2018 Summer

Membrane News Twente

Membrane Science & Technology

News magazine of the Membrane Science and Technology Cluster
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Welcome

A warm welcome to the newsletter of the Membrane Science and Technology Cluster! Within our cluster over 50 scientists work on nearly all aspects of membrane science and technology, ranging from membrane materials and transport phenomena to membrane modules and membrane processes.

In this newsletter we highlight the very successful 35th EMS Summer School, that was organized by the Membrane Science and Technology cluster. Over 60 PhD students from all over the world joined the school. The theme of this year's summer school was 'From Fundamental Concepts Towards Commercialization of Membranes'. In line with the broad approach to membrane science and technology, taken by our cluster, the approach at this year's summer school was also broad, and touched upon all major areas of membrane science. For every topic lectures were provided on fundamentals (mass transport, mechanisms, and characterization methods), membranes (materials, properties, fabrication, and configuration), and industrial applications and implementation process.

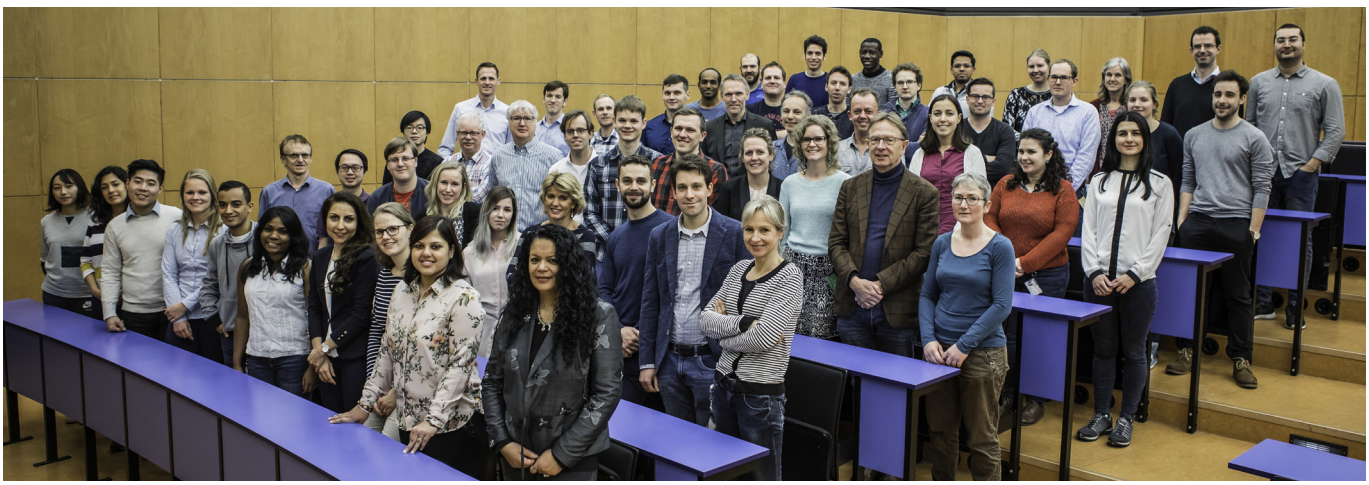
The lectures were given by the staff members of the MST cluster, but also by external experts, especially from industry. However, the summer school was much more than just a series of lectures. All participants worked together in small groups to solve various cases. In these cases, the participants worked out a separation problem from the selection of the membrane materials up to the financial aspects of starting a company. Finally, there was a strong social aspect to the summer school, with excursions to Pentair X-flow and Grolsch, and a membrane themed pub quiz.

Naturally, we also report on other aspects of the cluster, such as the many successful PhD graduations of the past 6 months and the many new people within our cluster. Finally, it is good to mention that there will be quite a few PhD and Postdoc positions available within the cluster over the coming months. If you are interested, then please keep an eye on https://www.utwente.nl/en/organization/careers/vacancy.

