Therefore, the development of new composite support membranes and the effect of using different silica sources in the synthesis of ZSM-22 was achieved.

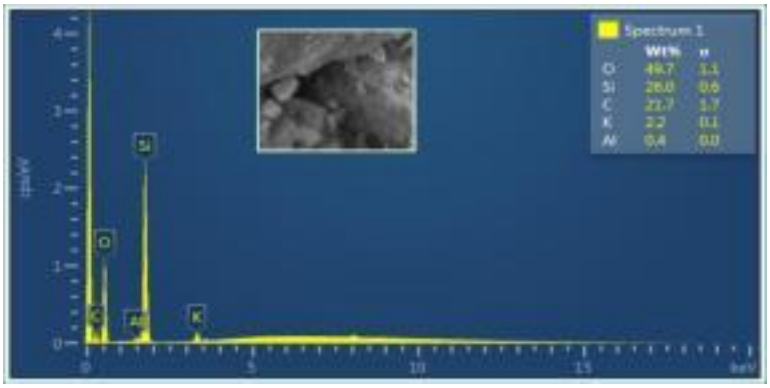


Figure 1. EDS spectra of a ZSM-22 material synthesised *via* hydrothermal approach at 160 ^{o}C for 72 hrs.

Keywords: ZSM-22 zeolite/polyether-sulfone; composite materials.

Reference

[1] Dai Z., Ansaloni L. and Deng L., Green Energy and Environment, 1, (2016), 102-128.
[2] Jamali S.H., Vlugt T.J.H., and Lin L., Journal of Physical Chemistry, 21, (2017), 11273-11280.
[3] Fard A.K., McKay G., Buekenhoudt A., Sulaiti H.A., Motmans F., Khraisheh M. and Atieh M., Materials, 11, (2018), 1-47.
[4] Basalp D. and Tihminliogu F., Journal of Thermal Analysis and Calorimetry, 94 (2008), 757-765.

2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Ultrafiltration Membrane Composites Tailored by ZIF@GO with Highly Improved Organic Dye Rejection Performances

Thollwana Andretta MAKHETHA[1,2] and Richard M. MOUTLOALI[1,2*]

[1]Department of Applied Chemistry, Faculty of Science, University of Johannesburg, Doornfontein 2028, Johannesburg, South Africa.
[2]DST/Mintek Nanotechnology Innovation Centre, Research Node, University of Johannesburg, P. O. Box 17011, Doornfontein 2028, Johannesburg, South Africa.

*Corresponding author : rmoutloali@uj.ac.za

Abstract

Membrane-based separation technology has attracted great interest in many separation fields due to its advantages of easy-operation, energy-efficiency, easy scale-up, and environmental friendliness Zang et al. (2016). The sufficiency of GO substrates as the main components of the composites to grow nanoscale ZIFs and increase dispersive forces was investigated as a way to control the growth of the ZIFs. These composites were used to produce a series of ZIF-8@GO polyethersulfone (PES) composite membranes through a phase inversion method. GO, ZIF-8, ZIF-8@GO and PES membranes incorporated with ZIFs@GO composites were successfully prepared and fully characterized. An increase in hydrophilicity of the composite membranes was observed, which played a significant role in the permeation flux and fouling of the membrane. In addition, pure water flux paths through the matrix were created through the porous ZIFs leading to decreased tortuosity and hence increased permeate flux in ZIF-8@GO/PES composite membranes compared with pure PES membrane. The nature of the incorporated ZIFs played a positive role in the increased selective rejection ratio observed for organic dyes. Finally, the enhancement in the fouling profile of the membrane composites due to the incorporation of the filler materials was demonstrated. The results showing improvements in membrane performance, i.e. improved water flux, retention ratio, and antifouling performance, demonstrated that using ZIF@GO composite materials as fillers to prepare composite ultrafiltration membranes is a highly efficient and promising way to develop advanced membranes for removal of organic dyes in wastewater.

Keywords: Zeolitic imidazolate framework-8 (ZIF-8); graphene oxide (GO); composite membranes; organic dyes; rejection

References

[1] Zhang R., Liu Y., He M., Su Y., Zhao, X., Elimelech, M. and Jiang, Z., Antifouling membranes for sustainable water purification: strategies and mechanisms, Chemical Society Reviews 45 (2016) 5888-5924.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Cadmium (II) Removal from Water using Carbon Nanodots Embedded on Polyethersulfone Membrane and Detection Using Anodic Stripping Voltammetry

Smith SAM, Soraya P. MALINGA* and N Nonhlangabezo MABUBA*

Department of Applied Chemistry, Faculty of Science, University of Johannesburg, Doornfontein 2028, Johannesburg, South Africa.

*Corresponding author :- nmabuba@uj.ac.za

Abstract

Water pollution by heavy metals is a serious problem in South Africa due to mining activities, electroplating industries, weathering of minerals and soils, coal combustion etc. The Umtata River is one of the water systems that has a problem with cadmium contamination and this is a problem because this river provides water and a conduit for effluent disposal in a densely populated area of the Eastern Cape. Water from the Umtata River is used for various purposes by a large population of the Transkei, most of which is rural - domestic (cooking, drinking and washing), agricultural (that is, livestock watering, irrigation is rarely done in the catchment), and recreational purposes (swimming) [1][2]. Therefore, this study seeks to provide a facile and effective method to remove heavy metal such as cadmium (II) from synthetic solutions and industrial water effluents. This will be achieved by modifying polyethersulfone (PES) membranes with carbon nanodots (CNDs) to improve the hydrophilicity [3] and water permeability of the PES membrane and also to assist in adsorption of Cd (II).

The CNDs were embedded on the PES via phase invasion and the resulting membrane (PES/CNDs) was characterized by contact angle and Fourier-transform infrared spectroscopy (FTIR). FTIR data confirmed that the CNDs poses bonds such as O-H, C-O and C=O which have been proven to have potential in absorbing Cd (II) ions in polluted water [4]. The transmission electron microscopy (TEM) showed that the CNDs were evenly dispersed and the size decreased with further grinding to 10 nm. After modification of PES with CNDs the contact angle was reduced from 73.043 (pure PES) to 64.404 (PES/CNDs membrane) indicating the increase in hydrophilicity of the PES/CNDs. Further studies on membrane characterisation such as AFM, SEM, flux and XRD are currently in progress and the adsorption of cadmium (II) from synthetic solutions and industrial water effluents by the PES-CNDs membrane will be monitored/determined by using Anodic stripping voltammetry.

Keywords: Cadmium (II), Polyethersulfone, Carbon nanodots, adsorption, Anodic stripping voltammetry.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Grafting of Polysulfobetaine Methacrylate (PSBMA) on Graphene Oxide Surface for Modification of Cellulose Acetate Membranes for Water Treatment

Sinethemba XABELA* and Richard. M MOUTLOALI

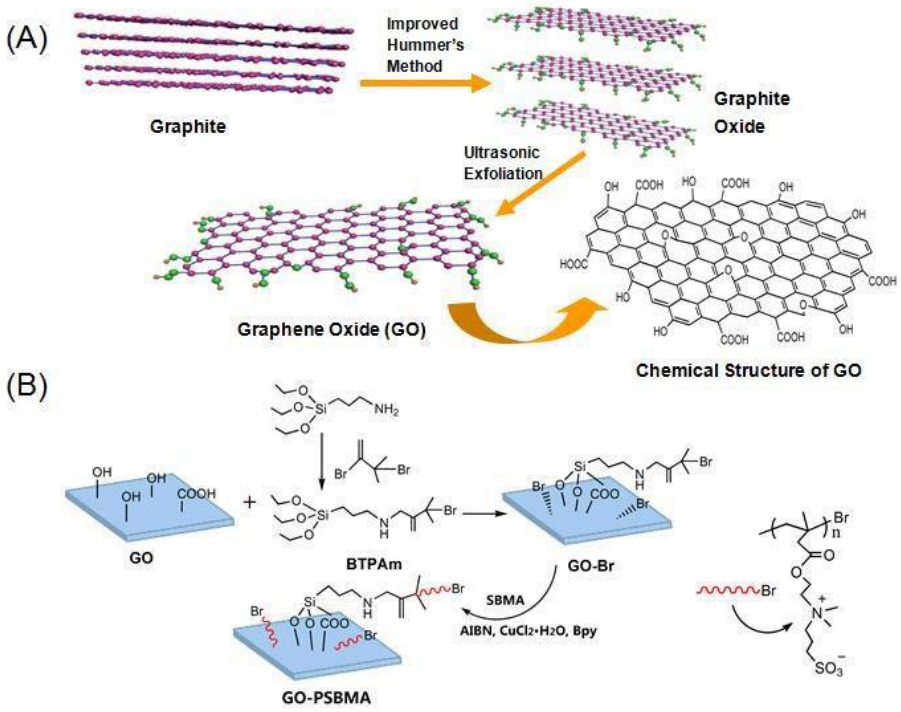
Department of Applied Chemistry, University of Johannesburg, Doornfontein 2028, Johannesburg, South Africa.

*Corresponding author: sinethembaxabela@gmail.com

Abstract

In this study, surface zwitterionization of graphene oxide (GO) was conducted by grafting polysulfobetaine methacrylate (PSBMA) onto the GO surface using reverse atom transfer radical polymerization (RATRP) technique to yield GO-PSBMA nanocomposite. GO-PSBMA nanocomposite was characterized using XRD, FTIR, SEM and TEM techniques to confirm that the zwitterion was successfully imbedded in the GO. Subsequently, nanocomposite membranes were prepared by embedding different amounts of GO-PSBM into cellulose acetate (CA) casting solution via phase inversion method. The effect of GO-PSBMA on the morphology and surface property of the CA membranes was examined using SEM and AFM. The contact angle, pure water flux, salt rejection and antifouling properties of the modified membranes were assessed to investigate the performance of the membranes.

The membranes produced showed a significant enhanced water flux and improved antifouling property upon addition of GO-PSBMA compared to the unmodified membranes reported in literature. Additionally, the resultant hybrid membrane exhibited an advanced mechanical strength due to the presence of rigid GO filler. A notable increase in rejection with increased GO-PSBMA content from the hybrid membranes was also observed.



Junyong Zhu et al (2016)

Keywords: Grafting of polysulfobetaine methacrylate; cellulose acetate membranes.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Graphene Oxide (GO) and Metal Organic Frameworks (MOFs) Hybrids; Synthesis, Characterization and Assessment in Membrane Application

Elizabeth G. Masibi[1,2] and Richard M. Moutloali[1,2]

[1]Department of Applied Chemistry, University of Johannesburg, Doornfontein Campus, P.O. Box 17011, Doornfontein 2028, Johannesburg, South Africa;
[2]DST/Mintek Nanotechnology Innovation Centre-UJ Water Research Node, University of Johannesburg, P.O. Box 17011, Doornfontein, 2028, South Africa.

*Corresponding author: gaobodiwemasibi9@gmail.com

Abstract

The presence of membrane technologies in the chemical and engineering industries has grown extensively and they are nowadays utilized in a wide range of applications. This study will prioritize the preparation of Polyamide Thin Film Composite Reverse Osmosis (PA-TFC RO) membranes that consist of two layers: i) a top thin polyamide (PA) active layer with a thickness of ~200 nm which plays a major role in controlling the membrane permselective properties; ii) a bottom polysulfone (PSF) sub layer, with a thickness of about 250 µm, serving as substrate for fabricating the polyamide layer which is formed by interfacial polymerization (IP). This PA-TFC RO membranes (polyamide Thin Film Composite RO membrane) will be adjusted by modifying the top active layer. Zeolitic imidazolate framework-8 /graphene oxide (ZIF-8/GO) composite will be embedded into the top thin layer of PA-TFC RO membranes. This step is accomplished by dispersing the zeolitic additive in the aqueous phase of m-phenylene diamine (MPD) which participates in the IP reaction.

Such modification of the PA layer is expected to improve its hydrophilicity, surface roughness, thickness, antifouling characteristics and surface charge properties. The composite membrane will be characterized by i) Fourier Transform Infrared (FTIR) spectroscopy to verify the functional groups of graphene oxide and PA layer, ii) X-ray diffraction (XRD) to check peak intensity of ZIF-8, GO and basal structure, iii) Scanning Electron Microscopy (SEM) to check its morphology and cross sectional areas, iv) Contact Angle analysis will be used for evaluating its surface hydrophilicity, and v) Atomic Force Microscopy (AFM) for studying its surface morphology. Membrane filtration performance will be assessed by determining the flux, recovery rate, and solute rejection. These measurements will be carried out in a dead-end configuration or by using a cross-flow filtration device.

