

## **BOOK OF ABSTRACTS**

**3rd INTERNATIONAL CONGRESS  
Separative Techniques Facing the Challenges  
of Sustainable Development**

**3ème CONGRES INTERNATIONAL  
Les Techniques Séparatives Face aux Défis  
du Développement Durable**



**FRANCOFILT 2023**

**10 - 12  
May 2023  
Fez - Morocco**



### ***Organized by***

Laboratory of Processes, Materials and Environment  
Faculty of Science and Technology of Fez  
Sidi Mohamed Ben Abdellah University  
Moroccan Membrane and Desalination Society  
Institute of Filtration and Separation Techniques

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## Fès – Maroc



Faisant partie des villes impériales, cette **ville historique du Maroc** a été à plusieurs époques la capitale du pays, et peut être considérée de nos jours comme la capitale spirituelle du pays. Sa fondation remonte à la fin du VIII<sup>e</sup> siècle.

La ville est particulièrement réputée pour sa médina, la partie ancienne de la ville, classée au patrimoine mondial de l'UNESCO. Fes el-Bali constitue le cœur de la médina. Fondé durant le haut Moyen-Âge (VIII<sup>e</sup> siècle), ce quartier entièrement piéton abrite notamment la mosquée des Andalous et la mosquée Quaraouiyin. Entourée de remparts, cette partie de la ville comporte de nombreux souks.

Après les animations et l'agitation des ruelles de la médina, le jardin botanique Jnan Sbil vous invitera à la détente et la sérénité. Au sein de cette véritable oasis de verdure magnifiquement rénovée en 2010, vous découvrirez les plus belles plantes typiques du Maroc mais aussi de nombreuses essences exotiques et pourrez-vous rafraîchir à loisir près des fontaines tout en appréciant le parfum délicat des fleurs d'oranger.

## Avant-propos



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### Laboratoire des Procédés, Matériaux et Environnement

Après le succès des précédentes éditions de Francofilt, cette année, Fès, ville impériale du Maroc, accueille le 3ème congrès international sur les Techniques Séparatives Face aux Défis du Développement Durable – Francofilt 2023. Cette manifestation scientifique est organisée par le Laboratoire des Procédés, Matériaux et Environnement (LPME) de la Faculté des Sciences et Techniques de Fès - USMBA de Fès, Maroc, la Société Marocaine des Membranes et de Dessalement (SMMD, Maroc) et l'Institut de la Filtration et des Techniques Séparatives (IFTS, France).

La thématique de ce congrès est particulièrement choisie, elle traite les enjeux du développement durable dans les secteurs de l'eau, de l'énergie et de l'environnement. Pour faire face aux défis des changements climatiques, des stratégies de gestion durable et de traitements efficaces de l'eau, des effluents industriels et domestiques devront être adoptées par les industriels, les scientifiques et les opérateurs afin de favoriser des solutions respectueuses de l'environnement.

Ce congrès est destiné à la communauté scientifique et technique, Il réunira des chercheurs, des décideurs et des gestionnaires provenant des universités, des instituts de recherche, des compagnies des eaux et des industries pour présenter les nouvelles avancées et faire le point sur les résultats de recherche dans le domaine de la filtration et de la séparation qui constituent le développement des procédés et des technologies durables.

Les travaux de ce congrès seront présentés et discutés durant les trois jours selon le programme scientifique qui comprendra des conférences plénières, des présentations orales et des posters. Un espace de stand d'exposition sera mis à disposition des industriels pour exposer leurs équipements.

Nous tenons à remercier le comité scientifique et le comité d'organisation qui ont contribué à la réussite de ce grand événement. Nous tenons à exprimer notre sincère gratitude à nos collaborateurs, à nos sponsors et aux participants pour leur contribution à cette manifestation scientifique de haut niveau.

Nous nous réjouissons de vous accueillir à Fès pour participer à cet événement passionnant.

