



The UK's only national chemical engineering research event

ChemEngDayUK 2014

Building on the past, engineering the future

Conference Proceedings

Welcome

From the Conference Chair, Mike Sutcliffe

On behalf of the University of Manchester I am delighted to extend a warm welcome to ChemEngDayUK 2014. The conference, organised in association with the Institution of Chemical Engineers, brings together over 300 research leaders and talented younger members of the community – showcasing the exceptional talent and creativity in UK chemical engineering and providing a catalyst for creating new contacts across the chemical engineering community.

The action packed programme kicks off with the opening plenary contextualising the chemical engineering landscape in 2014 – ranging from the traditional heartland (“fundamentals”) to the emerging hinterland. Next we are treated to around 170 posters, before launching into the first of our parallel technical sessions – including one led by the AIChE. We then focus on developing and nurturing the talent of early career researchers with a round table discussion and a speed dating session, before heading off to our networking conference dinner under the wings of Concorde. Tuesday kicks off with the second of our parallel technical sessions, followed by showcasing early career talent in the Junior Moulton Medal Lecture, leading in to the recognition and reward of emerging talent through the award of poster prizes. The Research Horizons closing plenary sends us out with a spring in our step – empowered to “seize the moment” and exploit those areas where we can make a unique and leading contribution.

The University of Manchester – the birthplace of chemical engineering – is honoured to host the UK’s only national chemical engineering event in 2014. I would like to thank all those whose contribution has made this event possible. We have enjoyed working with the IChemE, which has been particularly supportive – providing advice, staff time and marketing. ChemEngDayUK 2013 at Imperial College London provided an excellent springboard for this year’s meeting – preparations for ChemEngDayUK 2015 at the University of Sheffield are already underway.

I am sure that you will find the programme stimulating and enjoyable.



*Professor Mike Sutcliffe
Head of School of Chemical Engineering and Analytical Science
The University of Manchester*

We are grateful for the support of the following exhibitors and sponsors:



Institution of Chemical Engineers – the hub for chemical, biochemical and process engineering professionals worldwide

The Institution of Chemical Engineers (IChemE) is the global professional membership organisation for people with relevant experience or an interest in chemical engineering. We are the only organisation to award Chartered Chemical Engineer status. With a growing global membership approaching 38,000 the Institution is at the heart of the process community, promoting competence and a commitment to best practice, advancing the discipline for the benefit of society, encouraging young people in science and engineering and supporting the professional development of its members. We recognise that chemical engineering is changing and that the challenges the profession must address are becoming more complex. A sharp focus on core chemical engineering concepts and fundamental systems thinking must be maintained. In our new technical strategy, *Chemical Engineering Matters*, we commit to encouraging multidisciplinary working and maximising the effectiveness of knowledge exchange between the research base and teaching. We also pledge to foster more productive, multifaceted and effective relationships between the research base and industry. Chemical engineering research has the potential to make a major contribution to the UK's growth and prosperity. We are delighted to be working with Imperial College London to stimulate knowledge exchange, enhanced collaboration, and a strong sense of purpose within the UK's chemical engineering research community. For more information about IChemE visit www.icheme.org.

SIEMENS

Main Event Sponsors

YOKOGAWA 

Poster Prize Sponsors

ExxonMobil

Drinks Reception Sponsors

Contents

Welcome from the Conference Chair, Prof Mike Sutcliffe	3
Exhibitors and Sponsors	4
List of Participants	6
Networking Dinner	15
Abstracts for opening plenary	16
Abstracts for oral sessions	
Session 1 — Energy/Water/Food Nexus	17
Session 2 — Biological Engineering	18
Session 3 — Materials Innovation	20
Session 4 — Increased Manufacturing Value	23
Session 5 — Meeting our Energy Needs	25
Session 6 — Chemical Engineering Education	27
Medal Lecture	28
Closing Plenary	29
Poster Index	30
Poster Abstracts	
Sustainability and the Energy-Water-Food Nexus	37
Biological Engineering	55
Materials Innovation for the 21 st Century	67
Increased Manufacturing Value	77
Meeting Global Energy Demand	83
Other Research Themes	103
Seeking a Lectureship or Postdoc Position	145
Coack Pick Up Times and Locations for Networking Dinner	158

List of Participants

Abdulaziz	Rema	University College London	PhD Student
Adams	Dave	Siemens	
Adeleye	Adegboyega	London South Bank University	PhD Student
Adeyemi	Akinlabi	The University of Manchester	PhD Student
Adjiman	Claire	Imperial College London	
Ahsan	Bin	Linde Pakistan Limited	Support Engineer
Aiouache	Farid	Lancaster University	Senior lecturer
Akinmolayan	Shade	University College London	Graduate Research Engineer
Al Ghafri	Saif	Imperial College London	PhD Student
Alam Nazki	Aiman	Imperial College London	PhD Student
AL-Batty	Sirhan	The University of Manchester	PhD Student
Aldenhani	Mohammed	Lancaster University	Ph.D. Candidate
Aleem	Hosam	The University of Manchester	Lecturer
Al-Jubouri	Sama	The University of Manchester	PhD Student
Almustapha	Nurudeen	Heriot-Watt University	PhD student
Al-Qutbi	Aseel	London South Bank University	PhD Student
Alsadaie	Salih	University of Bradford	Student
Amienyo	David	The University of Manchester	Research Associate
Annett	Nicholas	University College London	Student
Anwar	Adeel	The University of Manchester	PhD Student
Arafef	Ali	The University of Manchester	PhD Student
Arafef	Ali	The University of Manchester	PhD Student
Arcelus Arrillaga	Pedro	Imperial College London	PhD Student
Avendano	Carlos	The University of Manchester	Lecturer
Azapagic	Adisa	The University of Manchester	Professor of Sustainable Chemical Engineering
Bages Estopa	Sara	The University of Manchester	PhD Student
Bages Estopa	Sara	The University of Manchester	PhD Student
Bakir	Riyadh	University of Sheffield	Student
Balakrishnan	Prabhuraj	The University of Manchester	PhD Student

Balcombe	Paul	The University of Manchester	PhD Student
Bamiduro	Faith	University of Leeds	PhD research Student
Belton	Daniel	University of Huddersfield	Senior Lecturer
Beresford	Keith	ABB Ltd	Sales manager Life Sciences
Bimbo	Nuno	University of Bath	Research Officer
Bjorck	Charlotte	University of Sheffield	Student
Blowers	Stephen	University of Edinburgh	PhD Student
Bourne	Richard	University of Leeds	
Bourne	Richard	University of Leeds	Research Fellow
Breen	Jessica	University of Leeds	Research Fellow
Brown	David	IChemE	Chief Executive
Brown	Sharon	University of Sheffield	
Burcin	Atilgan	The University of Manchester	PhD Student
Burgos-Marmol	Javier	The University of Manchester	PhD Student
Butters	Timothy	University of Manchester	Algorithm Developer (KTP Associate)
Butterworth	Tom	University of Sheffield	Student
Calderon	Andres	University College London	Student
Campbell	James	Imperial College London	PhD Student
Campbell	Grant	The University of Manchester	Reader
Carr	Wendy	Newcastle University	Research Engineer
Chang	Chen-Wei	The University of Manchester	PhD Student
Charonis	Spyros	The University of Manchester	PhD Student
Chatterjee	Sourav	Queen's University Belfast	post-graduate research student
Chauduri	Julian	University of Bradford	Dean
Chen	Rongjun	Imperial College London	Lecturer
Cherezov	Ilia	University of Cambridge	PhD student
Christy	John	University of Edinburgh	Head of Discipline of Chemical Engineering
Coffey	Paul	The University of Manchester	Research Associate
Cooper	Jasmin	The University of Manchester	PhD Student
Coopman	Karen	Loughborough University	Senior Lecturer
Coppens	Olivier	University College London	Ramsay Memorial Professor and Head of Department
Court	Elizabeth	University of Sheffield	Student
Cuellar Franca	Rosa	The University of Manchester	Research Associate
Cumming	Denis	University of Sheffield	Staff
Da Silva Burgal	Joao	Imperial College London	PhD Student
Danso-Boateng	Eric	Loughborough University	PhD Student
Darton	Richard	University of Oxford	
Daud	Nor	University College London	PhD Student

Davis	Luke	EPSRC	
De Haro-Del Rio	David	The University of Manchester	PhD Student
Dechatiwongse,	Pongsathorn	Imperial College London	PhD Student
Diaz Bejarano,	Emilio	Imperial College London	PhD Student
Dimitriou	Dr Ioanna	University of Sheffield	Staff
Dobson	Paul	University of Sheffield	Staff
Dolman	Ben	The University of Manchester	PhD Student
Downham	Joanne	IChemE	Finance & Business Director
du Toit	Hendrik	University of Bath	PhD Student
Dunbar	Alan	University of Sheffield	
Ekang	Iniobong	The University of Manchester	PhD Student
Elder	Dr Rachael	University of Sheffield	Staff
Enrriquez Gutierrez	Víctor Manuel	The University of Manchester	PhD Student
Fernandez Puerts	Eneritz	Imperial College London	PhD Student
Ferretti	Giulia	Imperial College London	PhD Student
Flavell White	Claudia	IChemE	Director of Publications
Flood	Joseph	The University of Manchester	PhD Student
Foo	James	The University of Manchester	PhD Student
Foster	Richard	The University of Manchester	PhD Student
Fragkopoulos	Ioannis	The University of Manchester	PhD Student
Furlong	Andy	IChemE	Director of Policy & Communication
Gabbott	Ian	AstraZeneca	Senior Scientist
Galindez	Silvia	The University of Manchester	PhD Student
Galindo	Amparo	Imperial College London	
Garcia Gutierrez	Pelayo	University of Sheffield	Student
Gbemi	Oluleye	The University of Manchester	PhD Student
Ghoshal	Parama	University of Cambridge	Student
Glassey	Jarka	Newcastle University	Reader
Goldrick	Stephen	Newcastle University	EngD Student
Gonciaruk	Aleksandra	The University of Manchester	PhD Student
Gorgojo	Patricia	University of Manchester	Research Associate
Gouveia Gil	Ana	Imperial College London	PhD Student
Guillen	Gonzalo	The University of Manchester	
Guzman Lagunes	Fernando	The University of Manchester	PhD Student
Hall	Simon	University of Sheffield	Student
Hallmark	Bart	University of Cambridge	Design lecturer