Keywords: Graphene oxide, metal organic frameworks.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Poly(M-Phenylene Isopthalamide) Ultrafiltration Membrane Incorporating Graphene Oxide-Metal Organic Framework with Improved Water Flux and Antifouling Properties

Azile NQOMBOLO, Thollwana A. MAKHETHA, Richard M. MOUTLOALI* and Philiswa N. NOMNGONGO

DST/Mintek Nanotechnology Innovation Centre-UJ Water Node, Department of Applied Chemistry, University of Johannesburg, Doornfontein Campus, P.O. Box 17011, Johannesburg, 2028, South Africa

*Corresponding author : rmoutloali@uj.ac.za

Abstract

Polymer membranes incorporating graphene oxide (GO) based composites have been shown to exhibit high efficiencies in liquid and gas separation processes, [1]. The improved performance is generally attributed to the presence of functional groups on the GO sheets such as carboxyl, epoxides and hydroxyl groups. On the other hand, metal organic frameworks (MOFs) were previously used to increase solute selectivity in ultrafiltration (UF) membranes, specifically dye separation processes [2]. In the current work, GO and MOF composites were prepared in order to assess the synergistic influence of the two components on the efficiencies and properties of the resulted polymer membranes. The presentation will discuss the results obtained when the GO@MOF composites were incorporated into poly (m- phenylene isophthalamide) (PMIA) membranes with respect to permeate flux, dye separation/degradation and fouling profile. The synthesised GO@MOF PMIA membranes were characterized by numerous spectroscopic techniques including Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), Scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS) among others. Water contact angle (CA) of the membranes showed that hydrophilicity increased increase in GO@MOF composite. In addition, flux and fouling resistance increased as the GO@MOF composite was increased. The results indicate the inclusion of the GO@MOF improved the efficiency of the resultant membranes which might lead to better performing membranes in the future.

Keywords: pH responsive; adsorption; polyamide; ion exchange capacity.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Synthesis and Application of Carbon Nanotube Infused Polymer Membrane (CNT/PSF/PVA) in the Treatment of Phenol-Containing Refinery Wastewater

Olawumi SADARE, Sunny IYUKE and Michael DARAMOLA*

School of Chemical and Metallurgical Engineering, Faculty of Engineering and the Built Environment, University of the Witwatersrand, Wits2050, Johannesburg, South Africa.

*Corresponding author : Michael.Daramola@wits.ac.za

Abstract

In this study, carbon nanotube infused polysulfone (PSF) membrane (CNT/PSF/PVA) was synthesized via phase inversion method and was applied to the treatment of refinery wastewater with a focus on phenol removal using a model wastewater. The membrane made of polysulfone as backbone was reinforced with functionalized carbon nanotubes (fCNTs) and polyvinyl alcohol (PVA) to enhance its mechanical strength and anti-fouling property respectively. The coating of the membrane with PVA helps to enhance the anti-fouling property of the membrane. Initially, an investigation was carried out to know the original flux of the synthesized membranes using pure water. Then the performance of the membranes was evaluated for the treatment of refinery wastewater using a dead-end filtration cell operated at different feed pressures of (2, 3, 5 and 8 bar). The uncoated membrane with 5% fCNTs had the highest permeate flux of 70.21 Lm^2h^{-1}, followed by the PVA coated membrane with 5% fCNTs at 59.63Lm2h-1.

The results showed that the uncoated PSF membrane with 5% CNTs displayed the highest permeability per unit thickness of 28.24 $Lm\text{-}2h^{-1}bar^{-1}$ at transmembrane pressure (TMP) of 1 bar. Pure PSF with 0% fCNTs showed the lowest permeability of 0.68 Lm-2h-1bar-1 at TMP of 1 bar. Analysis of the wastewater constituents using a pre-calibrated Gas Chromatography-Mass Spectrometry (GC-MS) reveal that the membrane reinforced with fCNTs (1% CNT loading) and coated with PVA showed the highest phenol rejection of 65%. It is noteworthy to mention that all the membranes showed 100% of selectivity for the hydrocarbons (petrol and kerosene) contained in the wastewater. The results of this study could be a platform to develop cost-effective membrane materials for refinery wastewater treatment applicable at low pressure for energy efficiency.

Keywords: Carbon nanotubes; Refinery wastewater; Phenol; Membrane; Polymer.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Iron Nanoparticles Infused Polyethersulphone (FeNPs/PES) Membrane for Treating BTEX Contaminated Water

Chinwe F. UNUIGBE[1], O. Moshood. FAYEMIWO[2], Maxwell C. OZONOH[1] and Michael O. DARAMOLA1'*

[1]School of Chemical and Metallurgical Engineering, Faulty of Engineering and the Built, University of the Witwatersrand, Wits 2050, Johannesburg, South Africa.
[2]Department of Chemical Engineering, Faculty and the Built Environment, University of Johannesburg, Doornfontein 2028, Johannesburg, South Africa

*Corresponding author : Michael.Daramola@wits.ac.za

Abstract

The advancement of nanotechnology in recent years has brought to the development of novel nanomaterials that are effective for treating and remediation of wastewater. This study evaluated the effectiveness of iron nanoparticles incorporated within the mixed matrix membrane for removal of volatile organic compounds. Iron nanoparticles were synthesized by adding iron salt mixture ammonium ferric (NH4)2Fe (SO4)2.6H2O and ferrous sulphate NH4Fe (SO4)2.12H2O with NaOH to the pomegranate leave. The surface morphology and crystallinity of the synthesized iron nanoparticles was evaluated using scanning electron microscopy (SEM) and X-ray diffractometer (XRD) before incorporation within the membrane matrix for organic compounds removal. After fabrication, the membrane was also examined using SEM, Fourier transform infrared (FTIR) for the surface chemistry,

Thermogravimetric analysis (TGA) for thermal stability and texture analyzer for the mechanical strength of the membranes. The membrane was evaluated for BTEX removal from BTEX-contaminated water having BTEX concentration of 191.29 g/l at 25oC and at feed pressure of 1.8 bar in a dead-end filtration cell. The results showed that fabricated membrane with 5% iron nanoparticles displayed BTEX removal of 22% as compared to an identical unloaded PES membrane which displayed BTEX removal of 16%. The membrane flux (permeate flux) during the separation for the loaded and unloaded membrane were 30 L.m-2h-1 and19.5 L.m-2h-1, respectively. In addition, the loaded membrane showed enhanced mechanical strength and thermal stability when compared to an identical unloaded PES membrane.

Keywords: Iron nanoparticles, Nanocomposite membrane, BTEX and membrane.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Nanocomposite Sodalite/Ceramic Membrane for Pre-Combustion CO2 Capture from Integrated Gasification Combined Cycle (IGCC)

Olawale OLOYE, Orevaoghene ETERIGHO-IKELEGBE and Michael DARAMOLA*

School of Chemical and Metallurgical Engineering, Faculty of Engineering and the Built Environment, University of the Witwatersrand, Wits 2050, Johannesburg, South Africa

*Corresponding author: michael.daramola@wits.ac.za

Abstract

Greenhouse gas (GHGs), secondary products from the combustion of fossil fuel, has been instrumental to global warming which causes climate changes. Carbon capture, storage and utilization (CCSU) is one of the promising ways to reduce CO2 emission and one of these methods is via pre-combustion CO2 capture. Membrane technology has been identified as one of the promising technologies for pre-combustion CO2 capture, but availability of membranes with high membrane integrity (high CO2 flux, high selectivity, good chemical and thermal stability) is a major challenge in advancing this technology. Against this background, synthesis and gas permeation of a two-layer nanocomposite sodalite/ceramic membrane prepared via a pore- plugging hydrothermal synthesis technique (PPH) are hereby reported. Morphology, purity of the sodalite particles and quality of the as-prepared membrane were checked using scanning electron microscopy (SEM), X-ray Diffraction (XRD), and Basic Desorption Quality Test (BDQT).

Single gas permeation experiments were carried out on the membrane at 298 K via Wicke-Kallenbach method (W-K) using pure component of CO2 and H2 to gain insight into the separation performance of the membrane. The single gas permeation results reveal H2 permeance and CO2 permeance of 7.37 x 10-8 mol. $s^{-1}.m^{-2}.Pa^{-1}$ and 1.14 x 10-8 mol. $s^{-1}.m^{-2}.Pa^{-1}$, respectively, with ideal selectivity of 6.46. In addition, H2 permeation through the membrane was adequately described with the well-known Maxwell-Stefan model.

Keywords: Carbon Capture and Storage, Gas permeation, Membrane, Nanocomposite, Sodalite.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Thermally and Microwave-Assisted Synthesis of Silver Nanoparticles for Growth Inhibition of the Thermophilic Bacteria on PVDF Nanofiber Membranes

Lebea.N. NTHUNYA[12], Sebabatso MAIFADI[12], Arne R. VERLIEFDE[12], Tobias G. BARNARD[12] and Sabelo D. MHLANGA[1]*

[1]Nanotechnology and Water Sustainability Research Unit, College of Science, Engineering and Technology, University of South Africa, Florida, 1709, Johannesburg, South Africa.
[2]Particle and Interfacial Technology Group, Department of Green Chemistry and Technology, Ghent, University, Coupure Links 653, 9000 Ghent, Belgium.

*Corresponding author : mhlansd@unisa.ac.za

Abstract

The antibacterial silver (Ag) nanoparticles (NPs) were synthesized on a microwave and thermal experimental set-up using the Granny Smith apple extracts as the reducing agents. The formation of the Ag NPs was confirmed by UV- Vis, XRD and EDS while their size distribution was determined using the TEM. The Ag NPs were uniformly distributed with sizes 28.24 ± 1.15 nm and 22.05 ± 1.05 nm for the thermally and microwave-assisted reduction methods. The Antibacterial Ag NPs were embedded on the PVDF nanofiber membranes and tested for their efficacy against thermophilic gram (+) Geobacillusstearotherophilis and gram (-) Pseudo aeruginosa. This was done to determine their potential in preventing the bacterial growth on the polyvinylidene fluoride nanofiber membranes. The antibacterial nanofibers successfully inhibited the growth of these bacteria.

Therefore, these nanofiber membranes could be used in water purification systems in membrane distillation membranes that are subjected to thermophilic bacteria such as Geobacillusstearotherophilis without compromised water recovery.
Keywords: Silver nanoparticles, antibacterial activity, Granny Smith apple extracts, polyvinylidene fluoride nanofiber membranes, thermally and microwave-assisted reduction

Keywords: Silver nanoparticles, antibacterial activity, Granny Smith apple extracts,polyvinylidene fluoride nanofiber membranes.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Membrane Bioreactors: in Microalgae Harvesting, in-Situ Fouling Degradation and Bioethanol Production

Abaynesh Yihdego GEBREYOHANNES*, Lisendra MARBELIA and Ivo F.J VANKELECOM

Centre for Surface Chemistry and Catalysis, Faculty of Bioscience Engineering, KU Leuven, Belgium.

*Corresponding author : abayneshyihdego.gebreyohannes@kuleuven.be

Abstract

We recently developed a new concept for bio-functionalization of magnetic nanoparticles (MNPs), i.e. by immobilizing enzymes on them in combination with a magneto-responsive hybrid membrane. This system is exploited to develop a reversible way of enzyme immobilization to form so called magneto-responsive biocatalytic membrane reactors (BMRSP). This reversible magnetic force facilitates dispersion of the enzymatically active magnetic nanoparticles (bio-nanocomposites) over the membrane surface, allows retention of the enzyme by a large pore, i.e. high-flux membrane, and renders enzyme recovery after use very easy. The feasibility and versatility of the concept is demonstrated for membrane fouling prevention through in-situ enzymatic membrane cleaning, which reduced filtration resistance by more than 75% [2,3]. Not only in-situ fouling degradation but also the BMRSP was used for simultaneous hydrolysis of lignocellulose in the potential lignocellulose-to-bioethanol conversion. Overall, the novel system provides platform for continuous reactor operation and opens a new horizon for applications benefiting from localized (bio)catalysis to enhance performance in industrial production, processing, environmental remediation and bio-energy generation.

For microalgae, membranes have been explored to be applied in different stages of their cultivation and processing [4]. Membrane application in photo-bioreactors helped to limit the microalgae wash-out, so that higher biomass concentrations and volumetric productivities can be achieved [5]. Membrane fouling during microalgae filtration is influenced by the operation mode, the properties of the membranes (surface charge and porosity) and of the microalgal broth properties. It was also observed that fouling in microalgae filtration is dominated by the formation of a cake layer by the cells, which is mainly influenced by cell shape and size, size distribution, and cell-wall rigidity [6].