We invite you to read this newsletter and hope you will enjoy it. In case you have additional questions or you would like to receive further information or publications, please feel free to contact us at MSTtnw@utwente.nl or +31 53 489 2950.

On behalf of all members of Membrane Science and Technology at the University of Twente, we would like to wish you a pleasant summer holiday!

Dr. Wiebe de Vos



The MST Cluster!

35th EMS Summer School

From Fundamental Concepts Towards Commercialization of Membranes

The 35th EMS Summer School was held from 24th June to 29th June 2018 in University of Twente by Membrane Science and Technology Cluster. More than 60 participants from all over the globe enjoyed the perfect Dutch weather while gaining more insight into the membrane world. The program was divided into five major themes: 1. Water: From MF to RO membranes, 2. Chemicals: Solvent resistant nanofiltration and gas separation, 3. Energy: Ion transport, 4. Inorganic membranes, and 5. Health and aging: Membranes in biological processes. Participants were also given case studies where they worked in groups to propose a product development plan related to one of the themes.

EMS Summer school 2018 was not only about courses and group cases, but also had a lot of fun activities such as BBQ, pub quiz, sports and leisure, and also an excursion to one of the largest brewery in the eastern Netherlands.

To give you an overview of the activities of Summer School, we asked one of the participants to share their experience with us. Jéré van Lente is a PhD student at Nanobiophysics group and the Membrane Science and Technology Cluster at the University of Twente. In the following paragraphs, you can find the details as experienced by the author.

In the last week of June 2018, I attended the 35th EMS Summer School at the University of Twente in Enschede, the Netherlands. The university's campus is a mostly self-contained area complete with its own accommodation and catering opportunities. Many of us, therefore, stayed at dedicated lodging cabins located on only a few minutes walk from the lecture hall, restaurant, and the supermarket. After arrival and settling in, there was a welcome reception where we had the first opportunity to get to know both each other and the organizers under the pleasure of a few drinks.

The Summer School lectures were organized by daily themes, with the thematic sessions divided into three lectures on the topics of fundamentals, membranes and industrial applications to give an overview of both the fundamental physical and chemical principles of the separation mechanisms all the way to examples from membranes in practice. The theme for the first day was water and emphasized the role of polymeric porous and dense membranes for aqueous separations. On the topic of water and membranes, one of the most important topics is that of wastewater treatment and the production of drinking water, where the CEO of Oasen showed us several examples of both. To see them in practice we took part in an excursion to

First day excitement at the EMS Summer School.

the nearby Pentair testing facility in Enschede, where water filtration membranes are stress-tested and their lifetime is evaluated.

Thumbs up for the camera!

The theme of the second day was chemicals, which covered both the use of organic solvents instead of water and the subsequent factors important to membranes and the use of membranes in gas separation. Evonik presented several of their gas separation commercially available membranes. Aside from the lectures, on this day we were introduced to the group case studies; in predetermined groups,several cases based on the themes of the summer school were given where the objective was to present a product. My group specifically was assigned a case based on hospital wastewater treatment, connecting neatly to the theme of yesterday. To enjoy the green and park-like environment of the campus there was some time scheduled for leisure time or sports based on everyone's personal preference. After dinner, the final lectures of the day were more light-hearted, dedicated to ethics in science and common pitfalls with hints and tricks for organizing your data into graphs that please editors, reviewers and readers alike. An important if often overlooked skill.

The theme of the third and halfway day was energy, which focused on ion transport and retention as they relate to membranes. A complicated subject that mostly has applications in the development of membrane-based batteries. Following the lectures, the research facilities of the Membrane Science & Technology research cluster of the University of Twente were available to be toured. To help us with our case study a workshop on business models and pitches gave us some pointers on what to pay attention to, as I am sure that I was not the only researcher that is not well versed in the business-side of transferring fundamental knowledge to commercial applications. The day was concluded by a group barbeque and a pub quiz on membrane knowledge, general scientific knowledge, and pop-culture. Unfortunately, I did not win.

Fierce competition during the pub quiz.