Harbottle	David	University of Leeds	Lecturer
Heslop	Mark	University of Sheffield	Staff
Hickling	Chris	The University of Manchester	PhD Student
Hill	Alf	University of Bath	Ph.D. Student
Ho	Tuan	University College London	PhD Student
Hobbs	Chris	ABB Ltd	Technology Manager
Hodgkinson	Richard	University of Sheffield	Student
Holmes	Stuart	The University of Manchester	Senior Lecturer
Holmes	Nicholas	University of Leeds	PhD Student
Holmes	Nicholas	University of Leeds	PhD Student
Hone	Christopher	University of Leeds	PhD Student
Hone	Christopher	University of Leeds	PhD Student
Hooker	Titchener	University College London	Head of Department
Houben	Claudia	University of Cambridge	Student
Howse	Corinne	University of Sheffield	4CU Project Manager
Ibrahim	Dina	University College London	Student
Jackson	George	Imperial College London	Professor of Chemical Physics
Jacob	Philipp-Maximilian	University of Cambridge	Student
Jajesniak	Pawel	University of Sheffield	Student
Jamili	Elnaz	University College London	PhD
Jansen	Richard	IchemE	
Jeswani	Harish	The University of Manchester	Research Associate
Jimenez Solomon	Maria	Imperial College London	PhD Student
Jolley	Katherine	University of Leeds	Post doctoral research fellow
Jones	Gemma	The University of Manchester	PhD Student
Jones	Martyn	The University of Manchester	
Kaisermann	Candice	The University of Manchester	PhD Student
Kamalanathan	Ishara	The University of Manchester	PhD Student
Karamerou	Eleni	The University of Manchester	PhD Student
Kellici	Suela	London South Bank University	Research Fellow
Kerry	Timothy	The University of Manchester	PhD Student
Kim	Jeong	Imperial College London	PhD Student
King	Patrick	The University of Manchester	Research Associate
Kings	Iain	University of Birmingham	Research Fellow
Krueger	Timm	University of Edinburgh	Chancellor's Fellow
Ladha	Abbas	University of Bath	UG Student
Landels	Andrew	University of Sheffield	Student

Lapkin	Alexei	University of Cambridge	Professor
Lawal	Kemi	University of Bath	PhD student
Lee	Koon-Yang	University College London	Lecturer in Chemical Engineering
Li	Yuqiong	Imperial College London	PhD Student
Li	Yongliang	University of Birmingham	Lecturer
Liu	Dun	The University of Manchester	PhD Student
Liu	Songsong	University College London	Research Associate
Livingston	Andrew	Imperial College London	Head of Department
López Gómez	José Pablo	The University of Manchester	PhD Student
Lopez Rodriguez	Rafael	The University of Manchester	PhD Student
Lorenzo	Di	University of Bath	Lecturer
Lynch	Michele	University College London	PhD Student
Mahbubani	Krishnaa	University of Cambridge	Post-doctoral Research Associate
Mahmoud	Heaven	The University of Manchester	PhD Student
Maitland	Geoff	Imperial College London	Professor of Chemical Engineering
Manerova	Jen	University of Sheffield	Student
Manning	Harriet	University of Bath	PhD Student
Mansor	Salida Wan	University of Bath	PhD Student
Marchetti	Patrizia	Imperial College London	PhD Student
Martin	Elaine	Newcastle University	Head of School
Martin	Peter	The University of Manchester	Senior Lecturer
Martin	Philip	The University of Manchester	Senior Lecturer
Martin	de	University College London	Postdoc Research Associate
Mas Hernandez	Elizabeth	The University of Manchester	PhD Student
Materazzi	Massimiliano	University College London	PhD student
Mattia	Davide	University of Bath	Reader
Mavituna	Ferda	The University of Manchester	Professor
Mays	Tim	University of Bath	Senior Lecturer and Head of Department
McCord	Stephen	University of Sheffield	Student
McDonagh	Sean	Siemens	Business Manager Chemical, Sales Manager Chem Pharm
Mehranjani	Ali	University of Sheffield	Student
Meoto	Silo	University College London	PhD student
Metcalfe	Ian	Newcastle University	Professor
Michailos	Stavros	The University of Manchester	PhD Student
Miller	Aline	The University of Manchester	Reader in Biomolecular Engineering
Mohammad	Hussain	The University of Manchester	PhD Student

Mohammed	Misbahu Ladan	London South Bank University	PhD Student
Muller	Frans	University of Leeds	Professor
Mummery	Tim	The University of Manchester	Assistant to Head of School
Nigra	Michael	University College London	Postdoctoral Research Associate
Noguera-Diaz	Antonio	University of Bath	PhD Student
Noofeli	Asa	University of Sheffield	Student
Norouzi Rad	Mansoureh	The University of Manchester	PhD Student
Ogden	Dr Mark	University of Sheffield	Staff
Oke	Banjo	University College London	Student
Oko	Bonahis	Imperial College London	PhD Student
Omar Ali	Hossam	University of Sheffield	Student
Omojola	Kayode	University of Sheffield	Student
Osarinmwian	Charles	The University of Manchester	Research Associate
Osborne	Gilly	IChemE	
Osei-Bonsu	Kofi	The University of Manchester	PhD Student
Owens	Simon	University of Bath	PhD Student
Ozdincer	Baki	The University of Manchester	PhD Student
Pakalidou	Nikoletta	The University of Manchester	PhD Student
Pandiella	Seve	The University of Manchester	Senior Lecturer
Pandya	Kedar	EPSRC	
Park	Kyeong	University College London	PhD Student
Patel	Bhavish	Imperial College London	PhD Student
Patel	Dipesh	London South Bank University	Research Assistant
Patterson	Darrell	University of Bath	Senior Lecturer (Associate Professor)
Patti	Alessandro	The University of Manchester	Lecturer
Paulauskas	Mindaugas	University of Leeds	PhD Student
Paulauskas	Mindaugas	University of Leeds	PhD Student
Peel	Christine	Teesside University	Subject Group Leader
Penumathsa	Bharat	Imperial College London	PhD Student
Perera	Ayomi	University College London	Postdoctoral Research Associate
Pérez Rivero	Cristina	The University of Manchester	PhD Student
Perkins	John	The University of Manchester	Professor
Phan	Ahn	University College London	Graduate Research Student
Pitt	Dr Martin	University of Sheffield	Staff
Poole	Colin	University of Leeds	Head of Process Engineering
Porrazzo	Rosario	Heriot-Watt University	Student
Powell	Keddon	Loughborough University	Research Student

Pugsley	Adam	University of Bath	UG Student
Qamar	Rizwan Ahmed	The University of Manchester	PhD Student
Quintana Gomez	Laura	University of Sheffield	Student
Rallan	Chandni	The University of Manchester	PhD Student
Raut	Eesha	Newcastle University	Student
Regis	Trish	IChemE	
Rende	Maria	Imperial College London	PhD Student
Rhodes	Gillian	University of Sheffield	
Rielly	Chris	Loughborough University	Head of Department
Rigaki	Aikaterini	The University of Manchester	PhD Student
Rodgers	Tom	The University of Manchester	Lecturer
Rooney	David	Queen's University Belfast	Director of Research
Ross	Daniel	Imperial College London	PhD Student
Rubini	Philip	University of Hull	Reader and Head of Chemical Engineering
Russo	David	University of Sheffield	Student
Saada	Rim	London South Bank University	PhD Student
Saenz	Pedro	University of Edinburgh	Student
Sans	Victor	University of Glasgow	Research Fellow
Schaschke	Carl	University of Strathclyde	Head of Department
Schmidt	Patrick	University of Edinburgh	PhD student
Schmidt Rivera	Ximena	The University of Manchester	PhD Student
Schroeder	Sven	The University of Manchester	Professor
Shah	Nilay	Imperial College London	Professor
Sharpe	Jessica	University of Bath	PhD Student
Sharrad	Clint	The University of Manchester	Senior Lecturer
Shier	Andrew	University of Leeds	PhD Student
Shokri	Nima	The University of Manchester	Lecturer
Siefker	Justin	University College London	Postgraduate Student Researcher
Simmons	Mark	University of Birmingham	Deputy Head of School
Siperstein	Flor	The University of Manchester	Reader
Siswanto	Anggun	University of Sheffield	Student
Sivena	Anastassia	Imperial College London	PhD Student
Skoulou	Vicky	University of Hull	Lecturer
Slater	Nigel	University of Cambridge	Professor & Head of Department
Smith	Robin	The University of Manchester	Professor
Sofikiti	Tonia	Newcastle University	

Sorensen	Eva	University College London	Reader in Chemical Engineering
Srisamai	Suna	Imperial College London	PhD Student
Stamatakis	Michail	University College London	Lecturer in Chemical Engineering
Stamford	Laurence	The University of Manchester	Research Associate
Stavrakakis	Efstratios	Queen's University Belfast	PhD student
Striolo	Alberto	University College London	Professor of Molecular Thermodynamics
Suhartono	Jono	Swansea University	Student
Sutcliffe	Mike	The University of Manchester	Head of School
Suwanmajo	Thapanar	Imperial College London	PhD Student
Symons	Symons	University of Cambridge	Lecturer
Szekely	Gyorgy	Imperial College London	PhD Student
Taddese	Tseden	The University of Manchester	PhD Student
Tagliaferri	Carla	University College London	Student
Tarpani	Raphael Ricardo Zepon	The University of Manchester	PhD Student
Taylor	Robin	National Nuclear Laboratory	
Tchuenbou-Magaia	Fideline	University of Birmingham	
Theodorakis	Panagiotis	Imperial College London	Research Associate
Theodoropoulos	Kostas	The University of Manchester	Reader
Thompson	James	The University of Manchester	PhD Student
Thompson	Lisa	University of Leeds	phd student
Tizaoui	Chedly	Swansea University	Associate Professor
Torrente	Laura	University of Bath	
Tran	Minh	University College London	Student
Valtcheva	Irina	Imperial College London	PhD Student
Verma	Amit	The University of Manchester	PhD Student
Vezzoli	Massi	University of Bath	Staff
Vitasari	Denny	The University of Manchester	PhD Student
Wang	Jiawei	The University of Manchester	Lecturer
Webb	Colin	The University of Manchester	Professor
Welch	Nathan	Imperial College London	PhD Student
Whiting	Andrew	The University of Manchester	PhD Student
Wilkins	Maurice	Yokogawa	
Wilkins	Sara		
Wilson	Ian	University of Cambridge	Reader in Chemical Engineering
Wright	Phillip	University of Sheffield	Head of Department

Wright	Julie		
Wu	Gaowei	University College London	PhD student
Xu	Wesley	University of Bath	PhD Student
Yang	Junfeng	Imperial College London	PhD Student
yang	lingjian	University College London	PhD student
Yi	Wei	The University of Manchester	PhD Student
Yin	Chun-Yang	Teesside University	Senior Lecturer in Chemical Engineering
Young	Neil	IchemE	UK membership & market development manager
Yousuf	Rawa	The University of Manchester	PhD Student
Zandi	Mohammad	University of Sheffield	Course Director
Zein	Sharif	University of Hull	Lecturer
Zhang	Di	University College London	PDRA
Zhao	Kun	Imperial College London	PhD Student

Networking Dinner



Networking is a central activity throughout ChemEngDayUK 2014.

On the evening of Monday 7 April a networking conference dinner will take place under the wings of the Concorde G-BOAC aircraft within its purpose built super-hangar at Manchester Airport. Guests will enjoy a drinks reception, three course meal, and a guided tour of Concorde.

Venue details:

The Runway Visitor Park
Sunbank Lane
Altrincham
WA15 8XQ

Travel

Coaches will depart from two locations on the evening of 7th April. For details of the pick-up times and locations, please see the back page of this booklet.