Keywords: Membrane bioreactors; magnetic nanoparticles.

References

[1] Gebreyohannes, A.Y., Bilad, M.R., Verbiest, T., Courtin, C.M., Dornez, E., Giorno, L., Curcio, E., Vankelecom, I.F.J., 2015. Nanoscale tuning of enzyme localization for enhanced reactor performance in a novel magnetic-responsive biocatalytic membrane reactor. J. Memb. Sci. 487, 209–220.

[2] Gebreyohannes A.Y., L. Giorno, I.F.J. Vankelecom, T. Verbiest, P. Aimar, 2017. Effect of operational parameters on the performance of a magnetic responsive biocatalytic membrane reactor, Chemical Engineering Journal 308, 853-862.

[3] Gebreyohannes A.Y., R. Mazzei, T. Poerio, P. Aimar, I.F.J. Vankelecom, L. Giorno, 2016. Pectinases immobilization on magnetic nanoparticles and their anti-fouling performance in a biocatalytic membrane reactor, RSC Advances 6, 98737-98747.

[4] Bilad, M.R., Arafat, H.A., Vankelecom, I.F.J., 2014. Membrane technology in microalgae cultivation and harvesting: A review. Biotechnol. Adv. 32(7), 1283-1300.

[5] Marbelia, L., Bilad, M.R., Passaris, I., Discart, V., Vandamme, D., Beuckels, A., Muylaert, K., Vankelecom, I.F.J., 2014. Membrane photobioreactors for integrated microalgae cultivation and nutrient remediation of membrane bioreactors effluent. Bioresour. Technol. 163, 228–35.

[6] Marbelia, L., Mulier, M., Vandamme, D., Muylaert, K., Szymczyk, A., Vankelecom, I.F.J., 2016. Polyacrylonitrile membranes for microalgae filtration: Influence of porosity, surface charge and microalgae species on membrane fouling. Algal Res. 19, 128–137.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Hydrophobically Modified PVDF Nanocomposite Membranes for Seawater Desalination via Direct Contact Membrane Distillation

Rajesha KUMAR*, Mansour AHMED, Garudachari B, Abbas AL-MESRI and Thomas JIBU

Water Research Center, Kuwait Institute for Scientific Research, Kuwait.

*Corresponding author: ralambi@kisr.edu.kw

Abstract

Membranes prepared for membrane distillation (MD) application by blending of hydrophobic nanoparticles has advantages over coating technique. The blending technique with highly dispersible nanoparticles demonstrates the incorporation of nanoparticles into the interior of membrane matrix to alter the membrane morphological features in favor of MD application. In the current work, the hydrophobically coated silica nanoparticles (HSN) were synthesized using a unique procedure to isolate the coated particles using a derivative of triethoxysilane. The obtained fluoro silica nanoparticles (FSN) demonstrated a high dispersion of up to 4.0 wt.% in 15 wt.% of polyvinylidene difluoride (PVDF) in N, N-dimethylformamide. The improved porosity with the increased contact angle was observed up to 4.0 wt.% of FSN loading. The membranes were prepared by phase inversion technique with a casting thickness of 150 µm. For each loading of FSN the membranes witnessed improved porosity and increased hydrophobicity compared to nascent PVDF membrane. The membrane morphological, contact angle, roughness and liquid entry pressure studies demonstrated suitable modification of membranes in favor of membrane distillation (MD) application. The MD performance was tested in direct contact membrane distillation (DCMD) configuration for the hot feed of 35 g/L aqueous sodium chloride solution, and cold deionized water as permeate.

Though, the loading of FSN above 4.0 wt% produced more hydrophobic membrane surfaces, the loading of 3.0 wt% of FSN was settled as optimized composition to attain high performance during MD. The maximum transmembrane permeate flux of 42.32 kg/m2h with total salt rejection was obtained for 3.0 wt% loading of FSN when feed solution (FS) temperature was 80 ºC and the cold distillate water at 20.0 ºC.

Keywords: Nanocomposite. Nanomaterial ; Membrane fabrication ; Membrane distillation ; Morphology.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

A Pilot Scale Study of Forward Osmosis Desalination System for Arabian Gulf Seawater Desalination

Mansour AHMED*, Rajesha KUMAR, Bhadrachari GARUDACHARI, Safiyah AL-MUQAHWI and Jibu THOMAS

Water Research Center, Kuwait Institute for Scientific Research, Kuwait.

*Corresponding author : mahmed@kisr.edu.kw

Abstract

A pilot scale forward osmosis (FO) desalination system using thermo responsive polymer as a draw solution is developed and investigated for desalinating Arabian Gulf seawater in the State of Kuwait. The aim of this paper was to share the experimental results and information obtained by assessing the efficiency of the innovative hollow fiber FO membrane configuration (on a commercial-scale) for seawater desalination utilizing a pilot plant test unit with a capacity of 10 cubic meter per day.

Furthermore, this paper will assess the efficiency of recently developed polymer solution as draw solution (DS). The pilot plant consisted of three stages: (1) pretreatment system using cartridge filters and anti-scalant dosing, (2) water permeation through the FO membrane and dilution of the polymer draw solution, (3) electrically heated coalescer system for polymer draw solution recovery, and (4) post treatment system consisting of nanofiltration membranes for removing any traces of polymer from the final product water. The membrane used was a commercially available hollow-fibre FO membrane made of cellulose triacetate and with 230 µm bore diameter. The polymer draw solution used was ethylene oxide-propylene oxide copolymer and the coalescer temperature was set at 85°C. The feed used was Arabian Gulf seawater obtained from beach-well of Doha desalination research plant, KISR, Kuwait. The feed solution was passed through the bore side and polymer draw solution was passed through the shell side of the membrane. The diluted draw solution due to the water permeated through the membrane due to osmotic pressure difference was sent to the coalescer where the diluted polymer draw solution was separated into supernatant water and re-concentrated draw solution. The concentrated polymer draw solution was re-circulated into the membrane to extract more pure water across the membrane. During the long-term operation, the experimental results showed that a single element of FO membrane was able to reduce the total dissolved solids from 42,000 mg/L to 180 mg/L with water recovery of 30%. The results of this study demonstrated the potential of using FO-thermal process for seawater desalination and will lead the scientific community to expediting the technical and economical evaluation of FO desalination systems.

Keywords: Forward osmosis, Polymer draw solution, Nanofiltration, Arabian gulf seawater desalination.

2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Fabrication of Nanofibrous Membranes for Selective Removal of Organic and Inorganic Pollutant

Thandanani NDLOVU*, Soraya MALINGA and Nonjabulo GULE

University of Johannesburg, Doornfontein 2028, Johannesburg, South Africa.

*Corresponding author: njabu@sun.ac.za

Abstract

Triclosan is an emerging organic pollutant. Ingestion of this chemical can disrupt hormonal activities. It has been detected in South African wastewater treatment plants [2]. Aluminium, on the other hand has been detected in South African water systems. Ingestion of aluminum can result in Alzheimer's disease [3]. These water pollution challenges have resulted in the development of more effective water purification technologies. Membranes have been found to remove a variety of contaminants in water and wastewater.

In this study, nanofibrous membranes will be prepared by electrospinning a polymeric solution of HPEI and PES dissolved in NMP solvent. Prepared nanofibrous will then be modified by functionalizing them with cysteamine. The fabricated membranes will be chemically characterized using nuclear magnetic resonance (1H NMR and 13C NMR) and Fourier transform infrared spectroscopy (FTIR). Surface morphology will be studied via atomic force microscopy (AFM), scanning electron microscopy–electron dispersive X-ray analysis (SEM- EDX), contact angle analysis. The efficacy of the synthesized membranes to remove the pollutants of interest will be evaluated using liquid chromatography- mass spectrometry (LC-MS) and inductively coupled plasma (ICP-OES).

Furthermore, thermal studies will be carried out using thermal gravimetric analysis (DSC) as well as differential scanning calorimetry (DSC). It is expected that fabricated nanofibrous membrane will remove triclosan and aluminum, have anti- fouling properties, a high surface area and high interconnection of pores thus increasing the adsorption capacity.

Keywords: triclosan, aluminium, HPEI, cysteamine, nanofibrous membranes

References

[1] Okonkwo JO, Maribe F (2005) Assessment of lead exposure in Thohoyandou, South Africa. Environmentalist 24:171–178.
[2] Edokpayi J, Odiyo J, Popoola O, Msagati T (2016) Assessment of Trace Metals Contamination of Surface Water and Sediment: A Case Study of Mvudi River, South Africa. Sustainability 8:135 .
[3] Bhardwaj N, Kundu SC (2010) Electrospinning: A fascinating fiber fabrication technique. Biotechnol Adv 28:325–347

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Effect of Blended P(MOA-DMPA) on PVDF Membranes

Nelisa N. GAXELA[1*], Richard MOUTLOALI[1,2] and Philiswa NOMNGONGO[1]

[1] Department of Applied Chemistry, Faculty of Science, University of Johannesburg, P.O. Box 17011, Doornfontein, 2028, Johannesburg, South Africa
[2] DST/Mintek Nanotechnology Innovation Centre – UJ Water Research Node, University of Johannesburg, P.O. Box 17011, Doornfontein, 2028, Johannesburg, South Africa.

*Corresponding author : nelisa.gaxela@gmail.com

Abstract

Wide spread usage and adoption of unmodified poly(vinylidene fluoride) (PVDF) membranes for water treatment is limited because their hydrophobic nature tends to promote surface fouling [1]. This shortcoming can be addressed by incorporating substances such as hydrophilic molecules, nanomaterials or polymers –e.g., graphene oxide, polyethylene glycol (PEG)- carbon nanotubes, zeolites or zwitterions into PVDF [2-5]. In the current approach, zwitterionic polymers have been added to PVDF membranes to render them hydrophilic. Zwitterionic polymers are hydrophilic polymers that simultaneously contain negatively charged and positively charged ions that are organized as pendent side-chain structures. This unique molecular structure imparts properties to modified PVDF filter by allowing them to bind water molecules better than PEG does, however, they do not possess antibacterial functionality. In this work, the zwitterion P(MOA-DMPA) was formed by mixing maleic anhydride-alt-1-octadecene (MOA) and 3-(dimethylamino)-1-propylamine (DMPA).

The zwitterion was then incorporated into PVDF to enhance its hydrophilicity and to optimize its rejection and antifouling properties. A series of PVDF and P(MOA-DMPA) blended PVDF membranes were synthesized by the phase inversion method. The weight percentage (wt %) of zwitterion was varied to study its effect on wettability, pore size, permeate flux, solute rejection and protein fouling of the membranes. Other characterization physicochemical techniques were introduced including contact angle measurements, scanning electron microscopy (SEM) and dead-end filtration. Based on contact angle data it was observed that a higher concentration of zwitterions enhances wettability.

This outcome was also consistent with the filtration results. Hence, it was concluded that PVDF membrane filtration performance could be sharply improved by the presence of zwitterions.

Keywords: Fouling; Hydrophilicity; Zwitterionic polymers.

References

[1] Venault A.et. al., 2016. Langmuir, 32, pp. 4113 – 4124.
[2] Zhao C. et. al., 2013. Journal of Environmental Chemical Engineering, 1, pp. 349-354.
[3] Zuo D.et. al., 2008. Chinese Journal of Polymer Science, 4, pp. 405-414.
[4] Chan W. et. al., 2013. ACS Nano, 7, pp. 5308-5319.
[5] Zhao X. and C. He. 2015. Appl. Mater. Interfaces, 7, pp. 17947-17953.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Improvement in Efficiency of Electroplating Wastewater Treatment through Development and modification of PAN Nanofiltration Membranes

Saeid HOSSEINI* and Azadeh Nazif Mohammad Amin Alaei SHAHMIRZADI

Department of Chemical Engineering, Tarbiat Modares University, Tehran, 14115-114, Iran.

*Corresponding author: saeid.hosseini@modares.ac.ir

Abstract

In the present study, response surface methodology (RSM) is employed according to central composite design (CCD) for modeling and optimization NF membranes fabricated for effective removal of Ni and Cr from electroplating wastewater streams. The effect of concentration of poly (acrylonitrile) (PAN: 21-25%) as the main membrane material as well as poly (ethylene glycol) (PEG: 0-1.5%) and titanium dioxide nanoparticles (TiO2: 0-1%) as the additives on membrane performance and morphology were investigated. The prepared membranes were characterized using SEM, contact angle, porosity, and pore size measurement. The optimized responses for Ni and Cr rejection and pure water flux were 87.093 (%), 83.271 (%) and 71.801 ($Lit.m^{-2}.h^{-1}$) respectively at optimum formulation PAN: 23.93%, PEG: 0.41% and TiO2: 0.82%.