Bienvenue à Fès

**Pr. Abdelhadi LHASSANI**

**Président du congrès FrancoFilt 2023**

## About SMMD

### Moroccan Membrane and Desalination Society (SMMD)



Website : [www.smmd.ma](http://www.smmd.ma)



Prof. Dr. Saad ALAMI YOUNSSI  
Director of Laboratory of Materials  
Membranes and Environment (L2ME)  
University Hassan II of Casablanca  
Moroccan Membrane and Desalination  
Society (SMMD), President

Moroccan Membrane and Desalination Society (SMMD) is a Moroccan Non-Governmental Organization (NGO) and Non-Profit Organization (NPO), created in May, 2005 by group of academic and industrial researchers in membrane technologies and desalination.

The SMMD is very pleased to co-organize with Laboratory of Processes, Materials and Environment-University USMBA of Fez and the Institute of Filtration and Separation Techniques, France the 3rd International Congress, FRANCOFILT 2023 "Separative Techniques Facing the Challenges of Sustainable Development", 10 - 12, May 2023, Fez – Morocco.

#### SMMD objectives

- Improvement of R&D in the field of water desalination and membrane technologies;
- Set up and improvement of knowledge management in the field of the use of membrane technologies at Moroccan and regional levels;
- Create synergy between researchers and industrial or potential users of the membrane technologies;
- Strengthen cooperation with Moroccan, and international organizations and institutions operating in the field of water and desalination;
- Technical assistance to promote the capacity building in the field of membrane technologies and water treatment.

#### SMMD organization

- Pole 1: Research and Development R&D;
- Pole 2: Interface, Technology Transfer, Expertise;
- Pole 3: Training and Communication.

#### SMMD's main scientific activities

- Second International Symposium on Nanomaterials and Membrane Science for Water, Energy and Environment Desalination and Reuse in the face of water scarcity, June, 1&2,2022 Tangier-Morocco
- International Workshop on Scientific Research for Industrial and Agricultural Development, December 19, 2019, Meknes, Morocco
- International Workshop on Pollutant Fate and Water Treatment, March 6, 2019, Fez, Morocco
- The first edition of International Symposium on Nanomaterials and Membrane Science for Water, Energy and Environment organized on October 2018 in Marrakech

- International Workshop on « Nitrates and pesticides in water: problems and treatments », April 5, 2018, Kenitra
- International Workshop on « Membrane Technologies for Desalination and Water Treatment: Current State and Research Prospects in Morocco », November 16, 2017, Mohammedia
- International Workshop « Sciences and Membrane Technologies » Renewable energy and water treatment. In collaboration with UNESCO Chair SIMEV and the African Membrane Society (AMS). April 15-17, 2014, Casablanca
- Set up research platform, in May 2014, at Al Anouar High school, Sidi Tayebi Municipality, Province of Kenitra. Morocco: membrane technology connected to photovoltaic and a wind power production system
- International Conference on « Desalination and Sustainability » in collaboration with IDA. March 1-2, 2012, Casablanca
- Course in collaboration with MEDRC « Desalination of sea and brackish waters by Nanofiltration and Reverse Osmosis. Modelling and simulation process ». February 2-5, 2009. Cerphos - OCP, Casablanca
- International meeting on «The Resources Management of Water in the dry zones », April 26-27, 2008. Palais des Congrès – Laayoune, Morocco

We warmly welcome you to Fez and we hope you enjoy your stay in our city and take the opportunity to see the sights.

- Tank You very mach

## About IFTS



### IFTS Institut de la Filtration et des Techniques Séparatives

Principal instigateur des congrès FRANCOFILT en 2017, l'IFTS est fier de contribuer activement à la dissémination de la connaissance en matière de Filtration et Techniques Séparatives avec un objectif supplémentaire original assigné aux congrès FRANCOFILT : celui de rassembler toute la communauté scientifique et technique francophone mondiale sur ce thème.