Poster titles

1. Sustainability and the Energy-Water-Food Nexus

pages 37-54

- 1.1 When the membrane is not enough: a simplified membrane cascade with adsorptive solvent recovery, *Jeong Kim*
- 1.2 Aqueous Methane in Slit-Shaped Silica Nanopores: High Solubility and Traces of Hydrates, *Anh Phan*
- 1.3 Life cycle environmental sustainability of lignocellulosic ethanol produced in integrated biorefineries, *Harish Jeswani*
- 1.4 Catalytic Conversion of HDPE Polymer into Olefin-Rich Liquid Hydrocarbons using Modified Sulphated Zirconia Catalyst, *Muhammad Nurudeen Almustapha*
- 1.5 Fluid Flows in Nanopores: Insight from Molecular Dynamics Simulation, *Tuan Ho*
- 1.6 Enhanced Carbon Capture using Nickel Nanoparticles, *Gaurav Bhaduri*
- 1.7 Acid Violet 17 Removal Using Adsorption and Electrochemical Regeneration, *Dun Liu*
- 1.8 Life cycle environmental impacts of meat and different meat replacement options in ready-made meals, *Ximena Schmidt Rivera*
- 1.9 The conversion of waste materials into value-added chemicals, *Laura Quintana Gomez*
- 1.10 Fuel Gas Storage – the challenge of hydrogen, *Nuno Maria Marques Dos Santos Bimbo*
- 1.11 A Hierarchical approach to evaluation of low-grade heat utilization opportunities, *Gbemi Oluleye*
- 1.12 Hybrid Carbon Nanotubes PVDF Membrane for Bromate and Natural Organic Matter (NOM) Removal, *Jono Suhartono*
- 1.13 The development of enhanced emulsifying agents by membrane fractionation of gum Arabic, *Harriet Manning*
- 1.14 An efficient and selective alkene epoxidation process, *Misbahu L Mohammed*
- 1.15 Environmental Impacts of Renewable Electricity Generation in Turkey, *Burcin Atilgan*
- 1.16 Strategic design and Optimisation of the BioSNG Supply Chain: A case study for the UK, *Andres Calderon*
- 1.17 Hydrothermal Upgrading of Algae Paste: Fast Liquefaction in a Continuous Flow Reactor, *Bhavish Patel*
- 1.18 Enzymatic Biodiesel Production using the Spinning Cloth Disc Reactor (SCDR), *Kemi Lawal*
- 1.19 Sustainable utilisation of biomass and waste for energy provision in cities, *Andy Whiting*
- 1.20 Reconstruction of 2-D temperature distribution profiles using Laser Absorption Tomography, *James Foo*
- 1.21 Enhancing the nutritional value of wheat-based Distiller's Dried Grains with Solubles, *Hosam Aleem*
- 1.22 A superstructure optimisation approach for clean water treatment, *Eva Sorensen*
- 1.23 Communicating the carbon footprint of food, *Gemma Jones*

2. Biological Engineering

pages 55-66

- 2.1 Breast cancer classification using microarray gene expression profile and protein interaction network, *Lingjian Yang*
- 2.2 Deformability-based red blood cell separation in deterministic lateral displacement devices, *Timm Krueger*
- 2.3 Confinement Protection Effects of Mesoporous Silica, Inspired by Chaperonin Complexes, *Michele Lynch*
- 2.4 Evaluation of biosurfactant production in glucose deprived media by *Bacillus subtilis* and its potential application in a continuous production system, *Candice Kaisermann*
- 2.5 Fabrication of Stable Biocatalyst Networks for the Cascadable Manufacture of Fine Chemicals, *Chris Hickling*
- 2.6 Enhancing the Cold Flow Properties of Biodiesel, *Adeel Anwar*
- 2.7 OneClick: A programme for designing focused mutagenesis experiments, *Hossam Eldin Omar Ali*
- 2.8 Yeast Microbial Oil from Biodiesel Waste Glycerol: A Promising Tool for Biorefinery Enhancement, *Eleni Karamerou*
- 2.9 The biological conversion of methane to methanol using fine bubble aeration, *Charlotte Bjorck*
- 2.10 Process development of biosurfactant production using cheap renewable substrates, *Ben Michael Dolman*
- 2.11 QuickStep-Cloning: A rapid method for sequence-independent DNA cloning, *Pawel Jajesniak*
- 2.13 Modelling Brain Temperature and Cooling Methods Using CFD, *Stephen Blowers*
- 2.14 Production of a generic fermentation feedstock from agricultural waste, *Chen-Wei Chang*
- 2.15 Interplay of Kinetics and Transport in Intracellular Decision Making Networks, *Aiman Alam Nazki*
- 2.16 SBA-15: A Compelling Therapeutic Carrier, *Justin Siefker*
- 2.17 Computational Models for Protein Solubility and Aggregation, *Spyros Charonis*
- 2.18 Information processing in multi-site phosphorylation-based signalling systems, *Thapanar Suwanmajo*

3. Materials Innovation for the 21st Century

pages 67-76

- 3.1 Understanding Pickering Emulsions using Multi-Scale Simulations, *Alberto Striolo*
- 3.2 A single rapid route for the synthesis of reduced graphene oxide with antibacterial activities, *Suela Kellici*
- 3.3 CO₂/CH₄ adsorption selectivity in model carbons, *Aleksandra Gonciaruk*
- 3.4 Graphene oxide (GO) as a membrane material in Direct Methanol Fuel Cells (DMFCs)- Possibilities and Review, *Prabhuraj Balakrishnan*
- 3.5 In-situ spectroscopy to probe electrochemical reactions in high temperature solid oxide cells, *Denis Cumming*
- 3.6 Coulometric Analysis and the Effects of Changing the 'Fluidisation Rate' on a Fluidised Cathode Process for the Direct Electrochemical Reduction of Tungsten Oxide in a Molten LiCl-KCl Eutectic, *Rema Abdulaziz*

- 3.7 From Virtual Catalysis to Practical Applications: Understanding and Designing Catalysts in Silico, *Michail Stamatakis*
- 3.8 Systematic Study of the Formation of Mesostructured Silica in Confining Spaces for Membrane Applications , *Silo Meoto*
- 3.9 A Self-assembling Three-Dimensional DNA Biosensor: DNA Recognising Motifs Immobilized on de novo Peptide-Based Hydrogels, *Patrick King*
- 3.10 Tailored for simplicity: Air-templated bio-based macroporous polymers, *Dina Ibrahim Abou El Amaiem*
- 3.11 Scalable hydrothermal synthesis of conjoined hexagonal rods of zinc oxide for optoelectronic applications, *Faith Bamiduro*
- 3.12 Understanding Catalysis Through Organic-Inorganic Hybrid Catalytic Materials, *Michael Nigra*
- 3.13 Highly Porous Gold Electrodes for Glucose Sensing and Biofuel Cell Applications, *Hendrick Du Toit*
- 3.14 Self-organisation behaviour and scope of application of mycobacterial porin MspA, *Ayomi Perera*
- 3.15 Microscopic modeling of consolidation powder stainless steel type 316L in hot isostatic pressing , *Charles Osarinmwian*

4. Increased Manufacturing Value

pages 77-82

- 4.1 Operando measurement of spatial composition variation within an operating fixed-bed catalytic reactor using MR CSI, *Luke David Baker*
- 4.2 Electrical Resistance Tomography for Process Monitoring, *Thomas Rodgers*
- 4.3 Mixed Integer Optimisation for Production and Maintenance Planning in Biopharmaceutical Manufacturing, *Sonsong Liu*
- 4.4 Business Productivity Improvement through the Application of Analyser Device Integration, *Eesha Raut*
- 4.5 Integrated platforms for chemical discovery, *Victor Sans*
- 4.6 Continuous Versus Periodic Flow Crystallization of a Pharmaceutical Drug in MSMR: Characterization with Integrated PAT Array, *Keddon Powell*
- 4.7 Roller compaction: The effect of primary particle hardness, *Riyadh Al Asady*
- 4.8 Dynamics of Thin Films over a Spinning Disk, *Kun Zhao*

5. Meeting Global Energy Demand

pages 83-102

- 5.1 Carbon capture and storage (CCS) whole chain analysis through modelling and simulation, *Eni Oke*
- 5.2 Life cycle assessment of Bio-SNG production from novel waste gasification, *Carla Tagliaferri*
- 5.3 Quick introduction to pyroprocessing, *Hugues Lambert*
- 5.4 Platinum PAMAM fourth generation hydroxide on carbon nanotubes (Pt-G4OHMWCNTs) as the cathode catalyst for oxygen reduction reaction in direct methanol fuel cell, *Heaven Mahmoud*
- 5.5 Thermodynamic and Hydrodynamic Study of Asphaltene Precipitation in Crude oil under Typical Industrial Heat Exchanger Conditions, *Junfeng Yang*

- 5.6 Structural Study of Polyamide Thin Film Composite Reverse Osmosis Membrane Using Nanoparticles and Real-Space Imaging, *Yuqiong Li*
- 5.7 Study of metals Composite Binding Layer for Direct Methanol Fuel Cell, *Sirhan AL-Batty*
- 5.8 Carbon dioxide utilisation for synthetic fuel production: Process analysis, *Ioanna Dimitriou*
- 5.9 Assessment of the Potential Application of Partial Oxidation in Supercritical Conditions for the Upgrading of Heavy Oil, *Pedro Arcelus-Arillaga*
- 5.10 A simulation and environmental LCA of a Solar PV, Stirling engine CHP and battery storage system, *Paul Balcombe*
- 5.11 Model for a foam front displacement in improved oil recovery, *Elizabeth Mas Hernandez*
- 5.12 Hydrocracking of Heavy Oil Model Compound and Investigation of Product Distribution using a Continuous Fixed-Bed Reactor (CFBR), *Anastassia Sivena*
- 5.13 Separation of Microalgae biomass from Suspensions using Adsorption for Biofuel Purposes, *Akinlabi Abdulganiyy Adeyemi*
- 5.14 Simulations of a Chemical Looping Combustion Power Plant using Aspen Plus, *Raffaella Ocone*
- 5.15 Fuel Gas Storage - the challenge of methane, *Adam Pugsley*
- 5.16 Functional Ceramic Hollow Fibres for Pre-combustion Decarbonization, *Ana Gouveia Gil*
- 5.17 Design of a reactor to assess the viability of graphite as a tritium removal technology in FHRs, *Eneritz Fernandez Puertas*
- 5.18 A study of controlled porosity activated carbon on the performance of Phosphonium and Sulphonium based Ionic Liquids in EDLCs, *Asa Noofeli*
- 5.19 Multi-objective optimisation for cost distribution among smart homes, *Di Zhang*
- 5.20 Measurements of Permeability and Capillary Breakthrough Pressure of Reservoir Cap Rock for Effective Carbon Dioxide Sequestration, *Nathan Welch*
- 5.21 Surfactant dependent foam stability in the presence of different hydrocarbons, *Kofi Osei-Bonsu*
- 5.22 Compression and transportation of CO₂ with impurities for Carbon Capture and Sequestration, *Nor Khonisah binti Daud*
- 5.23 Plasmolytic reduction of carbon dioxide in a ferroelectric packed bed plasma reactor, *Thomas Butterworth*
- 5.24 Life cycle sustainability assessment of UK electricity scenarios to 2070, *Laurence Stamford*
- 5.25 Sustainability Assessment of Shale Gas in the UK Energy Market, *Jasmin Cooper*
- 5.26 Optimal design and operation of hybrid electric vehicles, *Eva Sorensen*
- 5.27 Solid waste gasification: technical aspects and process performance of a two stage fluid bed-plasma process, *Massimiliano Materazzi*
- 5.28 The role of cesium promoter in achieving low temperature activity in heterogeneous catalysts for ammonia decomposition, *Alfred Hill*