The penultimate day was dedicated to inorganic membranes. So far most of the lectures had been about polymeric membranes which can, in general, be characterized as cheap, disposable and readily available. In contrast, inorganic membranes are far more expensive but can last multiple years. They provide a different membrane engineering challenge compared to polymeric membranes, but also

A little escape from the courses!

different benefits. After more time to work on the case studies an excursion to the local Grolsch beer brewery was on the agenda. The brewery tour showed us the brewing facilities (including membrane filtration), bottling lines and naturally, we finished with beer tasting next to dinner.

It's beer time at Grolsch!

The final day's theme was membranes in health and aging. We had mostly been discussing membranes in a chemical or physical sense however, membranes have applications in medicine and biology as well, such as for blood filtration in kidney dialysis. In addition to biomolecules making the exact processes in membranes difficult to follow, the body is an immensely hostile environment to (polymer) membranes. Before farewells, the afternoon was dedicated to presentations/pitches of the group case studies. Every case had two groups working on it so there was plenty of variety and interesting ideas to watch.

Finally, before we all left to go back to our homes, there were goodbye drinks as we exchanged farewells with our new friends and discussed at which conferences we'd meet up next. I think all of us will look back on the 35th EMS Summer School as an informative and fun time not to be forgotten anytime soon.

Jéré van Lente.

Jéré presenting his 'Carbon Company'.

A traditional picture with the University of Twente logo.

PhD Graduations of the MST Cluster

Dr. Anne Benneker

Dr. Anne Benneker with her thesis committee.

On April 20th, Anne Benneker successfully defended her thesis entitled "From Small to Big: Ion Transport at Interfaces" (SFI group, promotor Lammertink, co-promotor Wood). The work described in this thesis involved experimental and numerical investigations on ion and related fluid-transport near ion-selective interfaces. The primary system of interest was electrodialysis, where ions are transported under application of an external electric field and separated by charge-selective interfaces. This work was carried out over a variety of length scales, from ion-selective nanochannels to larger commercial ion-exchange membranes operating in electrodialysis stacks. Anne explored numerous aspects of these systems, including the use of temperature gradients to selectively-enhance transport and the role of system geometry on the resulting ion and fluid transport phenomena. Her work involved characterizing the concentration and fluid fields experimentally using a combination of microfluidic experiments where the fluid motion was determined using particle-tracking microscopy and concentration fields were measured using fluorescence imaging techniques in combination with electrical-measurements. In addition to the broad depth of experimental work performed during this thesis, Anne carried out numerous numerical simulations of ion-transport in systems containing charge-selective interfaces in order to further understand experimental results and design new experimental systems. The detailed investigations performed in this work yielded new insights into the understanding of ion-transport in systems with ion-selective interfaces and has implications in numerous ion-transport phenomena related applications.

As a next step, Anne is continuing her academic career. She will start this fall at the University of Calgary (Canada) as an Assistant Professor in the Schulich School of Engineering working on Interfacial and Transport Phenomena related to Energy Applications.

A digital copy of the thesis can be found at: https://doi.org/10.3990/1.9789036544924

Dr. Timon Rijnaarts

Timon Rijnaarts defended his thesis entitled "The role of Membranes in the use of natural salinity gradients for reverse electrodialysis" on the 3rd of May 2018. Timon performed the work in the Blue Energy theme within Wetsus. He was supervised by Prof. Kitty Nijmeijer (promotor) and Dr. Wiebe M. de Vos (co-promotor).

In his thesis, Timon studied how the chemistry of the membrane affects ion transport and properties in reverse electrodialysis (RED). A focus point in his thesis is the role of divalent ions and how their negative impact on RED can be mitigated by the correct choice of membrane and by pretreatment, such as Donnan Dialysis. Timon then also demonstrated that coating thin layers of polyelectrolytes on Ion Exchange membrane can provide a simple and cheap route towards ion selective membranes.

The full thesis of Dr. Timon Rijnaarts can be found at:
http://dx.doi.org/10.3990/1.9789036545402

Dr. Timon Rijnaarts pictured with his thesis.