Le congrès FRANCOFILT 2023 organisé à Fès conjointement avec la Faculté des Sciences et Techniques de Fès (Laboratoire des Procédés, Matériaux et Environnement (LPME) - USMBA de Fès, Maroc), et la Société Marocaine des Membranes et de Dessalement (SMMD, Maroc) répond parfaitement à ce double enjeu et ce congrès prévoit de tenir toutes ses promesses avec un axe particulier cette année : celui des « Techniques Séparatives Face aux Défis du Développement Durable ».

Créé en 1981 près de Bordeaux, France, l'IFTS (Institut de la Filtration et des Techniques Séparatives), est un Centre d'Etudes et d'Essais indépendant, existant sous forme associative et régi par la loi de 1901. L'IFTS déploie ses compétences et propose des produits et des services autour de tous les procédés de séparation des solides et des liquides par filtration, décantation, centrifugation, séparations membranaires... Plus récemment l'IFTS s'est développé dans le domaine de l'air et propose désormais des services spécifiques dédiés à ce milieu.

Au fil des ans, l'IFTS est devenu un partenaire privilégié de l'industrie mondiale : de la chimie à la mécanique et l'automobile, du nucléaire à l'aéronautique, de l'agroalimentaire au traitement des eaux, son champ d'application est immense et ses partenaires prestigieux. De grands noms de l'industrie comme Véolia, Total, Safran, Filtration Group, EDF, Sanofi, Arkema sont adhérents de longue date de l'IFTS. Ils viennent rechercher, comme d'autres PME ou TPE, son expertise unique. L'IFTS s'adresse aussi à toutes les collectivités particulièrement dans le domaine de la gestion de l'eau et des effluents.

L'IFTS dispose de 2500 m<sup>2</sup> de laboratoire à Foulayronnes et d'un laboratoire d'essais, unique au monde, dédié à l'eau et ses traitements, situé en bord de Garonne à Agen : le Centre d'Essais Roger Ben Aïm, du nom de son créateur. L'IFTS possède également un laboratoire en Chine spécialisé dans le secteur automobile à Shanghai ainsi qu'une représentation aux Etats Unis.

L'IFTS commercialise ses produit et services partout dans le monde et dispense des formations spécialisées en France dans le cadre de la formation continue en collaboration avec une structure certifiée QUALIOP, mais aussi à l'étranger. Grâce à son organisation, plus de la moitié de son chiffre d'affaire est réalisé avec des clients hors de France.

L'IFTS est doté d'un conseil scientifique composé de 40 membres à la fois adhérents de la structure ou chercheurs de laboratoires universitaires ce qui lui permet d'asseoir, sur des bases solides, sa recherche lui octroyant 3 labellisations : Centre de Ressources Technologiques, Structure de Recherche sous Contrat et Institut Carnot Eau et Environnement. Ses travaux de recherche sur les méthodes d'essais, souhaitées par ses adhérents industriels et validées par une communauté d'experts scientifiques, amène l'IFTS à les proposer en comité de normalisation. Grâce à ce mécanisme, l'IFTS est porteur de nombreuses normes d'essais industriels appelées par les bureaux d'études dans leurs cahiers des charges.

Pour réaliser ces essais normés, l'IFTS est par ailleurs accrédité par le COFRAC selon le référentiel ISO 17025 pour les prestations listées sur sa portée (voir renseignements sur le site de l'IFTS). L'IFTS est aussi certifié selon le référentiel ISO9001 et possède de nombreuses qualifications clients et reconnaissances de diverses organisations comme l'ANSM et la FDA américaine.