- 6.1 Eulerian modeling of lateral solid mixing in gas-fluidized suspensions, *Oyebanjo Oke*
- 6.2 Investigation of the effect of seeding in the preparation of hierarchically porous structured zeolite X over carbonized date stones, *Sama Al-Jubouri*
- 6.3 Quantification and Characterisation of Influenza Virus Size Distributions Using Differential Centrifugal Sedimentation (DCS), *Antonia Sofikiti*
- 6.4 Stability of macromolecules at liquid-liquid interface, *Tsedem Taddese*
- 6.5 Modelling of Electrochemical Promotion in Heterogeneous Catalytic Systems, *Ioannis Fragkopoulos*
- 6.6 Modelling the micellisation of a cationic surfactant by Monte Carlo simulations, *Jose Javier Burgos Marmol*
- 6.7 Catastrophic Phase Inversion vs. Direct Emulsification, *Aseel Al-Qutbi*
- 6.8 Synthesis of propylene carbonate from carbon dioxide using novel heterogeneous catalyst, *Adegboyega Adeleye*
- 6.9 Experimental and Modeling Study of the Phase Behavior of (Synthetic Crude Oil + CO₂), *Saif Al Ghafri*
- 6.10 Greener synthesis of DMC using a novel ceria–zirconiagraphene catalyst, *Rim Saada*
- 6.11 Modelling and simulation of MSF desalination plant: The effect of venting system design for non-condensable gases, *Salih Alsadaie*
- 6.12 Milling of debranned wheat described with the Double Normalised Kumaraswamy Breakage Function (DNKBF), *Silvia Patricia Galindez Najera*
- 6.13 Plasma microreactor modified by microbubbles technology for biofuel crop detoxification, *Anggun Siswanto*
- 6.14 An Iterative Immersed Boundary Method for the Simulation of Low-Re Particulate Flow, *Wei Yi*
- 6.15 Quantification of Substrate Consumption and Fungal Growth in Solid State Fermentations, *José Pablo López Gómez*
- 6.16 Effects of surface roughness on salt precipitation during evaporation from saline porous media, *Mansoureh Norouzi Rad*
- 6.17 Surfactant transport onto a foam lamella in the presence of surface viscous stress, *Denny Vitasari*
- 6.18 In situ Raman Spectroscopy for Solid Oxide Electrolysis Cells, *Jevgenija Manerova*
- 6.19 Double substrate limitation model for the experimental scale-up of succinic acid production from biorefinery glycerol, *Aikaterini Rigaki*
- 6.20 Convection and reaction in geological storage of CO₂, *Parama Ghoshal*
- 6.21 Monoethylene glycol – Brine transport due to settling of NaCl crystals in a laboratory scale MEG reclamation rig, *Rafael Lopez Rodriguez*
- 6.22 Interfacial instability in vertical counter-current gas-liquid flows, *Patrick Schmidt*
- 6.23 Ceramic bi-layered electrolyte for high temperature co-electrolysis, *Alireza S Mehranjani*

- 6.24 Electrochemically assisted catalysis - interactions between different promoting species, *Efstathios Stavrakakis*
- 6.25 Process concepts for conversion of sugar cane residue to value added products, *Stavros Michailos*
- 6.26 Highly active Lewis acidic Ce- and Ln-Beta zeolites: water tolerant catalysts for the hydrothermal transformation of glycerol, *Suna Srisamai*
- 6.27 Experimental strategies for increasing the catalyst turnover number in a continuous Heck coupling reaction, *Joao Porfirio Da Silva Burgal*
- 6.28 Enhancements in H₂ and Biomass Productivities of Unicellular Cyanobacterium using a Two-Stage Chemostat Photobioreactor System, *Pongsathorn Dechatiwongse*
- 6.29 Impact of deposit composition and importance of hydraulic effects in crude oil fouling, *Emilio Diaz-Bejarano*
- 6.30 Foam fractionation separation of protein-surfactant mixtures, *Ishara Dedunu Kamalanathan*
- 6.31 Carbon capture and utilisation: Designing environmentally sustainable systems, *Rosa Marisa Cuellar Franca*
- 6.32 Development and Testing of Structured Novel Catalysts, *Chandni Rallan*
- 6.33 Film formation and rheo-mechanical properties of a model multicomponent formulation, *Giulia Ferretti*
- 6.34 Multizone micro-trickle bed reactor for cascade catalytic reactions, *Sourav Chatterjee*
- 6.35 Predicting the release of pharmaceutically active compounds by wastewater treatment plants. *Raphael Tarpani*
- 6.36 Formation of aerated structure in confectionery wafers: study of the pressure profile generated during the baking process, *Amit Verma*
- 6.37 Three Way Separation of Ternary Systems Using Molecularly Imprinted Nanofiltration Membranes, *Gyorgy Szekely*
- 6.38 EARP: A Three Dimensional Characterisation, *Richard Foster*
- 6.39 Molecular Dynamics Simulations of Slip Flow in Nanopores, *Daniel Ross*
- 6.40 Experimental Study of Convection and Reaction of CO₂ in Saline Aquifers, *Ilija Cherezov*
- 6.41 Effect of amine chain length on CO₂ adsorption for amine-based mesoporous MCM-41, *Zhilin Liu*
- 6.42 Kinetics of hydrogen isotope exchange over solid storage media, *Simon Owens*
- 6.43 Absorption Spectroscopy of Gas in Porous Scattering Materials for Applications in the Environment and Industry, *Ali Arafteh*
- 6.44 Phenomena of Raman Scattering, *Claudia Houben*
- 6.45 An integrated decision-support framework for assessing sustainability: Methodology and case study, *Martyn Jones*
- 6.46 Carbon Footprint and Economic Assessment of Conventional and Highly Efficient Ovens, *David Amienyo*
- 6.47 Assessing the Carbon Footprint of the UK Chemical Industry – A Sub-subsectoral Approach, *Inibong Ekang*
- 6.48 Multidimensionality in fluidized nanoparticle agglomerates, *Lilian de Martin*

- 6.49 Hydrogen Integration in Oil Refining, *Rizwan Ahmed Qamar*
- 6.50 Simulation of waste water processing by waterhydrogen exchange in fusion reactors, *Farid Aiouache*
- 6.51 Co-electrolysis of carbon dioxide and steam in a solid oxide electrolysis cell for fuel production, *Kayode Omojola*
- 6.52 Retrofit of crude oil distillation systems, *Victor Manuel Enriquez Gutierrez*
- 6.53 Hydrothermal carbonisation of sewage sludge: Effect of process parameters on dewaterability, *Eric Danso-Boateng*
- 6.54 Optimising the Thin Film Photocatalytic Spinning Disc Reactor, *Wan Salida Wan Mansor*
- 6.55 Designing Encapsulates Loaded with Highly Reactive Water Soluble Active, *Fideline L. Tchuenbou-Magaia*
- 6.56 Oil-water flows in pipelines of different diameter, *Kyeong Hyeon Park*
- 6.57 High performance membranes by interfacial polymerization for Organic Solvent Nanofiltration, *Maria F. Jimenez Solomon*

7. Seeking a Lectureship or Postdoc Position

pages 145-157

- 7.1 Applications of Mixed Integer Optimisation in Process Systems Engineering, *Sonsong Liu*
- 7.2 Bio-inspired Sustainable Chemical Reaction Engineering, *Victor Sans*
- 7.3 New bioengineered tailored platforms for ex vivo culture system, *Maria Rende*
- 7.4 Pore scale dynamics of salt transport and precipitation in drying porous media delineated by x-ray micro tomography, *Mansoureh Norouzi Rad*
- 7.5 Synthesis of Supported Zeolites for Heavy Metal Adsorption, *David De Haro-Del Rio*
- 7.6 Turning up the heat: Can we increase the life expectancy of nano-particles at high temperature? *Denis Cumming*
- 7.7 Paul Balcombe Personal Statement, *Paul Balcombe*
- 7.8 Advanced manufacturing by nanofiltration, *Patrizia Marchetti*
- 7.9 On evaporating droplets and the stability of thermocapillary flows, *Pedro Javier Saenz*
- 7.10 Seeking an Academic Position in Chemical Engineering, *Dipesh Patel*
- 7.11 Spatial aspects of signal transduction: from enzymes to networks to processes, *Aiman Alam Nazki*
- 7.12 Advanced Separation Techniques for Pharmaceutical Downstream Processing, *Gyorgy Szekely*
- 7.13 Ximena Schmidt Personal Statement, *Ximena Schmidt Rivera*
- 7.14 Brief summary of myself, *Irina Valtcheva*
- 7.15 Suspended animation, *Krishnaa Trishna Ashok Mahubani*
- 7.16 High Performance Hybrid PolymerMOF membranes for Separations and Catalysis, *James Campbell*
- 7.17 My Journey Towards Chemical Engineering Lectureship, *Fideline L. Tchuenbou-Magaia*

Research Posters

1. Energy/Water/Food Nexus

1.1 Aqueous Systems Under Confinement: From Preferential Adsorption and Exotic Structures to Their Relevance in the Energy Landscape

Alberto Striolo

University College London

a.striolo@ucl.ac.uk

A number of experimental and simulation results consistently show that a solid surface perturbs interfacial liquids for up to 1-2 monolayers. When confined in pores of with up to 1.5 nm, it is possible that all the confined water molecules have structure and dynamic that differ compare to those of bulk water. Our group is interested in understanding how this perturbation can lead to macroscopic observables. (For example, Giotto's frescos in the Scrovegni's chapel, Padua, Italy, and the Mogao caves, in Dunhuang, China, a lasting but frail testimony to the Buddhist influences on modern Chinese culture, are endangered by the humidity caused by the breathing visitors.) For example, we have observed, in simulation results, evidence for ion-specific effects under confinement that might be of relevance for nuclear waste storage, as well as for the development of electric double layer capacitors. More recently, we have investigated the effect of confinement on the properties of aqueous systems containing ethanol, methane, and other short hydrocarbons. We will present here our results for preferential adsorption, various diffusion mechanisms, and perhaps for the formation of hydrates that seems to be triggered by confinement. We will discuss how these observations might be relevant for the emerging technology of hydraulic fracturing.

1.2 Deformability-based red blood cell separation in deterministic lateral displacement devices

Burcin Atilgan

University of Manchester

burcin.atilgan@manchester.ac.uk

Turkey is a developing country with a rapidly growing economy and population. Like many other countries, it has difficulties in meeting energy demand as the endogenous fossil energy resources are not sufficient. On the other hand, Turkey has several advantages in terms of variety and its potential of

renewable energy resources compared to fossil fuels. The electricity demand in Turkey has been growing rapidly, reaching 211,208 GWh in 2010, almost seven-fold higher than in the mid 80s. In 2010, renewables generated 58,018 GWh, contributing 26.4% to the total renewables generated 58,018 GWh, contributing 26.4% to the total generation. The most important renewable energy source to generate electricity is hydropower (24.5%). The high share of fossil fuels in Turkey's electricity mix together with the increasing demand has led to a steady increase in GHG emissions from the sector, growing by 115% between 1990 and 2010. It is, therefore, important that Turkey identifies and implements sustainable energy technologies suitable for the country, if climate change and other environmental impacts are to be curbed. This project aims to estimate for the first time the life cycle environmental impacts of electricity generation from renewables in Turkey, using 2010 as the base year. Two functional units are considered: i) generation of 1 kWh of electricity by hydropower, wind power and geothermal power plants; and ii) annual generation of electricity from hydropower, wind power and geothermal power plants. The scope of the study is from cradle to grave, comprising electricity generation as well as plant construction and decommissioning. There are 55 reservoir hydropower, 205 run-of-river hydropower, 39 wind and 6 geothermal power plants in Turkey all of which are considered in this study. GaBi v5 software has been used to estimate eleven environmental impacts using the CML Baseline method. Example results include the global warming potential estimated at 6.8 g CO₂-eq/kWh from hydropower, 7.2 g CO₂-eq/kWh from wind power and 63 g CO₂-eq/kWh from geothermal power plants. Annually, electricity generation from renewable energy is responsible for 0.43 Mt CO₂-eq. on a life cycle basis which is almost 260 times lower than that from fossil fuels (111 Mt CO₂-eq.). Therefore, the government should also consider expansion of electricity generation from renewables which would lead to significant reductions in environmental impacts from the electricity sector.