The results of validation experiment confirm the predicted model at optimum point (Ni rejection: 88.093 %, Cr rejection: 80.271 % and pure water flux: 76.801 $Lit.m^{-2}.h^{-1}$). The results revealed decrease of PEG concentration led to increase of Ni and Cr rejection and decrease of pure water flux. Using of TiO2 nanoparticles led to increase of Ni and Cr rejection and pure water flux at different PAN concentration.

Keywords: Nanofiltration membrane, Nickel & Chromium, Electroplating wastewater, Statistical analysis, Optimization.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Investigations of the Effect of Incorporation of TiO2 on the Performance of PES Ultrafiltration Membranes for Oily Water Treatment

Sina Fakharian TORBATI, Mohammad Amin Alaei SHAHMIRZADI, Tohid TAVANGAr and Seyed Saeid HOSSEINI*

[1]Department of Chemical Engineering, Tarbiat Modares University Tehran, 14115-114, Iran
[2]Department of Chemical Engineering, Amirkabir University of Technology, Tehran, Iran.

*Corresponding author: saeid.hosseini@modares.ac.ir

Abstract

In the present work, development of neat and nanocomposite polyethersulfone membranes composed of TiO2 nanoparticles are presented using non- solvent phase inversion process with the objective of improving antifouling, hydrophilicity, and mechanical properties for real and synthetic produced water treatment. The prepared membranes were characterized using SEM, contact angle, porosity, and pore size measurement. The performance of prepared membranes was also characterized using flux measurement and oil rejection. The contact angle results confirmed the improved hydrophilicity nanocomposite membranes upon addition of TiO2 nanoparticles owing to the strong interaction between fillers and water molecules either during phase inversion and filtration tests.

The increased water flux of nanocomposite membranes in comparison to neat ones can be due to simultaneous coupling of improved surface hydrophilicity, higher porosity, and formation of macro-voids in the membrane structure. The membrane containing 7 wt. % of TiO2 nanoparticles was the best nanocomposite membrane because of its good oil rejection, water flux, antifouling properties, and mechanical stability. The pure water flux of this membrane was twice greater than neat one without sacrificing oil rejection. The hydrophilicity and anti-fouling resistance against oil nominates this nanocomposite membrane for real and synthetic produced water treatment with extended lifespan

Keywords: TiO2 nanoparticle; Nanocomposite membranes; Ultrafiltration; Oil/water separation.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Modification of Polyethersulfone-Based Membranes with Novel Nanocellulose Crystal Powder NCC for Purification of Potable Water

Mokgadi Fredericka BOPAPE[12], Sejabaledi Eudith MAEKO[1], Xolelwa YOYO[1], Bart van der BRUGGEN[2] and Maurice Stephen ONYANGO[1]

[1]Tshwane University of Technology
[2]Katholieke Universiteit Leuven, Belgium

*Corresponding author : bopapemf@tut.ac.za

Abstract

In the past few decades, water quality issues have become central to the global community. Impacts from anthropogenic activities have had a negative effect on freshwater systems, particularly in developing countries. Of greatest concern is the microbial communities specifically, Escherichia coli and Enterococci species. numerous researches have effectively applied polyethersulfone-based (PES) ultrafiltration (UF) membranes for purification of potable water, however, the inherent hydrophobicity of PES causes severe fouling and ultimately, shorten the membrane's lifespan. In this work, biodegradable nanocellulose crystal (NCC) powder was incorporated in the fabrication and modification of PES membranes due to its unique physico-chemical properties.

Ultrasonic treatment and blending were used to impregnate the PES membrane with NCC. Optimal PES-NEC ratios were determined by varying the mass of NCC. The incorporation of NCC powder within the polymer matrix resulted in the improvement of surface characteristics, robustness, functionality, morphology and antifouling properties of PES, which, when applied to synthetic and whole water samples, was superior to PES alone.

Keywords: PES; Nanocellulose crystal (NCC); Composite membrane.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

An Investigation on the Important Role of Porous Support Layer in the Performance of Gas Separation Membrane Modules

J. Aminian DEHKORDI and S. Saeid HOSSEINI*

Department of Chemical Engineering, Tarbiat Modares, University, Tehran, Iran

*Corresponding author: Saeid.Hosseini@Modares.ac.ir

Abstract

Asymmetric hollow fiber membrane modules are becoming widespread equipments especially for natural gas treatment processes due to their attractive advantages and cost benefits. The porous support layer existing in the structure of the asymmetric hollow fiber membranes could have impacts on the performance in the gas separation process. In this study, the influence of porous support layer on the separation efficiency of CO2/CH4 binary gas mixture is examined. jQÎs assumed that viscous flow is conquering in the porous support layer of the hollow fibers.

The governing equations were solved using finite element method. Results show that considering the resistance of porous support layer leads to better predictions in hollow fiber membrane modules. Detailed analysis and trends are studied and provided. The findings and proposed methodology provide helpful information in order to develop the performance of hollow fiber membrane permeators.

Keywords: hollow fiber membrane, gas separation, porous support layer, mathematical modeling, finite element method.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Nickel and Cobalt Modified Nanocomposite Polysulfone Membranes and their leaching studies

Enemuo Ngozi DORIS

School of Chemistry, University of the Witwatersrand, Johannesburg.

*Corresponding author: 828645@students.wits.ac.za

Abstract

In spite of the undeniable importance of water for survival, a considerable number of people has no access to clean usable water as a result of high contamination of the water sources available to them. This has prompted research geared towards combating the global water scarcity, and membrane technology is one of such active research areas. In this study, polysulfone membranes were improved by modifying them with nickel and cobalt nanoparticles. The nickel and cobalt nanoparticles were synthesized by the hydrazine reduction of nickel (II) chloride and cobalt acetate tetrahydrate respectively. The modified polysulfone membranes were prepared by incorporating 3%, 5%, and 10% of the nickel and cobalt nanoparticles separately in a solution of polysulfone and dimethylacetamide, and finally casting the membranes through phase inversion. The purity and size of the synthesized nickel and cobalt nanoparticles were determined using X-ray Diffraction and Transmission Electron Microscopy respectively. The sizes of the Ni and Co nanoparticles were respectively 58.3±3.1nm and 17.3±2.1nm. The morphology of the modified membranes was obtained by Scanning Electron Microscopy (SEM). The result of the SEM analysis showed enhanced porosity as incorporated nanoparticles increased. However, the 3% Ni-modified PSF membranes have larger pores than its counterparts. The thermal stability, surface roughness, and hydrophilicity of the modified polysulfone membranes were also assessed using Thermogravimetric Analysis, Atomic Force Microscopy, and Contact Angle measurements.

The filtration performances of the respective Ni and Co-modified polysulfone membranes were also analysed using a dead-end filtration cell. The leaching of the incorporated nanoparticles from the modified membranes was investigated in order to determine the stability of the nanoparticles in the membrane matrix. Inductively Coupled Plasma Mass Spectroscopy was used for leaching determination.

Keywords: Nanocomposite Polysulfone; Membrane

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Towards Pd@Fe@HPEI/PMAA-PES and Pd@FeAg@HPEI/PMAA-PES Nano-Multicalytic Conposite Membranes for the Rapid Degradation of methyl orange in Water

Lwazi NDLWANA*, Keneiloe SIKHWIVHILU and Catherine NGILA

University of Johannesburg, South Africa

*Corresponding author: ndlwana@gmail.com

Abstract

Herein, the development of a new membrane with enhanced multicatalytic degradation abilities for the removal of the methyl orange (MO) via Fenton-like reactions is reported. Casting solutions were prepared by blending an already grafted PES powder (PES-g-PMAA) with hyperbranched polyethyleneimine (HPEI)-stabilized Pd@Fe and Pd@FeAg nano-multicatalysts. Membranes were then fabricated via phase inversion, and characterized by ATR-FTIR, XPS, XRD, optical contact angle (OCA), SEM, and HRTEM. The membranes were subsequently characterized for their reactivity towards methyl orange dye (MO) degradation as a function of pH, temperature, nano-multicatalyst loading as well as H2O2 and dye concentration. UV-Vis indicated 86% MO degradation for the Pd@Fe nano-multicatalytic composite membrane during the first 15 min.

The Pd@FeAg-based membrane possessed enhanced reactivity, removing <99% of MO in the first 10 min. Mineralization of the dye was measured by TOC, was 99.6and 99.7% for the respective membranes. High performance liquid chromatography positive electrospray ionization mass spectrometry (HPLC-ESI+-MS/MS) allowed for the elucidation of the degradation by-products.

Keywords: catalytic membranes; nanocomposites; polyethersulfone membranes.

2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Optimization of Tylosin Removal by Photo-Fenton Process Followed by Filtration on Dehydrated Wheat Bran

Abdelaziz SARAI[12*], Nachida KASBADJI MERZOUK[1] and Djilali TASSALIT[1]

[1]Unité de Développement des Equipements Solaires, UDES/Centre de Développement des Energies Renouvelables, CDER, Bou Ismail, 42415, W. Tipaza, Algérie.
[2]Laboratoire de Biomatériaux et Phénomènes de Transports LBMPT, Université Yahia Fares, Médéa, Algeria.

*Corresponding author: Sarrai_aziz@hotmail.com

Abstract

This work examined the treatment of Tylosin (TYL) by the photo-Fenton process followed by a filtration step on Dehydrated Wheat Bran (DWB). The feasibility of applying the photo-Fenton process for treating TYL from an aqueous solution was assessed during the first stage of the study. The photo-Fenton reaction was found to yield an optimum output under these conditions: H2O2 concentration of 0.4 g/L, a pH value of 2.6 and Fe (II) concentration of 6 mg/L. TYL mineralization rate reached 97.1% under these optimized values. In the second stage of the study, TYL removal from an aqueous solution was tested using DWB as an adsorptive substance. DWB was characterized by FT-IR, Scanning Electron Microscopy (SEM), BET and Energy Dispersive X ray spectroscopy (EDX) techniques.

The conditions identified to produce the highest level of TYL adsorption were as follows: a pH value of 5.05, a DWB concentration of 0.86 g/L, and a TYL initial concentration of 14.27 mg/L, for a total time of 111 minutes. Under these optimized parameters, the removal efficiency of TYL approached 93.1 %. TYL treatment by photo-Fenton process and its subsequent filtration on DWB was tested during the last stage of the study. TYL mineralization induced by photo-Fenton process reached 97.1% (optimal conditions). DWB SEM images and EDX analyses performed after filtration confirmed the adsorption of Fe (III) inside DWB pores. The presence of iron compounds inside DWB pores validates its uses as an efficient adsorbent for extracting residual iron elements generated during the photo-Fenton process.

Keywords: Photo-Fenton; Filtration; Dehydrated Wheat Bran; Adsorption; Tylosin

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Evaluation of Ag-ZnO Modified Polyamide Thin Film Composites Membranes, for Removal of 2.4-Dichlorophenol from Water

Kate KOTLHAO, Fanyana MTUNZI, Vusumzi PAKADE, Joe MODISE, Richard M MOUTLOALI, Michael J KLINK* and Neelan LALOO

VAAL University of Technology South Africa

*Corresponding author : michaelk1@vut.ac.za

Abstract

Commercial thin film membranes such as nanofiltration (NF) and reverse osmosis (RO) exhibit high solute rejection but low water permeability. These membranes are susceptible to fouling which leads to high energy consumption, hence less cost-effective during water treatment. The purpose of this study was to develop semi-permeable thin film membranes with good rejection properties. The Ag-ZnO modified polyamide thin film (PA-TFC) membranes were prepared in-situ using interfacial polymerization method, from reaction between piperazine (aqueous phase) and Trimesoyl chloride (organic phase). The amount of Ag-ZnO particles in the aqueous phase varied from 0.0 wt % to 2.0 wt %. The prepared PA-TFC membranes were characterised by ATR-FTIR and contact angle. The performance of the prepared Ag-ZnO/PA-TFC membranes was tested for flux, flux recovery, rejection and fouling using 2,4-Dichloropheol as a pollutant. The FTIR results showed a carbonyl carbon stretching, C=O (amide I) that appeared at 1670 cm-1, indicating the formation of the polyamide. From contact angle results; increasing amount of Ag-ZnO on the membranes, resulted the decreasing of contact angle from 74o to 53o reaching an optimum at 1.0 wt %.