Bon congrès à tous,



**Vincent EDERY**  
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R. BEN AMAR	University of Sfax, Tunisia
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P. C. GERVAIS	IFTS, Agen, France
N. GHAF FOUR	KAUST, Saudi Arabia
P. GINISTY	IFTS, Agen, France
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M. IJJAALI	Sidi Mohamed Ben Abdellah University, Fez, Morocco
F. KHALIL	Sidi Mohamed Ben Abdellah University, Fez, Morocco
Y. KONATE	2iE, Ouagadougou, Burkina Fasso
L. LE COQ	IMT Atlantique, Ecole des Mines de Nantes, France

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S. TAHIRI	Chouaib Doukkali University, Morocco
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A. ZEROUALE	Sidi Mohamed Ben Abdellah University, Fez, Morocco

## **Organizing committee**

A. LHASSANI (Chair)	Sidi Mohamed Ben Abdellah University, Fez, Morocco
F. KHALIL (Co-chair)	Sidi Mohamed Ben Abdellah University, Fez, Morocco
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M. IJJAALI	Sidi Mohamed Ben Abdellah University, Fez, Morocco
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H. LOUKILII	Hassan II University, Mohammedia, Morocco
M. TAHAIKT	Ibn Tofail University, Kenitra, Morocco

### **Organizing committee (PhD)**

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F. EI OUADRHIRI	LEMOME – FSDM USMBA, Fez, Morocco

## Francofilt 2023 Sponsors:



## *Conference Program*

**Topic 1:** Wastewater treatment and reuse. Circular economy and new paradigms: Zero liquid discharge and low carbon footprint for industrial effluents.

**Topic 2:** Desalination, membrane technology, climate change and sustainable development.

**Topic 3:** Water quality and environmental protection: Role of separation techniques and membranes; micropollutants and emerging pollutants.

**Topic 4:** Simultaneous reduction of water-energy footprints in the current economic context: Separative and membrane techniques for sustainable processes in the Agri-food, Pharmaceutical and Biotechnology industries.

**Day 1 : Wednesday 10 May 2023**

08 :30 - 09 :30	<b>Registration of the participants</b>	
09:30 – 10:15	<b>OFFICIAL OPENING CEREMONY</b>	
10:15 – 10:50	<b>PL1 : Roger Ben Aïm, IFTS, France</b> Comment réduire l'empreinte carbone et l'empreinte environnementale de l'osmose inverse, la technologie dominante en dessalement ?	
10:50 – 11:20	<b>Coffee break / Stands visit</b>	
	<b>Plenary Room / Chairs: J. Toyer &amp; M. Hafsi</b>	
11:20 – 11:55	<b>PL2 : Nouredine Ghaffour, KAUST, Saudi Arabia</b> Novel forward osmosis – membrane distillation (FO-MD) integrated system for produced water treatment	
11:55 – 12:30	<b>PL3 : Selma Jariri, ONEE, Rabat, Morocco</b> Le dessalement d'eau au Maroc : Une solution durable pour l'approvisionnement en eau potable	
12:30 – 14:30	<b>Lunch</b>	
	<b>Room 1 / Topic 1 : Wastewater treatment and reuse. Circular economy and new paradigms: Zero liquid discharge and low carbon footprint for industrial effluents.</b>  <b>Chairs : M. Ouammou &amp; R. Ben Amar</b>	<b>Room 2 / Topic 2 : Desalination, membrane technology, climate change and sustainable development</b>  <b>Chairs : A. Doucouré &amp; M. Bouhria</b>
14:30 – 14:55	<b>KN1 : Courfia Kéba Diawara, UZ, Ziguinchor, Senegal</b> Performance et intégration des membranes en Afrique de l'ouest pour l'accès à l'eau potable : apport des universités ou centres de formation et de recherche	<b>KN3 : Sudip Chakraborty, Calabria university, Italy</b> Plasmonic Nanomaterials for Environmental Filtrations
14:55 – 15:20	<b>KN2 : Marc Heran, University of Montpellier, France</b> Impact of treated wastewater on soil bacterial communities	<b>KN4 : André Deratani, Université of Montpellier France</b> Renewable energy-powered membrane technology
15:20 – 15:35	<b>O1 : Soumana Gagara, AMSIC – Niger</b> Wastewater Management Improvement in the UNAMID Headquarters in Central Darfur, Zalingei, Sudan	<b>O4 : Saidou Nourou DIOP, University Assane SECK of Ziguinchor Senegal</b> Application des procédés membranaires pour le traitement des eaux saumâtres en milieu rural au Sénégal
15:35 – 15:50	<b>O2 : Pascal Ginisty, IFTS France</b> Coagulation / Flocculation of industrial and urban sludges and wastewaters: challenges and perspectives	<b>O5 : Sana Gassara, Oneka Technologies, Sherbrooke, Canada</b> Ocean Wave-Powered Stand-Alone Oneka Buoy for Sustainable Desalination Solution