Dr. Terica Sinclair

On the 31st of May, Terica Sinclair defended her thesis "Virus Control by enhanced physical separation". Terica performed the work in the Virus Control theme within Wetsus. She was supervised Dr. Wiebe M. de Vos (co-promotor), Prof. Erik Roesink (promotor) and Prof. Ana Maria de Roda Husman (RIVM).

Dr. Terica Sinclair with her thesis committee.

The work of Terica revolved around the development of new membranes that could remove bacteria and waterborne viruses for the poorest and most remote parts of the world. This meant that the membrane preparation needed to be simple and that the membranes should be open enough that they can be used in a simple gravity driven operation. Terica resolved this by using a simple electrostatic adsorption mechanism. Micro-filtration membranes were coated with positively charged polymers to subsequently allow virus removal by adsorption of the negatively charged viruses to the membrane surface. In combination with viral inactivation agents such as silver and copper nanoparticles this lead to very high (99.99%) viral reductions when operating under challenging gravity driven operations.

The full thesis of Dr. Terica Sinclair can be found at: http://dx.doi.org/10.3990/1.9789036545495

Dr. Mehran Abtahi

On Monday the 18th of June 2018, S. Mehran Abtahi defended his thesis "Towards tertiary micropollutants removal by bioaugmented moving bed biofilm reactors and nanofiltration". Mehran performed his research in the framework of the Erasmus Mundus Doctorate in Membrane Engineering (EUDIME), and the project was a cooperation between 3 universities: Université Paul Sabatier (Toulouse, France), the University of Twente and KU Leuven. From the university of Twente he was supervised by Dr. Wiebe de Vos (co-promotor) and Prof. Dr. Erik Roesink (promotor). The graduation ceremony took place in Toulouse.

Dr. Mehran Abtahi and his committee directly after the defense.

In his research Mehran proposed a new approach to achieve the removal of micropollutants (MPs) from municipal wastewater. First a Nanofiltration (NF) membrane concentrates the MPs, and the concentrate is used to adapt bacterial strains.

The adapted bacteria were then used in a bioreactor to more efficiently metabolize MPs. The bioreactor part of this project was carried out in Toulouse, under the supervision of Dr. Claire Albasis and Dr. Claire Joannis Cassan. NF membranes were then developed in Twente on the basis of polyelectrolyte multilayer membranes, leading to NF membranes with a high MP retention and a low salt permeation. In Leuven, under the supervision of Ivo Vankelecom these membranes were even further improved on the basis of a salt annealing approach.

The full thesis of Dr. Mehran Abtahi can be found at: http://dx.doi.org/10.3990/1.9789036545594

Dr. Jordi Moreno

"Energy generation from salinity gradients with reverse electrodialysis, fouling management and process design" was the title of the thesis defended by Jordi Moreno on the 22nd of June. The work in this thesis was carried out within the Blue Energy Theme of Wetsus, in Leeuwarden. Much of the work was was carried out at the RED pilot plant located at the Afsluitdijk. This made the defense, which was held in Leeuwarden itself, extra special. Jordi Moreno was supervised by Prof. Kitty Nijmeijer.

In his thesis, Jordi studied approaches to improved RED performance by designing smart approaches to clean the membrane and by smart stack designs. For example, membrane stack cleaning by CO_2 bubbles led to excellent control over fouling, while a breathing cell approach, that allows a variable inter-membrane distance, lead to lower stack resistances. Finally, Jordi and Timon also worked together to study membrane fouling for different membrane surface chemistries.

Dr. Jordi Moreno with his PhD Diploma.

The full thesis of Dr. Jordi Moreno can be found at: http://dx.doi.org/10.3990/1.9789036545747

Dr. Evelien Maaskant

Evelien Maaskant defended her thesis titled, "Mix and match: new monomers for interfacial polymerization" on Friday, 6th of July 2018. Evelien worked on interfacial polymerization in the Films and Fluids group of Prof. Nieck Benes, who was also her promotor.