The addition of Ag-ZnO nanoparticles improved hydrophilic properties of the membranes. Pure water flux and flux recovery for the selected PA-TFC membranes improved compared to the neat PA – TFC membrane.

Keywords: Modified Polyether Sulfone; Interfacial polymerization; Antifouling.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

The effect of PEI Component in PES/GO/PEI/AgNPs Nanocomposite Membranes for the Treatment of Organic Dyes and Removal of Heavy Metals in Water

Christopher CHUKWUATI*, Richard MOUTLOALI

University of Johannesburg, South Africa

*Corresponding author: chukwuaticchristopher@gmail.com

Abstract

Polyethersulfone (PES) nanocomposite membranes incorporating graphene oxide (GO), branched polyethyleneimine (PEI), spherical silver nanoparticles (AgNPs) were prepared through phase inversion. The resultant membranes were assessed for the removal of inorganic dyes (methylene blue, amaranths), endocrine disrupters (Bisphenol A) and heavy metals (cadmium, lead and chromium). Under optimized phase inversion conditions, the only membrane component that was varied was PEI whilst other components (PES, GO and AgNPs) remained constant.

The fabricated membranes were characterized using various techniques; SEM for surface morphology, FTIR-ATR for presence of specific functional groups, hydrophilicity test was carried out using the static contact angle analysis. All filtration and rejection experiment for inorganic dyes, endocrine disrupters and heavy metals was carried out using the dead-end cells. The results obtained for the removal of organic dyes was quantified by the UV-Vis while heavy metals rejection was quantified by atomic absorption spectrometer (AAS).

The results obtained indicates that the positively charged PES membranes in all component additives exhibit excellent removal abilities of water contaminants in high percentage for cationic dye: methylene blue, anionic dye: amaranths, endocrine disrupters: Bisphenol A. The fabricated membranes also exhibit improve water flux and antifouling ability with high removal of lead and cadmium. The result indicates that introduction of PEI to the membrane matrix play an important role towards enhancing water flux and heavy metal rejection.

Keywords: Polyethersulfone nanocomposite membranes; Graphene oxide; Branched polyethyleneimine; Silver nanoparticles; Water treatment.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Effect of Chitosan on the Heavy Metal Removal Efficiency of Chitosan Modified Polyethersulfone (PES) Membrane During Treatment of Acid Mine Drainage

Mutshutshu J. MATHABA[12] and Mikhael O DARAMOLA[1]*

[1]School of Chemical and Metallurgical Engineering, Faculty of Engineering and the Built Environment, University of the Witwatersrand, Private Bag X3, Wits 2050, Johannesburg, South Africa.
[2]Department of Chemical Engineering, University of Johannesburg, P.O. Box 17011, Doornfontein 2028, Johannesburg, South Africa.

*Corresponding author : michael.daramola@wits.ac.za

Abstract

This study investigated the influence of chitosan on the performance of polyethersulfone membrane during metal removal from acid mine drainage. Effect of chitosan on membrane chemical structure, morphology, wettability and separation performance was evaluated using FTIR, SEM, Contact angle and dead-end filtration setup. The water flux of polyethersulphone membrane was enhanced from 94 to 152 L/m2h after chitosan modification.

The contact angle was reduced from 92 to 30.2 showing a membrane with improved hydrophilic property. Metal removal was improved from 89 to 92% for Mg2+ and 74 to 84% for Fe2+. Thus, this showed that chitosan had potential to modify polymeric membranes as a secondary polymer to improve the performance of polyethersulphone membranes.

Keywords: polyethersulphone, chitosan, modification, metal removal, acid mine drainage.

2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Spacers for Spiral Wound Modules

Glenn LIPSCOMB*

University of Toledo United States.

*Corresponding author: glenn.lipscomb@utoledo.edu

Abstract

Membranes in the form of sheets are used to form spiral wound membrane modules for a wide variety of separations ranging from seawater desalination to carbon dioxide capture from coal-fired power plants. Spacers are a critical component of these modules. Spacers create and maintain uniform flow channels for the feed and permeate flows. Spacers also are used to mix fluid within the channel to enhance mass transfer. Unfortunately, spacers increase pressure drop. This increase depends strongly on spacer geometry.

The literature that addresses spacer performance is reviewed. This body of work includes simulations using computational fluid dynamics (CFD) and experimental measurement of macroscopic performance as well as velocity field variations in the flow channel. The evaluation of design parameters for conventional ladder and diamond spacers as well as novel designs are emphasized.

The concept of an upper bound on performance is discussed. The upper bound is related to the trade-off between increased mass transfer performance and increased pressure drop. Increases in mass transfer coefficient typically are achieved by increasing shear rate adjacent to the membrane surface. Increased shear rates lead to increased pressure drops and an apparent upper bound

Keywords: Membrane spiral wound modules.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Benchmarking of Standard Nanofiltration Membranes for Gold Mining Water Treatment

Bakary DEMBELE[1], Adama TOLOFOUDYE[1*], Abdoulaye DOUCOURE[2] and Sylvie CONDOM[3]

[1]Université des Sciences Techniques et Technologiques de Bamako - Laboratoire de Génie Chimique - Mali
[2]Hollingsworth & Vose, High Efficiency Specialty Filtration division - Virginia – USA
[3]Ecole Nationale Supérieure de Chimie de Montpellier / Institut Européen des Membranes - Montpellier, France

*Corresponding author:

Abstract

The level of heavy metals in sludge and excavated residual rocks resulting from gold mining activities in Mali are significant enough to generate acid mine drainage. Furthermore, the combination of cyanide compounds with gold can boost environmental contamination by mainly affecting local groundwater sources. This research study was designed to leverage nanofiltration (NF) membrane technology in order to process Mali's gold mine water withdrawn from the ground or originating from sludge sources and treated liquid effluents.

The laboratory tests compared the performance of three standard NF polymeric membranes (NF2, NF20 and NF200 from Sepro, Inc -USA) in treating synthetic and raw water with varying ionic concentrations of sodium, potassium, lead, copper, iron and arsenic elements. An attempt to correlate the structural properties and filtration performance was made by relying on physical characterization of these nanofilters, analyzing their permselective properties and leveraging results from the literature. It was found that the rejection rate of NF2 and NF200 membranes for several ions was significant enough to produce treated water in compliance with Mali national water quality standards.

Keywords: Mining water, heavy metals, gold treatment, nanofiltration, ionic rejection.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Advanced Polymer-Based Separation Membranes with Tailored Barrier and Surface Properties

Mathias ULBRICHT*

Lehrstuhl für Technische Chemie II, Universität Duisburg-Essen, 45117 Essen; CENIDE – Center for Nanointegration Duisburg-Essen, 47057 Duisburg; ZWU – Center for Water and Environmental Sciences, Universität Duisburg-Essen, 45117 Essen, Germany.

*Corresponding author : mathias.ulbricht@uni-essen.de

Abstract

Membrane technologies have been established in a wide range of industrial applications; the most successful processes are nowadays realized in very large scale. Organic polymers are the dominating materials, intense research and development is focused on innovations leading to advanced membranes with higher separation performance adapted to the specific requirements of important applications [1]. In this presentation, we will illustrate recent examples from own research how to improve the efficiency of membrane-based separations by developing membranes with higher intrinsic permeability at high selectivity and high resistance to fouling, as well as additional functionalities based on stimuli-responsive properties.

The focus will be on the integration of functional inorganic nanoparticles, tailored block copolymers or grafted polymeric nanolayers in polymer-based membranes, as well as additional but rather easy-to implement processing steps during membrane manufacturing, leading to advanced or new membranes for ultrafiltration, nanofiltration or osmotic processes [2-6]. Such generic innovations in membrane materials will contribute to more sustainable membrane processes for applications in water purification, bioseparation or medical therapies.

Keywords: polymer, membrane treatment, surface properties

Reference

[1] Ulbricht M., State-of-the-art and perspectives of organic materials for membrane preparation in Comprehensive Membrane Science and Engineering, 2nd Edition (Eds.: E. Drioli, L. Giorno, E. Fontananova), Elsevier, ISBN: 9780444637758, 2017, Vol. 1, 85-119; see also: https://doi.org/10.1016/B978-0-12-409547-2.12252-8

[2] Quilitzsch M., R. Osmond, M. Krug, M. Heijnen, M. Ulbricht, Macro-initiator mediated surface selective functionalization of ultrafiltration membranes with anti-fouling hydrogel layers applicable to ready-to-use capillary membrane modules, J. Membr. Sci., 2016, 518, 328-337.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

New Directions in Mixed Matrix Membranes

Mamadou S. DIALLO

Graduate School of EEWS (Energy, Environment, Water and Sustainability, Korea Advanced Institute of Technology
Department of Applied Physics and Materials, Division of Engineering and Applied Science California Institute of Technology
AquaNano, LLC, Monrovia, CA, USA (Founder and Chief Technology Officer)

Corresponding author : diallo@wag.caltech.edu ; mdiallo@howard.edu

Abstract

Synthetic membranes have become the critical components of a broad range of sustainability and bioengineering related applications including 1) water purification and resource recovery, 2) energy generation, conversion and storage, 3) gas separations and chemical manufacturing, 4) CO2 capture, conversion and storage and 5) downstream bioprocessing for the production of protein therapeutics (e.g. monoclonal antibodies) and plasmid DNA for vaccines and gene therapy. However, current commercial polymeric membranes are not very effective at addressing existing and emerging separation and manufacturing challenges in sustainability and bioengineering. First, these membranes exhibit a permeability-selectivity trade-off; i.e. highly permeable membranes have low selectivity and vice versa. Second, commercial polymeric membranes have a high fouling propensity. Third, they cannot perform multiple functions (e.g. rejection, ion transport, adsorption and catalysis) without lengthy and costly surface and/or matrix modifications. In my presentation, I will summarize the work that my group has carried out during the last 5 years to develop a new generation of mixed matrix membranes (MMMs) with in-situ synthesized polymer particles that can carry out multiple functions (e.g. retention, sorption and catalysis) with higher permselectivity, flux, and lower fouling propensity.

By using a combined in-situ dope polymerization and phase inversion casting process, we have developed a novel, facile and scalable route for the preparation of MMMs with in-situ synthesized functional polymer particles using branched macromolecules as particle precursors1-5. These new membranes can be tailored for a broad range of applications including: 1) weak-base anion exchange (AEX) membrane adsorbers for protein separations1, 2) fouling-resistant ultrafiltration (UF) membranes for desalination pretreatment, water reuse and microalgae harvesting2-3, 3) Chelating UF membranes for metal ion recovery from aqueous solutions4, and 4) regenerable catalytic UF membranes with in-situ synthesized supramolecular hosts for Pt(0) nanoparticles (2-3 nm). These new membranes show high catalytic activity for the hydrogenation of alkenes and alkynes at room temperature and atmospheric pressure (~ 1 bar). 5In my presentation, I will summarize our results and discuss their impact in the context of ongoing work aimed at developing the next generation of scalable MMMs that overcome the permeability-selectivity trade off of current commercial membranes.

Keywords: Synthetic membranes, dope polymerization and phase inversion casting process.

Reference

[1] Kotte, M. R.; Cho, M. and Diallo, M. S. A Facile Route to the Preparation of Mixed Matrix Polyvinylidene Fluoride Membranes with In Situ Generated Polyethyleneimine Particles. J. Membr.Sci.2014, 450, 93-102.
[2] Kotte, M. R.; Hwang, T.; Han, J-I. and Diallo, M. S. A One-Pot Method for the Preparation of Mixed Matrix Polyvinylidene Fluoride Membranes with In Situ Synthesized and PEGylated Polyethyleneimine Particles. J. Membr. Sci. 2015, 474, 277–287.
[3] Hwang, T.; Kotte, M. R.; Han, J-I.; Oh, Y-K and Diallo, M. S. Microalgae Recovery by Ultrafiltration Using Novel Fouling-Resistant PVDF Membranes with In Situ PEGylated Polyethyleneimine Particles Water Research. 2015, 73, 181-192.
[4] Kotte, M. R.; Kuvarega, A.; Mamba, B. B; Cho, M. and Diallo, M. S. Mixed Matrix PVDF Membranes with In Situ Synthesized PAMAM Dendrimer-Like Particles: A New Class of Sorbents for Cu (II) Recovery from Aqueous Solutions by Ultrafiltration. Environ. Sci. Technol.2015, 49, 9431-9442.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

An Energy Reduction in Membrane Bioreactors – Some Novel Findings

V Lingam PILLAY

Department of Process Engineering, Stellenbosch University,

Corresponding author: pillayvl@sun.ac.za

Abstract

Membrane bioreactors combine a biological reactor with membranes as a separation step. Internationally there has been a major swing towards immersed membrane bioreactors (IMBRs) for wastewater treatment due to the myriad advantages that IMBRs offer over conventional biological processes. These include: - significantly higher throughput, or conversely lower footprint; very high product quality; reduced sludge production; better resistance to upset conditions. A major challenge with IMBRs is fouling of the membranes. This is normally redressed by continually scouring the membranes with air, to remove the fouling layer. Conventional wisdom indicated that the greater the rate of air scouring, the greater will be the removal of foulants from the membrane, resulting in improved membrane performance. However, the major energy requirement in IMBRs is for air scouring, and this constitutes the major operating expense.