15:50 – 16:05	<b>O3 : Hafida Ayyoub, Ibn Tofail University, Kenitra, Morocco</b> Aerobic treatment of fish canning wastewater using a pilot-scale external membrane bioreactor	<b>O6 : Mohamed Farah, Ibn Tofail University, Kenitra, Morocco</b> Fouling investigation of ceramic ultrafiltration membranes : influence of transmembrane pressure
16:05 – 16:30	<b>Coffee break / Poster session / Stands visit</b>	
	<b>Room 1 / Topic 1 : Wastewater treatment and reuse. Circular economy and new paradigms: Zero liquid discharge and low carbon footprint for industrial effluents.</b>  <b>Chairs : M. Nawdali &amp; R. I. Peinador Davila</b>	<b>Room 2 / Topic 2 : Desalination, membrane technology, climate change and sustainable development</b>  <b>Chairs : N. Tijani &amp; J. Bennazha</b>
16:30 – 16:45	<b>O7 : Wiem Mezlini, University of Tunis El Manar, Tunisia</b> Recent advances in photocatalytic application in industrial wastewater treatment: principle, latest advances, challenges and perspectives	<b>O11 : Youssouf El Idrissi, ENSEM University Hassan II Casablanca</b> Sélection d'une zone d'étude de dessalement des eaux saumâtres par des procédés hybrides
16:45 – 17:00	<b>O8 : Roukaya Bouyakhsass, Hassan II University of Casablanca, Morocco</b> Leachate anaerobic treatment : the case of Mohammedia-Benslimane landfill	<b>O12 : Mohamed Idrisse, Ibn Tofail University, Kenitra, Morocco</b> Contribution to the study of fluoride ion transfer in nanofiltration and reverse osmosis membranes
17:00 – 17:15	<b>O9 : Rida El-Bardai, Ibn Tofail University, Kenitra, Morocco</b> Development of a novel glasses based on phosphate and its application as a promising adsorbent for crystal violet dye removal	<b>O13 : Addar Fatima Zahra Université Ibn Tofail, Kenitra, Maroc</b> Comparison of response surface method and artificial neural network in predicting fluoride removal by nanofiltration
17:15 – 17:30	<b>O10 : Doha Elmachtani idrissi, Hassan II University of Casablanca, Morocco</b> Fabrication of low-cost kaolinite/perlite membrane for microfiltration of dairy wastewater	<b>O14 : Bassma El Gouch, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Characterization of water-soluble ions of PM2.5 in Kenitra, Morocco
<b>Day 2 : Thursday 11 May 2023</b>		
	<b>Plenary Room / Topic 3 : Water quality and environmental protection : Role of separation techniques and membranes ; micropollutants and emerging pollutants</b>  <b>Chairs : M. Taky &amp; S. Y. Alami</b>	
09:00 – 09:35	<b>PL4 : Anthony Szymczyk, Université de Rennes, France</b> Improving our understanding of organic solvent nanofiltration through molecular simulation	
09:35 – 09:50	<b>O15 : Mustapha Tahaikt, Ibn Tofail University, Kenitra, Morocco</b> Fluoride removal by electrodialysis: Competition of fluoride ions with other anions through ACS membrane	