Her research work focused on the synthesis of new materials prepared by interfacial polymerization by incorporating new monomers. The hyper-cross-linked nature of films prepared from monomers with a high functionality, significantly reduces the loss of membrane performance by e.g., swelling or plasticization. She proved that the choice of monomers and reaction conditions plays a crucial role in the properties of the film formed. The defect free composite membranes were then used to separate different compounds with high retention. She also proposed the preparation of thin (2–5 µm) cyclomatrix polyphosphazene films. Depending on the pKa values of the monomers used, the cross-link density of the films can be altered.

Dr. Evelien Maaskant receiving her PhD diploma from Prof. Nieck Benes.

The full thesis of Dr. Evelien Maaskant can be found at: http://dx.doi.org/10.3990/1.9789036545167

New MST Members

Technical Staff

Mees Meulenbeek

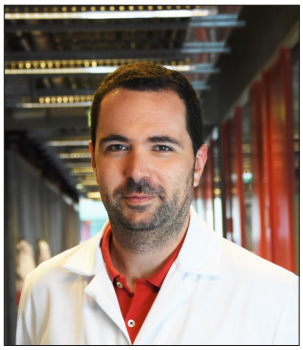
Association: Membrane Science and Technology

Research Assistant

Rosalind Gertenbach

Association: European Membrane Institute

Industrial Researcher



Dr. Alberto Tena Matias

Association: European Membrane Institute

Post Doctoral Staff

Dr. Marie-Alix Pizzoccaro

Group: Inorganic Membranes

Dr. Türkan Ormancı-Acar

Group: Membrane Surface Science

PhD Students

Ameya K. Bysani, MSc

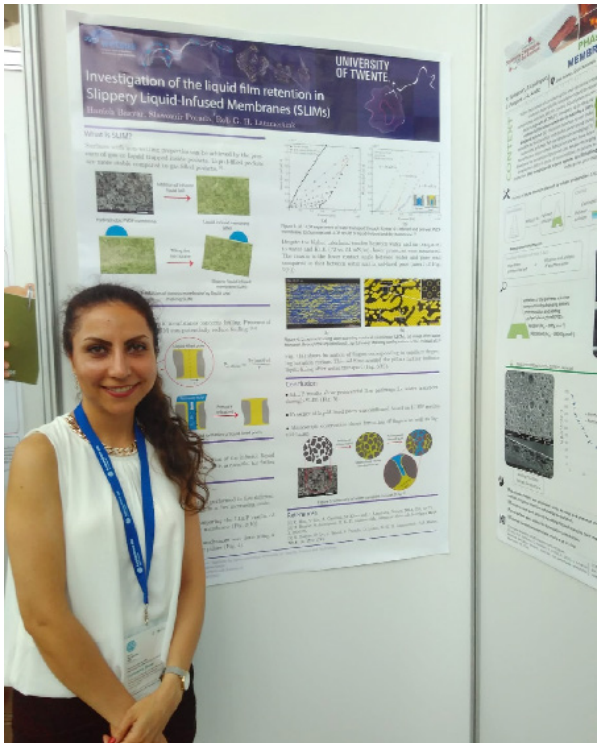
Group: Membrane Surface Science

Nicole Timmerhuis, MSc

Group: Soft Matter, Fluidics and Interfaces

Euromembrane 2018

VALENCIA - EMI Twente recently attended Euromembrane 2018 as an exhibitor. They were very pleased with the high level of interest the stand generated from the 700 international participants. Their next exhibit will be at the 17th Aachener Membran Kolloquium, 14/15 November 2018.



Hanieh Bazyar of SFI won the best poster presentation award at Euromembrane 2018. The title of her poster was, 'Investigation of the liquid film retention in slippery liquid-infused membranes (SLIMs)'.

MNT- Information

Membrane News Twente is published two times per year and aims to inform the membrane community about the activities of the Membrane Science and Technology cluster of the University of Twente (MSTtnw@utwente.nl, www.utwente.nl/tnw/mtg).

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