1.3 An efficient and selective alkene epoxidation process

Misbahu L Mohammed

London South Bank University

mohamm74@lsbu.ac.uk

Chemical industries are continuously faced with increasing challenges of regulatory requirements and rising cost of manufacturing intermediates. Hence, a greener and efficient route for chemical synthesis that could improve manufacturing efficiency by reducing operational cost and minimising waste products is highly desired. Epoxides are key raw materials or intermediates in organic synthesis, particularly for the functionalisation of substrates and production of a wide variety of chemicals such as pharmaceuticals, plastics, paints and adhesives. The conventional methods for the industrial production of epoxides employ either stoichiometric peracids or chlorohydrin as an oxygen source. However, both methods have serious environmental impact as the former produces an equivalent amount of acid waste, whilst the latter yields chlorinated by-products and calcium chloride waste. There has been considerable effort to develop alternative alkene epoxidation methods by employing an oxidant such as tert-butyl hydroperoxide (TBHP) as it is environmentally benign, safer to handle and possesses good solubility in polar solvents. A notable industrial implementation of alkene epoxidation with TBHP was the Halcon process that employed soluble molybdenum(VI) as a catalyst for liquid phase epoxidation of propylene to propylene oxide. However, homogenous catalysed alkene epoxidation has several drawbacks

including deposition of catalyst on the reactor walls and increased difficulties in separation of catalyst from the reaction mixture. In this novel process, an efficient and selective polystyrene 2-(aminomethyl) pyridine supported molybdenum (VI) complex (Ps.AMP.Mo) has been used as a catalyst for batch epoxidation of 4-vinyl-1-cyclohexene. This process is solvent-free and uses environmentally benign TBHP as an oxidant. Experiments have been carried out in a 0.25 L batch reactor to study the effect of catalyst loading, feed molar ratio (FMR) of 4-VCH to TBHP and reaction temperature on the yield of 4-vinyl-1-cyclohexane 1, 2-epoxide for optimisation of reaction conditions. A detailed evaluation of molybdenum (Mo) leaching from the polymer supported catalyst has been investigated by isolating any residue from reaction supernatant solutions and then using these residues as potential catalyst in epoxidation reactions. Experimental results confirmed very high selectivity and efficiency of Ps.AMP.Mo catalyst for alkene epoxidation with TBHP as an oxidant.

1.4 The development of enhanced emulsifying agents by membrane fractionation of gum arabic

Harriet Manning and Michael Bird

University of Bath

h.manning77@gmail.com

Gum arabic is a hydrocolloid extracted from Acacia Senegal trees native to sub-Saharan Africa and is used widely. The gum is comprised of three fractions, each of a different structure, molar mass and functionality:-

- (i) 2 %Glycoprotein (GP) - 250 kDa
- (ii) 88 %Arabinogalactan (AG) – 280 kDa
- (iii) 10 %Arabinogalactan-protein complex (AGP) - 1500 kDa 1,2

The highest molar mass fraction (the AGP complex) has been shown to be the functional component in emulsification^{1,3} and therefore, high proportions of this AGP complex are desired in commercial products. Gum Arabic fractionation via chromatographic techniques has been previously reported but this paper demonstrates the first reported work on fractionation of gum arabic using synthetic membranes. Membranes offer the possibility of significant cost savings and improved scalability over the chromatographic separations route, albeit at lower product purities. As well as creating more effective emulsifying agents, gum arabic fractionation would also allow the blending of high AGP content streams with poorer quality gum in order to remove the, often significant, natural variation between batches. The AGP-poor fraction could then be used in non-emulsifying applications such as in adhesives or as a soluble source of dietary fiber. Permeate flux, Volume Reduction Factor and species transmission data are presented for flat sheet polymeric microfiltration membranes operated in a crossflow module. The use of 0.1 µm and 0.5 µm polysulfone flat sheet membranes (MFG1 and GRMRT5, Alfa Laval) give up to 85% rejection of the largest AGP fraction, whilst allowing selective transmission of the smaller AG and GP species. However, fouling leads to relatively high flux declines and low overall solids transmission values (transmission values reported are less than 10%). The effect of altering membrane pore size and material, along with feed temperature and mechanical filtration conditions are reported. The nature and

extent of the membrane fouling is described, and strategies for reducing fouling and improving selectivity and flux are reported. Regenerating the membrane through chemical cleaning is also considered and studied via imaging techniques.

Acknowledgements

This project has been supported by Kerry Ingredients and Flavours, Draycott Mills, Cam, Gloucestershire, UK

(1) Randall, R. C.; Phillips, G. O.; Williams, P. A. *Food Hydrocolloids* 1988, 2, 131.

(2) Randall, R. C.; Phillips, G. O.; Williams, P. A. *Food Hydrocolloids* 1989, 3, 65.

(3) Nishino, M.; Katayama, T.; Sakata, M.; Al-Assaf, S.; Phillips, G. O. In *Gum Arabic*; The Royal Society of Chemistry: 2012, p 269.

1.5 Hybrid Carbon Nanotubes PVDF Membrane for Bromate and Natural Organic Matter (NOM) Removal

Jono Suhartono

Swansea University

jonosuhartono@yahoo.com

This research studied the performance of a fabricated carbon nanotubes (CNTs) impregnated into a PVDF membrane for the removal of bromate and natural organic matter in water. The CNTs/PVDF membrane was fabricated using the phase inversion technique. Functionalised Plasma Carbon Nanotubes (CNTs-O) and Pristine Carbon Nanotubes (CNTs-P) were used in this study. Fabricated membranes using different concentrations of CNTs in the range 0-0.4 %mass were characterised and their water permeability and solute rejection under different pH and trans-membrane pressure were studied. As expected, the pure water flux for all membranes almost increased linearly with the TMP. On the other hand, increasing CNTs concentration increased water flux up to 0.2 %mass followed by a reduction in the flux when CNTs concentration increased further. The rejection of bromate was found to increase with CNTs content by up to 2.17 and 2.49 times as compared to pure PVDF membrane for CNTs-P and CNTs-O, respectively. However, increasing CNTs content has only affected a slight improvement on NOM rejection as compared to pure PVDF membrane. The membranes exhibit higher rejection ability for bromate and NOM at higher pH solution either with or without addition of CNTs. At lower pH solution, the membrane was found to foul by NOM easily whilst operation at higher pH around 10 significantly reduced membrane fouling from about $22 \times 10^{-2} \text{ mg/cm}^2$ to $2.76 \times 10^{-4} \text{ mg/cm}^2$ at pH 2.5 to pH 10, respectively.

1.6 A Hierarchical approach to evaluation of low-grade heat utilization opportunities

Gbemi Oluleye, Megan Jonson & Robin Smith

University of Manchester

Hybrid Carbon Nanotubes PVDF Membranes for Bromate and Natural Organic Matter (NOM) Removal



Prifysgol Abertawe
Swansea University

Jono Suhartono and Chedly Tizaoui

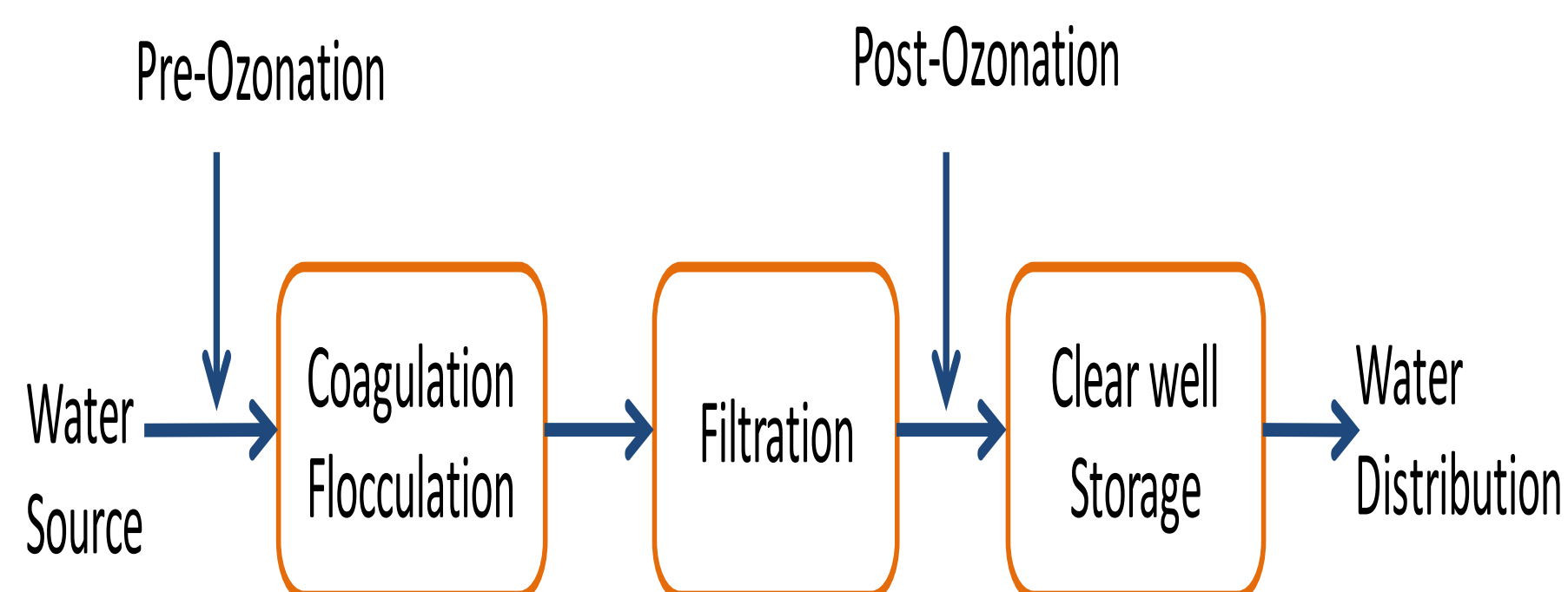
Centre for Water Advanced Technologies and Environmental Research (CWATER)

College of Engineering, Swansea University, SA2 8PP, UK

Email: c.tizaoui@swansea.ac.uk; jonosuhartono@yahoo.com

Research Background

Drinking water process schematic Diagram



Bromide

- Fresh water (trace – 0.5 mg/L)
- Desalination water (~ 1.0 mg/L)
- Sea water (65 – 80 mg/L)

Natural Organic Matter (NOM)

- Concentration varies depending on the raw water source.

Disinfection by Products (DBPs)

Bromate

- Carcinogenic
- Maximum contaminant 0.01 mg/L (WHO, 2011)
- Might be generated during water treatment ~ 0.293 mg/L.

Trihalomethanes (THMs) and Haloacetic acids (HAAs)

- Carcinogenic, liver, kidney, nervous system and reproductive effects
- Maximum contaminant 0.02 – 0.3 mg/L (WHO, 2011).