In a study performed in both Durban and Cape Town, the effect of air scouring on fouling rates was investigated. The original intention of the study was to optimise the air scouring regime for a woven fabric microfiltration immersed membrane bioreactor (WFMF-IMBR). However, initial results indicated that air scouring has the opposite effect on fouling rates from that widely reported in the literature. With no air scouring the rate of fouling was substantially lower than when high air scouring rates are used! As this contradicts conventional wisdom reported in the literature, investigations were repeated extensively, and activated sludge from three wastewater treatment plants were investigated, viz. Zandvleit, Macassar and Belville. Further, a detailed study was done on Belville, where mixed liquor from various zones were investigated. The results all led to the same conclusion, viz. air scouring can increase the rate of fouling! This paper will present the results of the above investigations, as well as a possible explanation. It is not known at this stage whether these ‗anomalous 'results apply only to the WFMF-IMBR or whether they are equally applicable to commercial polymeric IMBRs. This could have a major impact on the operation and energy consumption of IMBRs, if the results of this study are widely and generally applicable.

Keywords: Membrane bioreactors, fouling of the membranes, energy consumption of IMBRs.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Increasing Separation Performance by Integration of Tailored Functional Polymeric Layers in Established Filtration Membranes and Modules

Mathias ULBRICHT

Group of Technical Chemistry, University of Duisburg-Essen

Corresponding author: mathias.ulbricht@uni-due.de

Abstract

Membrane-based separations are well established for many applications, for instance in water purification or for various bioseparations. However, separation performance is often limited by insufficient selectivity of the membrane or by membrane fouling. This presentation will focus on our recent work devoted to tailored surface functionalization's of ultrafiltration or nanofiltration membranes in order to reduce membrane fouling or to introduce additional selectivity via integration of adsorber properties (e.g. for heavy metal ions or organic micropollutants). In particular, we will discuss newly developed approaches which can be used to integrate polymer-based coatings with different task specific functionality, internal architecture (especially degree of cross-linking) and thickness. This can be done selectively on either the outer or the inner surface of commercial flat-sheet or capillary membranes. Such approaches are based on the surface-selective initiation of *in situ* (cross-linking and/or graft) copolymerizations with help of pre-adsorbed macroinitiators or on using tailored macromolecular building blocks in combination with coupling and cross-linking reactions via highly efficient —clickǁ chemistry. Examples will illustrate how such methods can be tailored to specific separation problems and, hence, to certain base membranes, and how such functionalizations can also be performed with membranes already assembled in modules. Such functionalizations enable less fouling and cleaning, or they lead to processes where the membrane has two different separation functions, i.e. based on size and on selective adsorption (realized in two different regions of the same membrane). By this means, the versatility and overall performance of membrane-based separations can be improved significantly.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

A Novel Interfacial Polymerization Technique for Fabrication of Thin Film

Woei Jye LAU*, G.S. LAI, Pei Sean GOH, Ahmed Fawzi ISMAIL

Advanced Membrane Technology Research Centre (AMTEC), Universiti Teknologi Malaysia, Malaysia.

Corresponding authors: lwoeijye@utm.my; lau_woeijye@yahoo.com

Abstract

Recent advances in incorporating the organic polyamide (PA) layer of composite membrane with inorganic nanomaterials have further improved the bare PA layer characteristics, overcoming the trade-off effect between water permeability and solute selectivity and improving the resistance against foulants attachment. This new generation of composite membrane — thin film nanocomposite (TFN) membrane was first reported by the scientists from the United States of America in 2007. Although many nanomaterials such as carbon nanotubes, zeolite, titania nanotubes and silver nanoparticles have been utilized over the years for the synthesis of TFN membranes, there remain several key challenges related to the TFN membrane fabrication. One of the main problems encountered is the uneven distribution and agglomeration of nanomaterials in the thin PA layer.

In view of this, we developed a novel interfacial polymerization technique to pre-coat the microporous membrane substrate with nanomaterials followed by vacuum filtration of amine aqueous solution before initiating PA cross-linking process. The findings showed that nanomaterials could be well distributed throughout the substrate surface and played positive role in improving membrane water permeability. The newly developed membrane also exhibited better antifouling resistances when tested with feed solution containing bovine serum albumin or dyes and demonstrated better performance in comparison to the composite membrane made of conventional IP technique.

Keywords: Interfacial polymerization, thin film nanocomposite, inorganic nanoparticles, polyamide layer, water.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Performance of PV-Powered Stand-Alone OSMOSUN® Unit under Intermittent Operating Conditions

M. Ben HALIMA[1], G. HAMMAMI[1], Sanna GASSARA[1], C. ANTONELLI[1], André DERATANI[1], T. GAREL[2], M. HAUDEBOURG[2] and Marc VERGNET[2]

[1]Institut Européen des Membranes, IEM – UMR5635, ENSCM, CNRS, Univ Montpellier, Montpellier, France.
[2]Mascara NT, Espace Atlantic Lot 16B, Gellainville, France.

Corresponding author: Andre.Deratani@umontpellier.fr

Abstract

Solar energy as a renewable source can be regarded as the best solution for water desalination when remote areas and location with poor infrastructure are considered. The continuous decrease of the PV panel price makes its integration to RO desalination economically attractive. This paper examines how intermittency and fluctuation of the resource impact the desalination performance of stand-alone system and which strategy can be propose to avoid the variation of the power input. Finally, a systematic analysis of the fluctuations is presented using a commercially available stand-alone membrane desalination unit.

Keywords: Renewable energy, Seawater desalination, Stand-alone reverse osmosis unit, Solar energy, Fluctuations

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Modulating Membrane Selectivity: A Comparative Study

Richard MOUTLOALI

DST/Mintek Nanotechnology Innovation Center – UJ Water Research Node

Corresponding author: rmoutloali@uj.ac.za

Abstract

Demands on membranes to perform at certain levels is the current driver in membrane materials innovation. High selectivity at relatively elevated permeate flux is a topical area that our group is currently involved in. In regard, the presentation will cover the work done in the past three years, specifically reviewing results from two different approaches to the subject. In the first instance, chemical grafting of pH sensitive functional groups will be compared to the results on inclusion of tailored nanofillers in increasing rejection while maintaining a relatively unchanged permeate flux under similar operating conditions. The presentation will then conclude with future prospects in the field.

Keywords: membrane materials, innovation, chemical grafting

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Study and Synthesis of Modified Electrospun Membranes for Application in Novel Solar-Driven Water Purification System

Charmaine TSHANGANA, Bulelwa NTSENDWANA Edward NXUMALO and Sabelo MHLANGA

Nanotechnology and Water Sustainability Research Unit, College of Science, Engineering and Technology University of South Africa, Johannesburg, South Africa

Corresponding author: charmainetshangana@yahoo.com

Abstract

Africa faces a huge challenge supplying clean water to communities in rural and urban communities, only 16% of people in sub-Saharan Africa have access to drinking. To circumvent the problem; a novel ultra/nanofiltration blend electrospun membrane modified with graphene and carbon nanotubes is designed. The membranes are able to remove all organic, inorganic and biological contaminants from water. The membranes are robust, have high flux and are resistant to fouling. These membranes will be applied in solar-driven water purification system that has been tested in a field test in rural parts of Mpumalanga, South Africa.

Keywords: clean water, novel ultra/nanofiltration, solar-driven water purification system.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Surface Modification of Low-Pressure NF Membranes Via Lbl-Assembly: Characterization and Application in Brackish Ground Water Treatment

Machawe M. MOTSA, Bhekie.B. MAMBA

Nanotechnology and Water Sustainability Research Unit, College of Science, Engineering and Technology, University of South Africa Science Campus, Johannesburg, South Africa

*Corresponding: machawemmvulane@gmail.com

Abstract
The pair of polyethyleneimine (PEI) and Poly (Sodium 4 styrene-sulfonate (PSS) was used to build polyelectrolyte bilayers deposited on PES and PAN polymers. The interaction between polymeric substrates and the polyelectrolytes was studied. The prepared membranes were tested on their potential to treat brackish groundwater. The membrane exhibited a better performance compared to the commercial NF270 membrane in producing high quality product water that meet the stipulated guideline values. The LBL membranes had comparable permeate fluxes to the high flux NF90 membrane; recording pure water of permeabilities of 9.4 and 10.2 l/m h bar respectively. And they had superior rejection of monovalent ions (Na+ and K+) compared to the NF90 membranes recording 88% compared to the 78% of NF90. Tests with the various mono and divalent salts showed the following rejection order: MgSO4> CaCl2>KCl ≥ NaCl. The dominant presence of polar functionality on the membrane surface limited foulant membrane interaction, thus improving its fouling resilience.

Keywords: Brackish water, Desalination; Membranes, Polyelectrolytes, Salt rejection.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Carbon Nanotube Embedded PVDF Membranes: Effect of Solvent Composition on the Structural Morphology for Membrane Distillation

Edgar C. MAPUNDA, Bhekie B. MAMBA, Titus A. M. MSAGATI*

Nanotechnology and Water Sustainability Research Unit, College of Science, Engineering and Technology, University of South Africa, South Africa

*Corresponding author: msagatam@unisa.ac.za

Abstract

In this work multi-walled carbon nanotube embedded polyvinylidene fluoride membranes for application in membrane distillation desalination were prepared via non-solvent induced phase separation method. The casting solution was prepared using mixed solvents (N, N-dimethylacetamide and triethyl phosphate) at varying ratios to study the effect of solvent composition on membrane morphological structures. Membrane morphological features were studied using a number of techniques including scanning electron microscope, atomic force microscope, SAXSpace tensile strength analysis, membrane thickness, porosity and contact angle measurements.

It was revealed that membrane hydrophobicity, thickness, tensile strength and surface roughness were increasing as the composition of N, N-dimethylacetamide in the solvent was increasing with maximum values obtained between 40 and 60% N, N-dimethylacetamide. Internal morphological structures were changing from cellular structures to short finger-like and sponge like pores and finally to large macro void type of pores when the amount of N, N-dimethylacetamide in the solvent was changed from low to high respectively. Multi-walled carbon nanotube embedded polyvinylidene fluoride membranes of desired morphological structures and physical properties can be synthesized by regulating the composition of solvents used to prepare the casting solution.

Keywords: membrane distillation, Carbon Nanotube Embedded PVDF Membranes.

References

[1] EC Mapunda, BB Mamba, TA M Msagati, Physics and Chemistry of the Earth 100 (2017) 135-142

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Uptake of Membrane Technology by the Public Sector in South Africa

Gomotsegang Fred MOLELEKWA

Tshwane University of Technology, South Africa

Corresponding author: telex@gomotsegang.co.za

Abstract
The paper explores the reception of membrane technology by the government and state funded/controlled entities in relation to usage, support in terms of funding for implementation and research.

Keywords: Membrane Technology, state funded/controlled entities.

2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Physicochemical Properties Monitoring of UF Hollow Fiber Membrane During Fabrication and Ageing

Sana GASSARA[1*], Céline POCHAT-BOHATIER[1], Olivier LORAIN[2] and André DERATANI[1]

[1]EM, Institut Européen des Membranes, Université Montpellier 2, Place Eugène Bataillon, 34095 Montpellier, France
[2]Laboratoire d'Ingénierie des Procédés de l'Environnement (EA833), Département de Génie des Procédés Industriels, Institut National des Sciences Appliquées, France

Corresponding author: sana.gassara@iemm.univ-montp2.fr

Abstract
Due to its geometry and small size, it is not easy to monitor the physicochemical parameters of the hollow fiber membranes during the fabrication and ageing in use. This paper aims at presenting a set of simple and rapid techniques which have been developed in the joint R&D laboratory M2Lab to determine the pore size distribution and interfacial properties of UF hollow fiber membranes for water treatment.