09:50 – 10:05	<b>O16 : René I. Peinador Davila, IFTS, France</b> Natural Generation, Characterization and Membrane Filtration of Nanoplastics in water	
10:05 – 10:20	<b>O17 : ADLANE Sanaa, Hassan II University of Casablanca, Morocco</b> Preparation of low-cost ultrafiltration membrane made from purified pyrophyllite	
10:20 – 10:35	<b>O18 : Mohamed Chiban, Ibn Zohr University, Agadir</b> Kinetic, equilibrium and thermodynamic studies for Chrome (VI) removal by magnesium aluminum layered double hydroxides (MgAl-LDH), synthesized by urea hydrolysis method	
10:35 – 10:50	<b>O19 : Lachquer Farah, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Purification of Drinking Water Using Highly Selective Catalytic Reduction of Nitrates into Nitrogen over Keggin-Type Polyoxometalates Materials	
10:50 – 11:20	<b>Coffee break / Poster session / Stands visit</b>	
	<b>Plenary Room / Topic 3 : Water quality and environmental protection : Role of separation techniques and membranes ; micropollutants and emerging pollutants</b>  <b>Chairs : N. Ghaffour &amp; A. Dératani</b>	
11:20 – 11:35	<b>O20 : Doucouré Abdoulaye, Virginia, USA</b> Growing trend for advanced liquid filtration capabilities in cleanroom facilities	
11:35 – 11:50	<b>O21 : Sakina BELHAMIDI, Ibn Tofail University, Kenitra, Morocco</b> Anaerobic digestion of vinasse derived from ethanol manufacturing using a continuous stirred tank reactor pilot plant	
11:50 – 12:05	<b>O22 : Tarik Eljaddi, IFTS, France</b> Design and validation of a locally assembled sand filter to remove iron and manganese from drinking water in Mali	
12:05 – 12:20	<b>O23 : Elazhar Fatima, Ibn Tofail University, Kenitra, Morocco</b> Comparison of diverse direct and hybrid membrane processes for nitrate removal from brackish water	
12:20 – 12:35	<b>O24 : BOULJOIHEL Bader, Hassan II University of Casablanca, Morocco</b> Elaboration de nouveaux catalyseurs hybrides à base d'un alliage Ni-Cu/Polymère conjugué pour le suivi de la réaction d'évolution de l'hydrogène	
12:35 – 14:00	<b>Lunch</b>	
	<b>Room 1 / Topic 3 : Water quality and environmental protection : Role of separation techniques and membranes ; micropollutants and emerging pollutants</b>  <b>Chairs : M. Elrhazi &amp; T. Eljaddi</b>	<b>Room 2 / Topic 4 : Simultaneous reduction of water-energy footprints in the current economic context: Separative and membrane techniques for sustainable processes in the Agri-food, Pharmaceutical and Biotechnology industries</b>  <b>Chairs : A. Aaddane &amp; M. Heran</b>