Polyvinylidene fluoride (PVDF) membrane

- Have shown good ability in rejecting solutes
- Their fabrication is relatively easy
- Excellent resistance to oxidants.

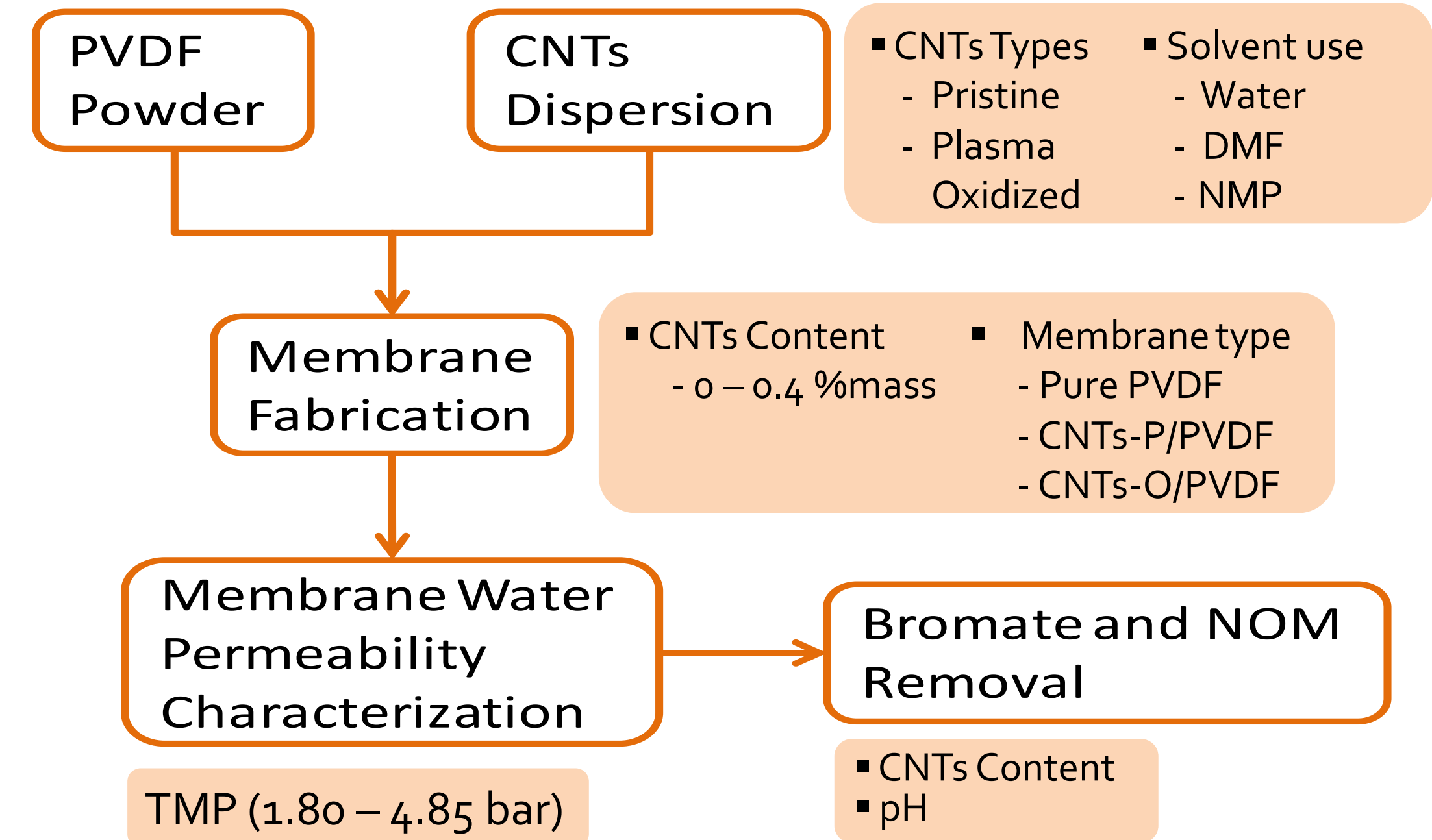
Carbon Nanotubes (CNTs)

- Surface functionalization changes CNTs properties
- Enhance membrane performance due to their unique physical, chemical and electrical properties
- Increase membrane permeability.

Research Objectives

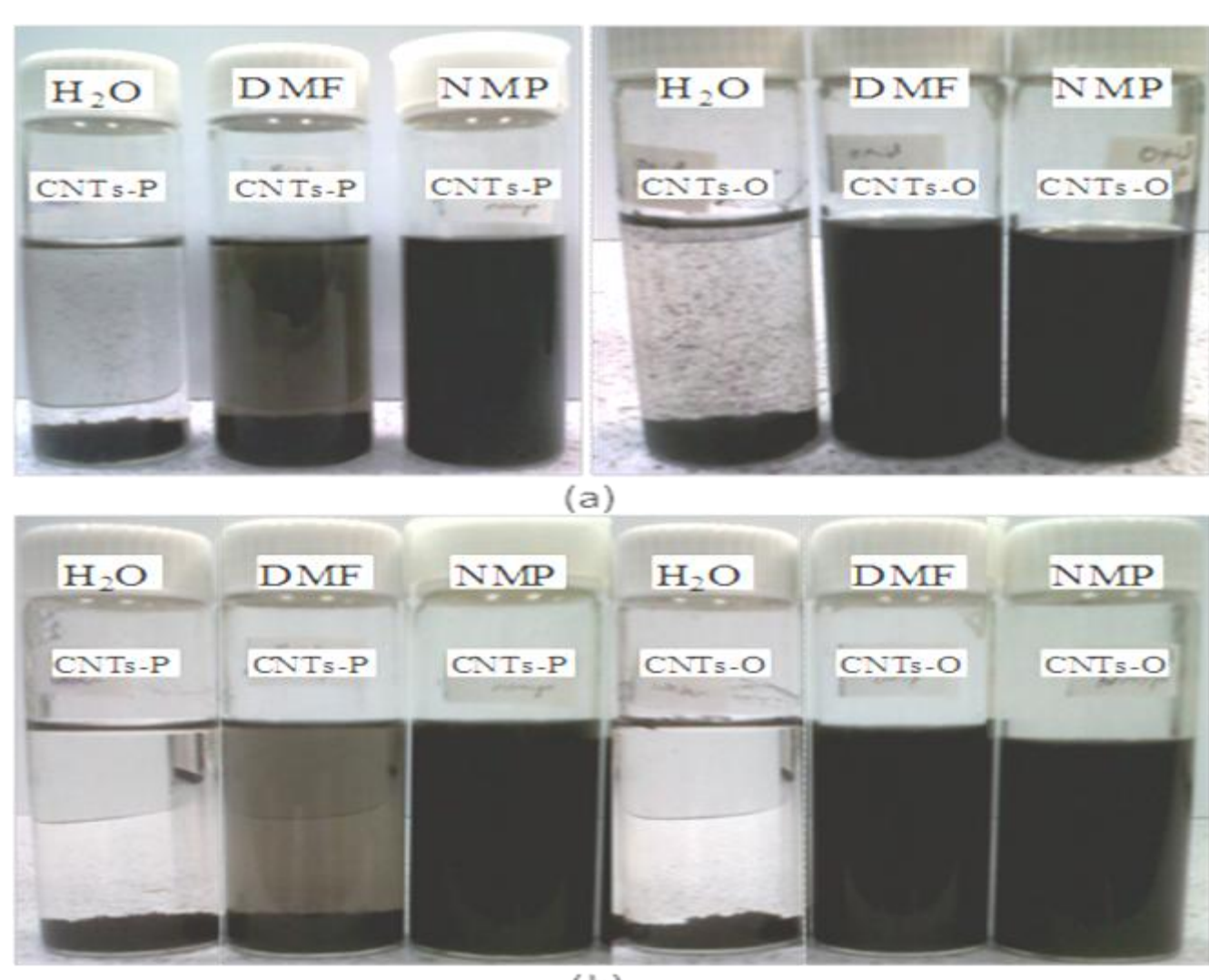
Study the performance of a fabricated carbon nanotubes (CNTs) impregnated PVDF membrane for the removal of bromate and natural organic matter in water.