Keywords: Ultrafiltration, hollow fiber membranes, monitoring, PVP quantification, pore size.

2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Use of Zeta Potential Measurement to Monitoring Membrane Fouling and Enhance Membrane Separation Performance

Itumeleng BLOCK

Anton Paar, France

Corresponding author: info.fr@anton-paar.com

Abstract
Nanofiltration membranes have attracted much attention lately for their distinctive separation performance. They have nominal nano-scale pores with an estimated pore size of 0.5–2 nm on their active surface. Applications of nanofiltration are found in many industrial sectors, both for the removal of organic and inorganic components. The interaction of dissolved compounds in the feed solution with the membrane surface is responsible for membrane contamination (membrane fouling). Because of this effect the filtration resistance increases and the permeate flux through the membrane decreases with time. Fouling thus causes higher energy consumption for membrane operation, a higher cleaning frequency and a shorter lifetime of the membrane. Severe membrane fouling may require intense chemical cleaning or membrane replacement. Studies on the membrane fouling behavior help to optimize the membrane surface and to extend its usage time, which consequently reduces process costs. The presented work aims to address aspects of the streaming current measurement technique to reveal the changes on the membrane surface by fouling during the filtration process and to enhance membrane separation performance. Thin-film composite polymer membranes typically show a high negative zeta potential. The decrease in the negative zeta potential after filtration indicates the deposition of a foulant layer on the membrane surface. The zeta potential helps to monitor fouling during filtration and to optimize the efficiency of membrane cleaning.

Keywords: Zeta Potential Measurement, fouling control.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Photocatalytic TiO2 Co-Doped Nanomaterials for Water Treatment Applications

Majid JAHDI, Shivani B. MISHRA, Edward N. NXUMALO, Sabelo D. MHLANGA, Ajay K. MISHRA

Nanotechnology and Water Sustainability Research Unit, College of Science, Engineering and Technology, University of South Africa Science Campus, Johannesburg, South Africa

Corresponding author: bhards@unisa.ac.za

Abstract

The outstanding properties resulting from the modification of TiO_2 band gap have stimulated broad interest in the designing high-performance photocatalysts that can be integrated in diverse applications such as water treatment.

The properties of TiO_2 can be tailored by doping or impregnating with suitable elements to make an efficient nano-structured photocatalyst that can effectively purify water. In this work, TiO_2 photocatalysts co-doped with fluorine (F) and copper (Cu) were synthesized by hydrothermal synthesis using microwave-assisted heating method.

The advantage of co-doping TiO_2 was to synthesize a photocatalyst which limits the recombination effect of electron-hole pairs. The nanomaterials were characterized by X-ray diffraction (XRD), ultraviolet visible (UV-Vis) spectroscopy, scanning electron microscopy (SEM)/energy-dispersive spectroscopy (EDS), and transmission electron microscopy (TEM). The TEM and SEM images showed that the cooped samples were nanometric with an average particle size below 20 nm. Because of its high electronegative effect on the TiO_2 lattice, F was used as a dopant and a morphology controlling agent to enhance the photocatalytic activity of TiO_2 by controlling the growth of the anatase phase. Unlike F, Cu narrowed the band gap of TiO_2 and a significant shift of the photocatalytic activity to the near infrared light region was observed. In addition, we demonstrate that co-doping TiO_2 with these two ions is an effective pathway for the efficient photo-degradation of pharmaceutical compounds.

Keywords*:* Photocatalysis; Co-doping; Band gap; Titania; Pharmaceutical photodegradation

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Reduction in Greenhouse Water Usage through Inlet CO2 Enrichment

Neil Stacey JAMES and Fox Diane HILDEBRANDT

Institute for the Development of Energy for African Sustainability (IDEAS), UNISA.

Corresponding author:

Abstract

Agriculture is mankind's single largest usage of water, comprising 70% of all water usage. Optimizing water usage in agriculture is therefore crucial to ensuring global water security. We model a greenhouse as a bioreactor that is effectively a CSTR, and we show that the bulk of the water supplied to a conventionally aspirated greenhouse is lost in the form of humidity with the aie exiting the greenhouse. This implies that evaporative losses in agriculture comprise a clear majority of mankind's total water consumption. Inlet CO2 enrichment using existing membrane materials can minimize the air feed rate required to supply adequate CO2 for photosynthesis, thereby mitigating evaporative losses.

Keywords: Greenhouse Water Usage, CO2 Enrichment

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Salinity Gradient Power Generation by Reverse Electrodialysis: System Performance Using Natural Feed Streams

Efrem CURCIO[1], Ahmet H. AVCI[1], Ramato A. TUFA[2], Enrica FONTANANOVA[3] and Gianluca Di PROFIO[3]

[1]Department of Environmental and Chemical Engineering (DIATIC) University of Calabria
[2]Department of Inorganic Technology, University of Chemistry and Technology Prague, Czech Republic
[3]Institute on Membrane Technology, National Research Council of Italy (ITM-CNR**)**

Corresponding email: e.curcio@unical.it

Abstract

Salinity Gradient Power (SGP), a sustainable and renewable energy source generated by converting the osmotic energy of salt solutions into electrical or mechanical energy, is currently gaining a growing attention among the scientific community. In particular, Reverse Electrodialysis (RED) is emerging as one of the most promising membrane-based technologies for electrochemical energy generation by mixing two solutions having different salinity.

At present, the effectiveness of Reverse Electrodialysis (RED) in real practice is not clearly defined due to the lack of specific studies in literature, being investigations in large part limited to artificial pure NaCl solutions.

In this study, we experimentally assessed the impact of natural feed streams (collected from Licetto river and Tyrrenian sea in Amantea - Italy) in terms of Open Circuit Voltage (OCV) and power density (Pd) measured on labscale RED stack prototype; results have been compared to those obtained when using NaCl solutions having equivalent ionic strength. Within the range of operational conditions investigated, highest OCV (3.68 V and 4.09 V) and Pd values (0.46 and 1.41 W·m-2) were observed at 60°C for real and synthetic feeds, respectively. For a better understanding of electrochemical phenomena taking place in the system, the extent of ion exchange membrane/electrical double layer/diffusion boundary layer resistances was elucidated by electrochemical impedance spectroscopy (EIS).

Keywords: Reverse Electrodialysis; Salinity Gradient Power; natural feed stream

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Low Energy, Low Maintenance Membrane Systems for Developing Economies-Recent Developments

V Lingam PILLAY

Department of Process Engineering, Stellenbosch University

Corresponding author: pillayvl@sun.ac.za

Abstract

Internationally, developing economies face major challenges in providing safe drinking water and adequate sanitation to their communities. Membrane technologies, specifically microfiltration (MF) and ultrafiltration (UF) could potentially revolutionise the provision of potable water to currently unserviced communities, resulting in substantial improvements to both health and economic prospects. Polymeric and ceramic membrane technologies are well established internationally, and their use in potable water treatment, wastewater remediation and industrial separations is growing exponentially. However, the uptake of these membrane technologies to redress Africa 's water and sanitation challenges has been very limited. Possible reasons for this include the lack of local expertise and knowledge on membrane technology, and concerns over cost and robustness factors of current internationally available commercial membranes. Woven fabric microfilters (WFMF) offers a viable alternative to bring the benefits of membrane technology into developing countries. The major advantages of WFMF include: robustness (cannot be easily destroyed), easy of cleaning (no expensive chemicals required – membranes are cleaned simply by brushing), no major skills required of operators, and potentially lower cost. South Africa has been a leader in the development of WFMF. A point-of-use gravity driven system, the VulAmanz Rural Water Filter (VA-RWF) has been demonstrated at 1000 households in South Africa and the technical performance, user uptake and sustainability has been phenomenal. Current research is focused on the application of WFMF in larger scale potable water production, pool backwash water recovery, rain water harvesting, septic tank harvesting, immersed membrane bioreactors (IMBRs) and various industrial separation applications. Results to date indicate that WFMF could make a significant contribution to bringing the benefits of MF to potable water provision and sanitation in developing economies. This presentation will discuss the history of woven fabric membranes, and the current status of this technology. This is an emerging technology which offers many opportunities for innovation, collaboration and partnerships.

Keywords: Maintenance Membrane Systems, emerging technologies.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Novel Graphical Design Methods Membrane Separations Systems

Neil STACEY and Diane HILDEBRANDT

Institute for the Development of Energy for African Sustainability (IDEAS), UNISA.

*Corresponding author:

Abstract

Much research focuses on finding or developing a —perfectll membrane, that is a membrane that achieves a perfect separation. The separation is then performed in a devise that approximates single stage. However, there are alternative approaches.

Firstly, if a membrane achieves some separation, equipment, such a membrane column, can be designed to achieve the desired separation. We have developed novel graphical methods to aid with the design of such equipment. Alternatively, membranes that achieve some separation can be combined so as to give a composite membrane the achieves the desired separation. The methods that we have developed can be used to synthesis and analyze such composite membrane systems.

Keywords: Membrane Separations Systems, novel graphical methods

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Synthesis and Characterization of Hyperbranched Polyethyleneimine Multi-Walled Carbon Nanotube Incorporated with Fe-Cu Bimetallic Nanoparticles for Water Treatment

Sakhile DUBE, Soraya MALINGA* and Richard MOUTLOALI

Department of Applied Chemistry, University of Johannesburg, Johannesburg, South Africa

*Corresponding emails: smalinga@uj.ac.za, rmoutloali@uj.ac.za

Abstract

Compounds are stable and bio-accumulate in the environment, thus making it impossible to be removed. Pesticides such as 2,4,6-TCP have been detected in South Africa water systems, these mainly emanate from agricultural activities. In this study, a membrane consisting of highly catalytic Fe- Cu bimetallic nanoparticles, hyperbranched polyethyleneimine (HPEI) and multi-walled carbon nanotubes (MWCNTs) will be used in the degradation of hexachlorobenzene. HPEI is a highly branched cationic dendritic polymer. Its main role in this study was to assist in the dispersion of multi-walled carbon nanotube (MWCNTs) and Fe-Cu bimetallic nanoparticles. HPEI was covalently attached to MWCNTs via an amide bond to form HPEI-MWCNTs nanocomposite. Fe-Cu bimetallic nanoparticles were incorporated via co-complexation to form HPEI/MWCNTs/Fe-Cu.

Fourier transform infrared spectroscopy (FTIR) analysis confirmed the formation of a new bond at 1680 cm-1 which was attributed to an amide bond which confirmed the successful synthesis of HPEIMWCNTs. Functionalized MWCNTs with thionyl chloride shown a diameter of 10.02 nm were incorporated into HPEI to provide mechanical robustness to nanocomposite polymer. The incorporation of bimetallic nanoparticles was confirmed by Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX) and X-ray diffraction spectroscopy (XRD). The HPEIMWCNTs/ Fe-Cu/PES membrane was further evaluated for the removal of hexachlorobenzene from the water.

Keywords: trichlorophenols, Hyperbranched polyethyleneimine (HPEI), Multiwalled carbon nanotubes (MWCNTs), Fe-Cu bimetallic nanoparticles.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

A Novel Long-Life Air Cleaning Unit and its Continuous Operation Performance Analysis

X. FENG[1], R. VIJAYAKUMAR[2], B. LU[1], H. ZHANG[1] and H.DENG[3], Y.T. YANG[3]

[1]China Academy of Building Research 30 North 3rd Ring East Rd., Beijing, P.R.China
[2]Aerfil Ltd.
[3]Yantair Co. Ltd.

Corresponding author: xfengjbai@hotmail.com

Abstract
This paper introduces a novel long-life air cleaning unit with low maintenance requirements. This unit adopted a new design with auto-rolling structure and auto self-cleaning to greatly lower the requirements for maintenance and medium change. The prototype machine equipped with G4 media was installed and operated continuously in a subway station in Beijing since December, 2016. The monitoring test results of the prototype unit performance was recorded and analyzed. According to monitoring results, the air resistance of this unit is lower than 40 Pa/(m/s) during long term operation. The overall filtration efficiency for airborne PM10 is about 20% to 30%. The maintenance frequency is expected to be as low as once per 6 months, much lower than the traditional pre filters which require cleaning or change out at least once a week. After the use of a new type of media compromising of G4 media and nanofiber substrate, the unit is then upgraded to comparable a higher-class filtration unit with low energy consumption and suitable for long time use.

Keywords: air cleaning, auto-rolling filtration unit, PM10, PM2.5, nanofiber

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Predicting the Fouling Tendency of RO/NF Membranes Using Fractal Analysis and Membrane Autopsy

Amos ADENIYI, Maurice ONYANGO, Richard MBAYA and Patricia POPOOLA
Tshwane University of Technology, South Africa

Corresponding author: amosadeniyi7@yahoo.com

Abstract

Membranes for water filtration are expected to have high water recovery, high solute rejection, and low fouling tendency in order to minimize the cost of water treatment. Hydrophilic membranes are known to have high water recovery. The degree of crosslinking which depends on the manufacturing process conditions, determines how effective the membranes can reject solutes. Here the fouling of three hydrophilic membranes were investigated in order to relate the fouling tendencies to membrane properties. This is important for fouling resistant membranes to be fabricated through variation of membrane properties. Membrane fouling is commonly investigated using flux decline study, but in this work, it was investigated using membrane autopsy and fractal analysis of the cake layer which formed on the top of the membrane during a dam water filtration experiment.

A model relating fouling cake and fractal dimension is presented. Thee commercial hydrophilic membranes, AFC40 (NF), AFC80 (RO) and AFC99 (RO) made from 1,2-benzisothiazol-3(2H)-one sodium salt, were obtained from Xylem UK. The three membranes were subjected to fouling by micro pollutants through a filtration experiment done on a laboratory pilot plant with a pretreated raw dam water. The virgin and fouled membranes were characterized using XRD, SEM, AFM and FTIR. The AFM and SEM images were analyzed using WSxM 5.0 Develop 8 and image software to obtain percentage porosity, nodule size, root mean square height and roughness average. The virgin membranes were also characterized for contact angle using sessile drop measurement. Fractal dimensions of the fouling cake was determined using WSxM 5.0 Develop 8 software. Results showed that fractal dimension of the fouling cake formed on the surface of the membranes can be used to predict the fouling tendency of the membrane. For hydrophilic membranes, fouling tendency increases with reduction in hydrophilicity and increase in surface roughness of the membrane. Fractal dimension increases with increase in percentage porosity of the membrane and contact angle of the membrane. Fractal dimension also increases with increase in the root mean square height and roughness average of the membrane.

Keywords: membrane autopsy, fractal analysis, fouling tendency, reverse osmosis, fractal dimension

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Relating Key Parameters in a Membrane Separation System and Performance Prediction

Alexander R. ANIM-MENSAH

ITW-Hobart Corporation, Technology Center, Troy Ohio 45373, USA

Corresponding authors: alex.anim-mensah@itwfeg.com alexraymonda@yahoo.com

Abstract

Pressure-driven polymeric membranes especially those that have affinity involved in their separation principles such as reverse osmosis and nanofiltration used in organic systems separations are subject to swelling and/or compaction. Significant swelling is encountered during when membranes are conditioned in liquids for preservation, preparation or conditioned for permeation or wetting for permeation while under no pressure. Also, these membrane because of the high operating permeation pressures are subject to significant compaction. Moreover, both extreme swelling and/or compaction significantly affects membrane performances and consequently membrane destruction. For the foregoing reasons, a balance between swelling and compaction appears to be a key deciding factor in these system ‘s separation performances and needs to be understood. The above information suggests a separation system should be well selected in addition to operating in a safe region where the separation performance is optimized while not compromising membrane life.

Not much research has been done relating real-time measurements of membrane swelling and/or compaction while membrane is permeation with observed separation performance because of difficulty, cost of equipment involved as well as the accuracy. Attempts to understand these membranes swelling and compaction behavior and relation to the observed separation performances led to *Anim-Mensah et al* development of a chemical, mechanical and thermodynamic model that related various key parameters in a separation system. This model related membranes performances to the solute distribution coefficient between the membrane and solvent, compressive Young‘s modulus, solvent density, solubility parameter of the solute and solvent, the Poisson ratio, membrane extent of constraint in a permeation cell, as well as the ratio of initial swelling to permeation compaction.

It is worth to point out that the Poisson ratios (v) required for model ‘s prediction all lied outside the normal range of -1 to 0.5 i.e. $v > 0.5$ and $v < -1$ for stable materials. This suggest membranes constraint while permeated behaved as smart materials and may be dependent on the applied pressure and the extent of constraint and may be the membrane morphology. Moreover, varying Poisson ratios in the model to fit a published or experimental data could be a clue to estimate compaction at an operating pressure in the absence of a sophisticated real-time instruments. Another interesting finding from the model was the definition of a membrane dimensionless number (β) that related the ratio of the membrane affinity characteristics to the membrane

mechanical characteristics. The affinity characteristic considers the solute distribution coefficient between the solvent and membrane, permeate solute concentration, and the solubility parameter. solvent and solute. The membrane mechanical characteristics considers the compressive Young's modulus (i.e. applied pressure - compaction behavior) and extent of membrane constraint while under permeation. In simple terms, it is the natural logarithm of the ratio of swelling to compaction. For different the separation systems, different extent of affinity exists between the membrane-solute, solute-solvent and membrane-solvent as well as different mechanical stabilities. It is this affinity and mechanical stability that could decides the extent of swelling, compaction, fouling, transport and possible membrane degradation, hence, contribute to the observed separation performance. Versions of developed model predicted very closely the separation performance trends of some published experimental data on pervaporation, pressure driven nanofiltration and reverse osmosis applied to aqueous - organic and purely organic separation and purification. Future plans include exploring the practical significance of the new membrane dimensionless number (β).

Keywords: Pressure-driven polymeric membranes**, The membrane mechanical characteristics**

Reference

[1] Alexander Anim-Mensah and Rakesh Govind, Prediction of Polymeric Membrane Separation and Purification Performances: A Combined Mechanical, Chemical and Thermodynamic Model for Organic Systems, Springer 2015.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Novel Membranes with Ordered Nanowell Structure for Gas Separation

Katerina SETNICKOVA[1], Hongta YANG[2], Tomas STRASAK[1] and Petr UCHYTIL[1]

[1]Institute of Chemical Process Fundamentals of the Czech Academy of Sciences
[2]National Chung Hsing University, Department of Chemical Engineering

Corresponding authors: setnickova@icpf.cas.cz, uchytil@icpf.cas.cz

Abstract

Due to environmental, operational and economic impacts of acid gases such as CO_2, H_2S, NO_x and SO_x, development of new separation technologies with enhanced efficiency and low capital cost is an emerging demand in the near future. Membrane separation processes are considered as promising for gas removal and recovery owing to reasonable cost, good selectivity and low environmental impact. The development of innovative membranes having both high gas permeance and selectivity becomes very important. The aim of the presented work was to test a self-assembled hemispherical nanowell array in a new membrane design for gas separation.

Highly permeable polymer was used for the preparation of controllable size nanowell structure, representing support layer of membrane. The separation efficiency was achieved by the deposition of separation layer (1) ionic liquid or (2) different type of polymer, having preferential solubility for some gases (especially carbon dioxide) on the nanowell structure support. Moreover, the mechanism of the gas transport through novel membranes as well as the possible interactions between polymer matrix and ionic liquid were investigated in this study.

Acknowledgements: The financial support of the Czech Academy of Sciences and Ministry of Science and Technology, Taiwan (grant no. MOST-18-03) is greatly appreciated.

Keywords: gas separation, membrane process, ionic liquids.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Carbon Sphere-Assisted Solar Evaporation of Urine for the Recovery of Nutrients

Ellen KWENDA[1,2], Bhekie MAMBA[1], Arne VERLIEFDE[2] and Sabelo MHLANGA[1]

[1]Nanotechnology and Water Sustainability Research Unit, College of Science, Engineering and Technology University of South Africa, Florida, Science Campus, Johannesburg, South Africa,
[2]Department of Applied Analytical and Physical Chemistry, Faculty of Bioscience Engineering, Ghent University, Ghent, Belgium

Corresponding author: sdmhlanga1@gmail.com

Abstract

In the past 5 years, there has been an upsurge in the research on the preparation, application and efficiency of converting light-to-heat of a photothermal material. The photothermal material absorbs, confine and convert solar energy to heat. This heat is then used to heat liquids in solar evaporation by photothermal material to generate steam or vapor. Metallic nanoparticles such as Au/SiO2 produce steam due to the delocalized electrons absorb light and convert the light to heat [1]. However, the disadvantage of using metallic nanoparticles is their cost. Attractive but less expensive materials that exhibit light absorbing properties are carbon materials as these act as good heat sinks through a combination of the material's thermal conductivity, specific heat property and hydrophobic nature are able to float on the air-liquid interface where the evaporation takes place. In addition to the ability to absorb light, the carbon nanomaterials were selected because they are inert materials that are free of impurities, insoluble at the pH of urine and they are biocompatible with the environment. In this study, carbon spheres (CS) were synthesized by a chemical vapor deposition method and functionalized by acid treatment (CS-acid). The CSs were used in the evaporation and the recovery of the nitrogen and phosphorus contained in human urine. Two configurations of photothermal solar evaporation were tested; the self-floating configuration was the carbon spheres dispersed in urine and the 2D water channel which mimics water transpiration in trees configuration was when the carbon spheres were attached to cellulosic filter paper and placed above urine.

Keywords: carbon spheres, photothermal solar evaporation, a chemical vapor deposition method.

Reference

[1] O. Neumann, A.S. Urban, J. Day, S. Lal, P. Nordlander, N.J. Halas, Am. Chem. Soc. 7 (2013) 42–49.

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Air Products in South Africa: Fundamentals and Products

Palesa MENZE

Air Products South Africa

Corresponding author: Menzep@Apsap.co.za

Abstract

In a competitive and highly regulated market, industries are under constant pressure to increase productivity, optimise their process and improve quality, while reducing pollution and costs. Legislation and tough competition have resulted in an increased demand for more accurate and reliable analyses of a wide range of chemical compounds.

Companies need to keep on mind that with fewer impurities in the gases they use, they are bound to have a head start. With the introduction of BIP technology the gases have impurity levels as low as 100ppb total hydrocarbons, 10ppb oxygen and 20ppb moisture, which effectively means they deliver the lowest level of impurities.

Keywords: reduction of the pollution and costs, BIP technology

amsic 2
2nd African Membrane Society International Congress
29 July - 1 August 2018
UNISA Science Campus, Florida, Johannesburg, South Africa

Electrospun Superhydrophobic/Superoleophilic CNTs-PVDF supported Nanofibrous Mats for Oil/Water Separation

M MOFOKENG[1], Edwards NXUMALO[1*], P MATABOLA[2]

[1]Nanotechnology and Water Sustainability Research Unit, College of Science, Engineering and Technology, University of South Africa, Florida Campus, 1709, Johannesburg, South Africa
[2]MINTEK DST/NIC ,200 Malibongwe Dr, Praegville, Randburg, 2194

* Corresponding author: nxumaen@unisa.ac.za

Abstract

There is constant presence of Fats, oils and grease (FOGs) in waste water treatment plant due to oil refinery operations[1]. However, their complete removal during purification process is still a challenge [2]. Removal of these FOGs using superhydrophobic/superoleophilic based materials can provide high separation efficiency and selectivity [3]. In this work, we will fabricate a novel electros punned nanofiber material with Polyvinyl (PVDF) supported on carbon nanotubes (CNTS) via a facile exfoliation method. The PVDF-CNTs nanofiber sheet will be characterized using UV-vis spectroscopy, FTIR, FESEM, TEM, BET, AFM, XPS, XRD and TGA.

The removal efficiency of FOGs will be evaluated using contact angle. The as-synthesized PVDF-CNTs nanofiber sheet should possess high tensile strength, high surface tension and displayed excellent FOGs removal ability. We anticipate that the PVDF-CNTs nanofiber sheet can serve as an alternative material for the removal of FOGs.

Keywords: Nanofibrous, waste water treatment, electros punned nanofiber material.

References

[1] G. Alther, “chemical methods for removing contaminants from water,” 1999.
[2] [J. Gu, P. Xiao, J. Chen, J. Zhang, Y. Huang, and T. Chen, “Janus polymer/carbon nanotube hybrid membranes for oil/water separation,” *ACS Appl. Mater. Interfaces*, vol. 6, no. 18, pp. 16204–16209, 2014.
[3] Y. Shang *et al.*, “An in situ polymerization approach for the synthesis of superhydrophobic and superoleophilic nanofibrous membranes for oil-water separation,” *Nanoscale*, vol. 4, no. 24, pp. 7847–7854, 2012.