Research Method



Results and Discussion

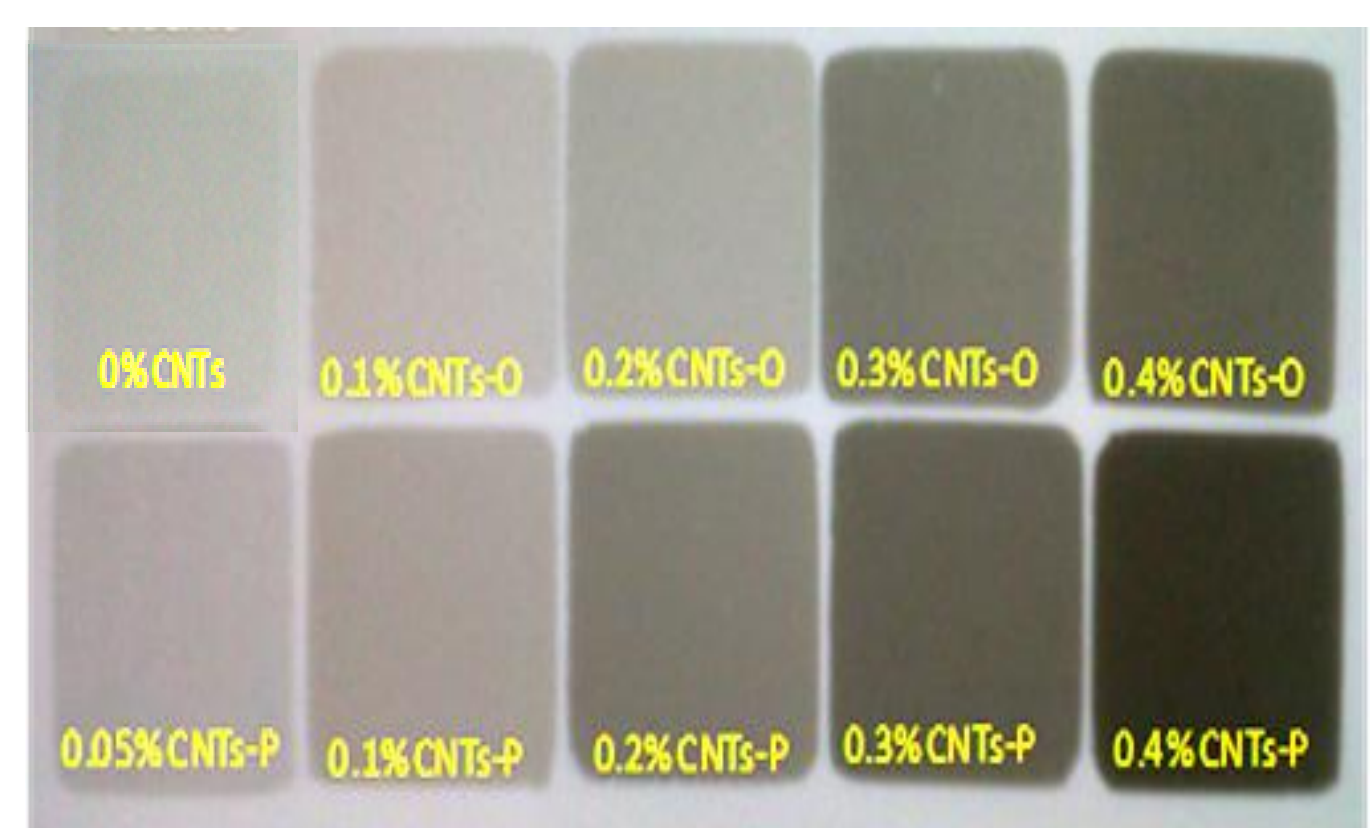
CNTs Dispersion



Dispersion of CNTs after (a) 1 hour and (b) 1 week

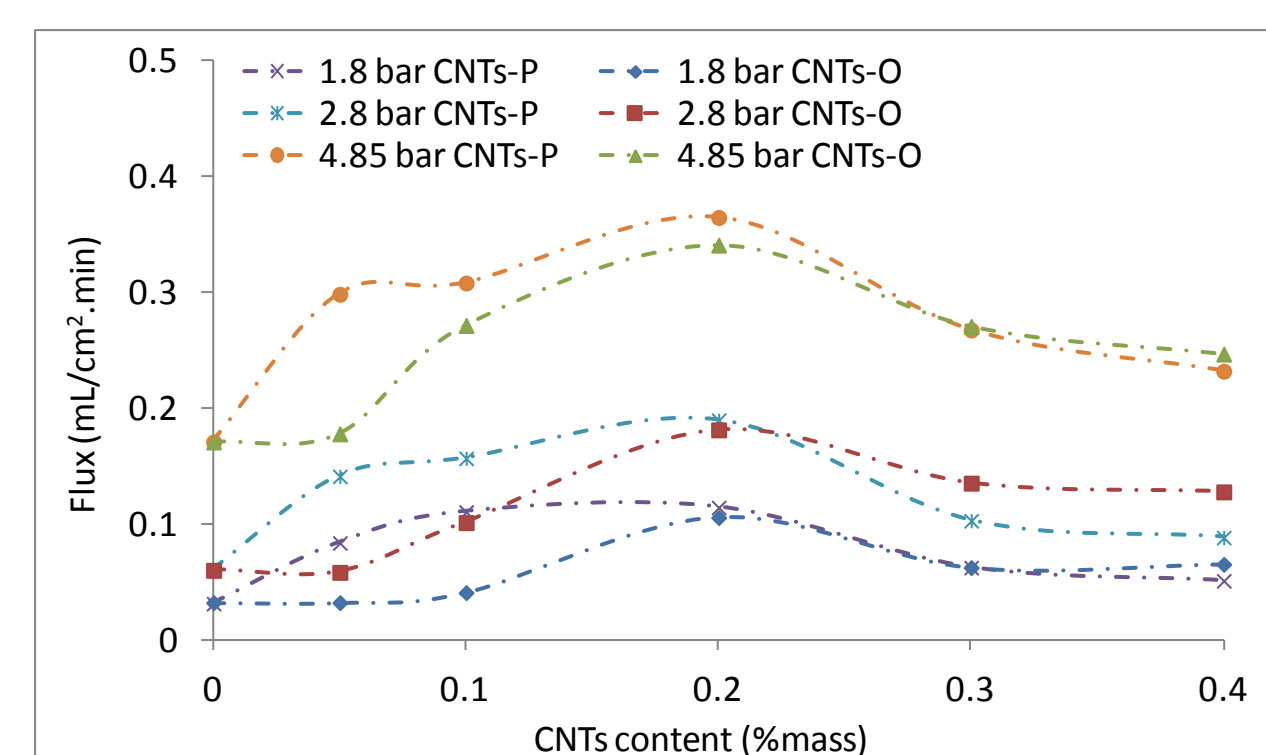
- The most stable dispersion was in NMP
- Both CNTs-P and CNTs-O perform stable dispersions after 1 week settlement.

Fabricated membrane images



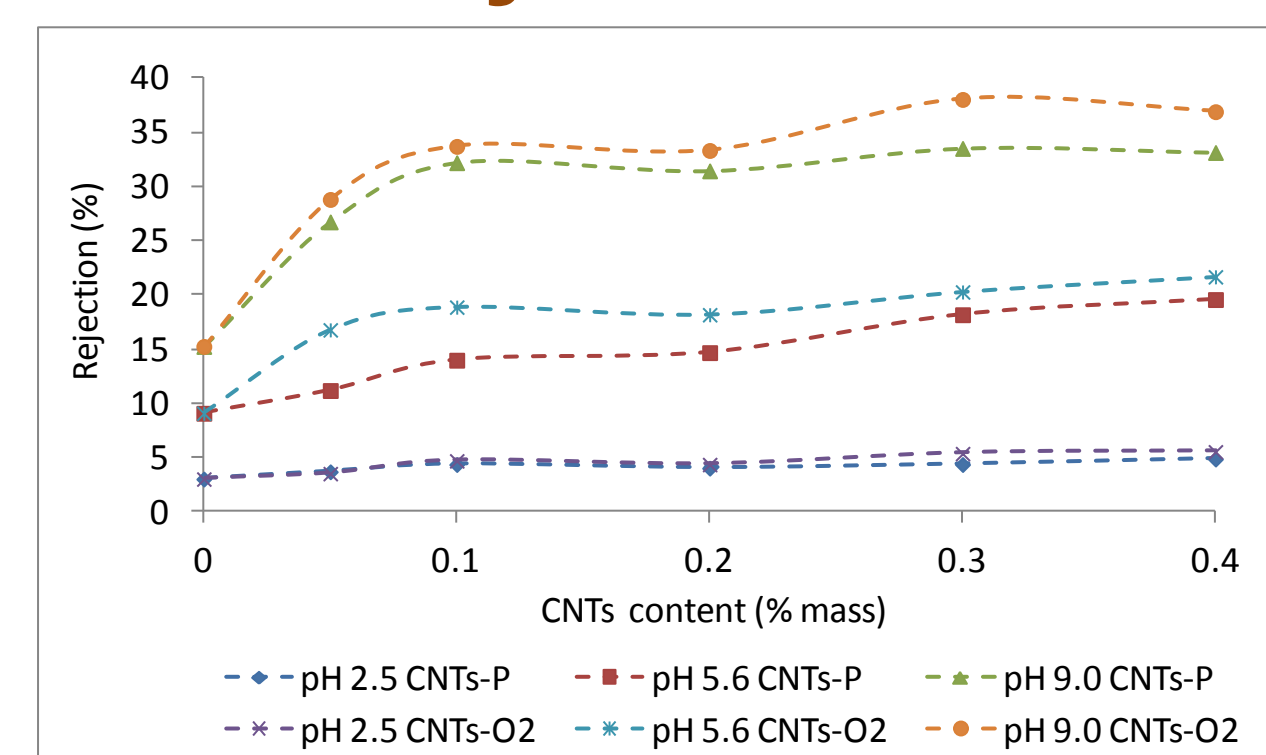
- Darker colour due to CNTs.
- Agglomeration of CNTs at high content were inevitable.

Membrane Water Permeation



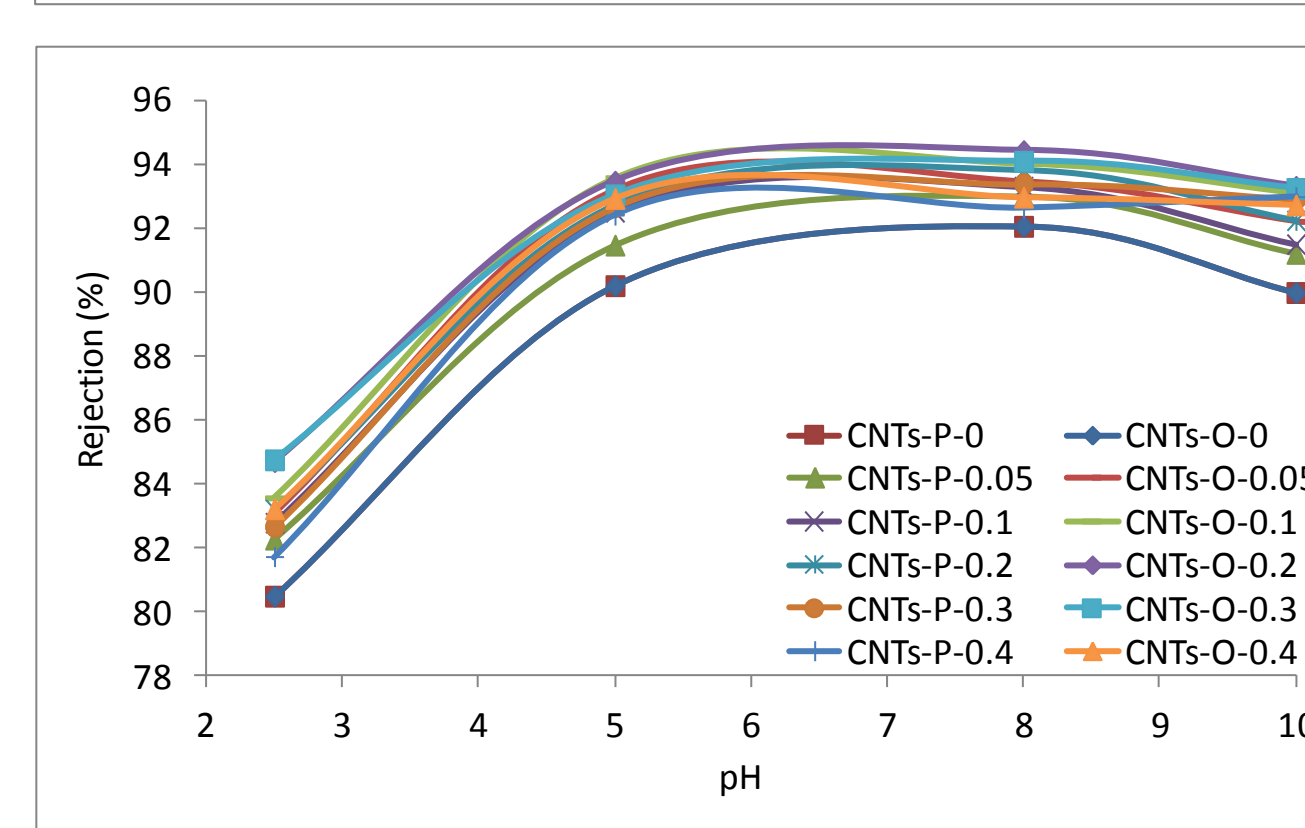
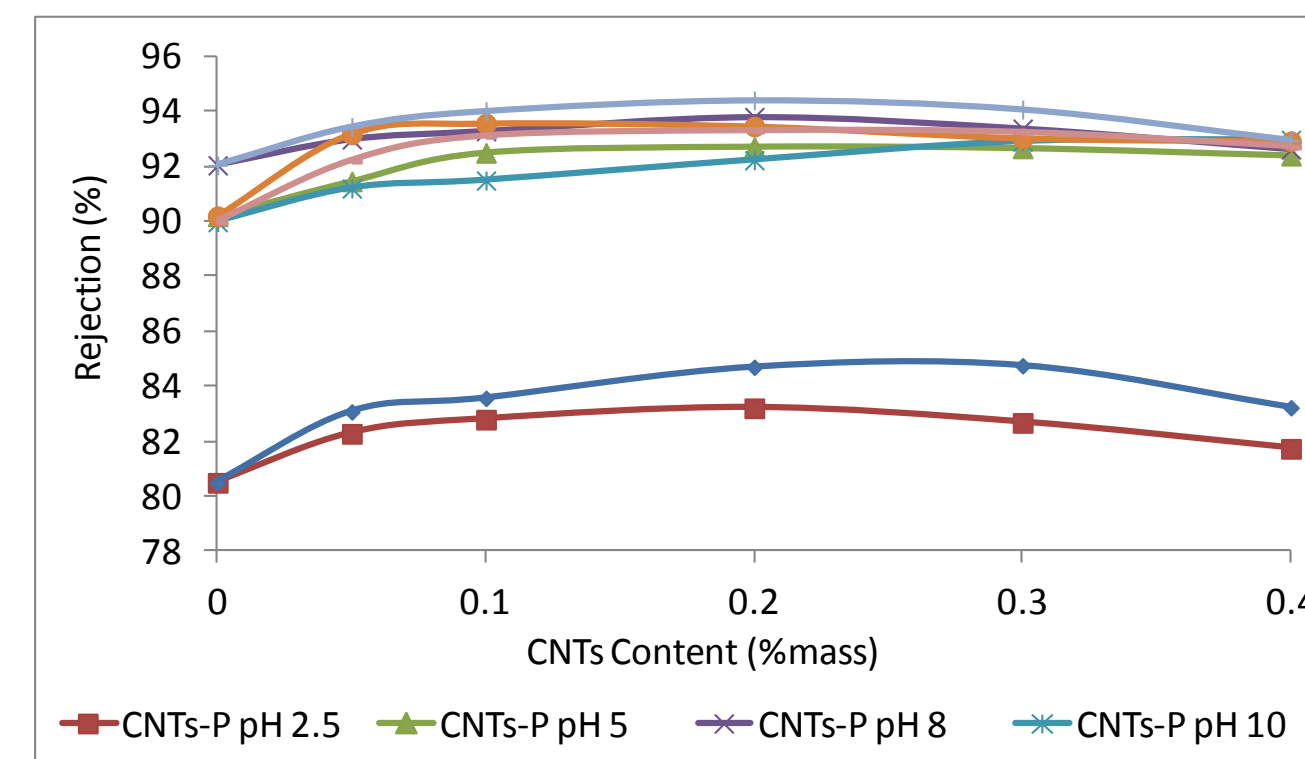
- Water flux continued to increase up to 0.2 %mass CNTs addition then followed by a decrease if further addition of CNTs was made.
- At 0.2 %mass CNTs, the flux has increased as compared to pure PVDF membrane at TMPs of 1.8, 2.8, 4.85 bar by 3.3, 3.0, and 2.0 times and by 3.7, 3.2, and 2.1 times for CNTs-O and CNTs-P respectively.

Bromate Rejection

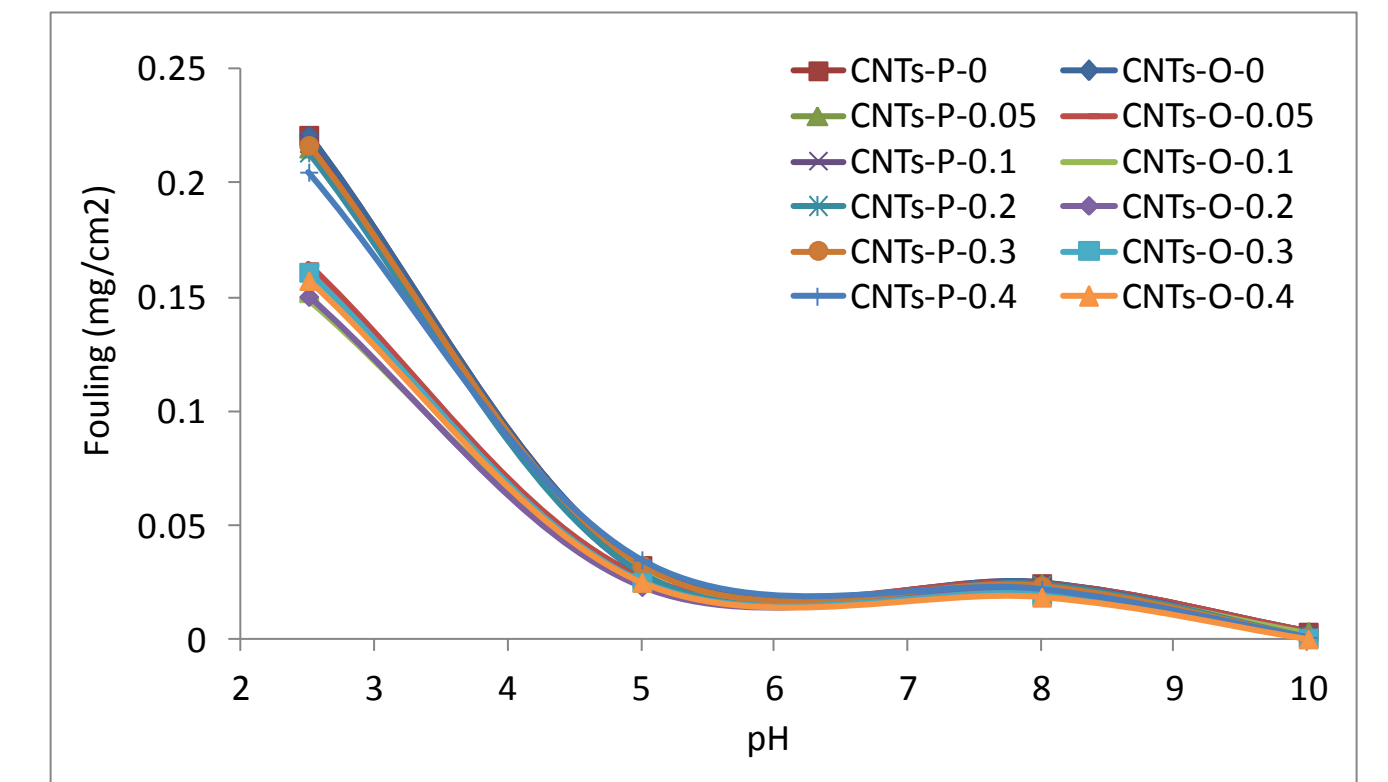
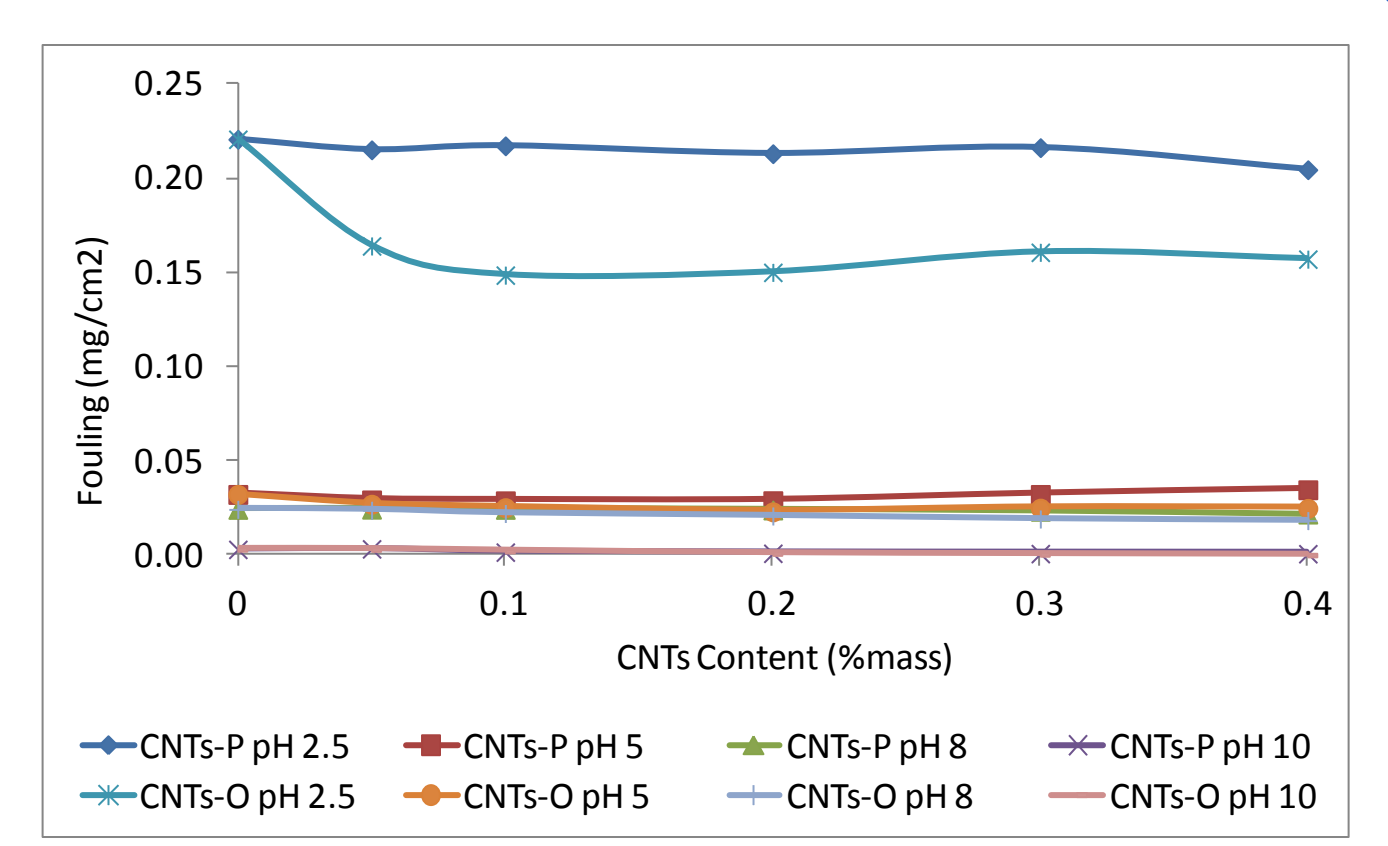


- The maximum rejection of BrO_3^- was only about 40%
- The rejection of bromate increased with CNTs content by up to 2.17 and 2.49 times as compared to pure PVDF membrane for CNTs-P and CNTs-O, respectively.

NOM Rejection and Fouling



- The membranes exhibited higher rejection of bromate and NOM at higher pHs due to their surface becoming strongly negatively charged.
- Increasing CNTs content has increased only slightly NOM rejection as compared to pure PVDF membrane.
- At lower pH solution, the membrane was found to foul by NOM more strongly whilst higher pH around 10 significantly reduced membrane fouling from about $22 \times 10^{-2} \text{ mg/cm}^2$ to $2.76 \times 10^{-4} \text{ mg/cm}^2$ at pH 2.5 and pH 10, respectively.
- CNTs reduced fouling by up to 67.33% and 73.54% for CNTs-P and CNTs-O, respectively.



Conclusion

- PVDF membranes showed rejection of bromate and addition of CNTs have improved their performance (max. ~40%).
- NOM rejection was significant in PVDF membrane.
- Higher pH operation resulted in higher solute rejection and reduced fouling of the membrane.
- Oxidized CNTs membrane tend to exhibit a slight improvement in rejection and fouling resistance.

Future work

- Study the membrane rejection using raw water.
- Study the removal of bromate and NOM in a hybrid ozone/membrane system.