14:00 – 14:25	<b>KN5 : Raja Ben Amar, Université de Sfax, Tunisia</b> Study of performances of low-cost ceramic membranes for oily wastewater treatment	<b>KN6 : Pierre-Yves Pontalier, ENSIACET, Toulouse, France</b> Microalgae fractionation
14:25 – 14:40	<b>O25 : Fouad SINAN, Ibn Zohr University, Agadir</b> Green membrane to remove Cd <sup>2+</sup> from aqueous solutions	<b>O31 : Omar DOUGHMI, IbnTofail University, Kenitra, Morocco</b> Oak acorn treated with citric acid and its application as biosorbent for the removal of crystal violet dye in aqueous solutions
14:40 – 14:55	<b>O26 : Dagher Ghadi, Université de Poitiers, France</b> Prediction of multi-cycle fouling of hollow fiber ultrafiltration membranes using time series analysis	<b>O32 : Pascal Ginisty, IFTS France</b> The role of filtration and other separative techniques in plant extraction: new challenges, new techniques to meet industrial needs
14:55 – 15:10	<b>O27 : Hassna Laalaoua, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> A Comprehensive study of nitrate and ammonium removal from water by membrane technology	<b>O33 : Emna Selmane Bel Hadj Hmida, IPEIEM, Tunis, Tunisia</b> Zéro gap electrolysis used to produce bleach
15:10 – 15:25	<b>O28 : Jabkhiro Hajar, Hassan I University of Settat, Morocco</b> Application of Mg(Al)O mixed metal oxides (MMO) nanoparticles in the preparation of sustainable mixed matrix membranes for water treatment	<b>O34 : Amri Nabil, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Etude électrochimique des propriétés inhibitrices de la corrosion du colorant organique : Jaune de Méthanile sur l'acier XC38 en milieu acide chlorhydrique 1M
15:25 – 15:40	<b>O29 : Moumni Boutaina, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Removal of Malachite Green (MG) using low cost adsorbent: Isotherm, Kinetics and Thermodynamic Studies	<b>O35 : Soukaina El Abbadi, Moulay Ismail university, Meknes, Morocco</b> Efficiency of aluminum pillared clay for the removal of phenol from aqueous solution: Characterization, kinetics and adsorption isotherm
15:40 – 15:55	<b>O30 : Hazra Mohamed, Ibn Tofail University, Kenitra, Morocco</b> Removal of ammonium ions for drinking water by electro dialysis: Feasibility and optimization	<b>O36 : Zraraa Kenza, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Extraction and Characterization of Antioxidant properties of Mucilage from Flax ( <i>Linum usitatissimum</i> )
15:55 – 16:25	<b>Coffee break / Poster session / Stands visit</b>	
	<b>Room 1 / Topic 3 : Water quality and environmental protection : Role of separation techniques and membranes ; micropollutants and emerging pollutants</b>  <b>Chairs : P-Y. Pontalier &amp; B. Achiou</b>	<b>Room 2 / Topic 4 : Simultaneous reduction of water-energy footprints in the current economic context: Separative and membrane techniques for sustainable processes in the Agri-food, Pharmaceutical and Biotechnology industries</b>  <b>Chairs : C.K. Diawara &amp; P. Ginisty</b>

16:25 – 16:40	<b>O37 : Hamou Moussout, Ibn Tofail University, Kenitra, Morocco</b> Étude de la cinétique de dégradation thermique des coquilles de noix et leur application dans la rétention de l'orange de méthyle	<b>O42 : Aaddane Abdellah, Hassan II University of Casablanca, Morocco</b> Development of ultrafiltration ceramic membranes based on purified natural clays
16:40 – 16:55	<b>O38 : Rajaa Mouratib, Chouaib Doukkali University, El Jadida, Morocco</b> Elaboration of low-cost ceramic membrane from physicochemical water treatment sludge and its application to wastewater filtration	<b>O44 : El Ouadrhiri Faïçal, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> N, P co-doped carbocatalyst from olive pomace obtained by catalytic hydrothermal carbonization for persulfate-based advanced oxidation process
16:55 – 17:10	<b>O39 : Jihan FAOUZI, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Vertical transfer of bacteriological and parasitological pollutants from irrigation water to soil eggplant and cardoon	<b>O45 : Laila Lahrizi, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Ethnobotanical study on the use of the plant "Ajuga lva" by the Moroccan populations
17:10 – 17:25	<b>O40 : Oumaima Beroigui, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Streptomyces as vital additives for solid waste composting	<b>O46 : Boulahfa Hicham, METITO OVERSEAS LTD , Morocco</b> MEMBRANE FOULING CHARACTERIZATION OF A FULL-SCALE BRACKISH WATER REVERSE OSMOSIS DESALINATION PLANT IN MOROCCO: MEMBRANE AUTOPSY
17:25 – 17:40	<b>O41 : Sam Simanye, University of Johannesburg, South Africa</b> A piezoelectric electrospun nanofiber mat (PVDF/ Kaolin) for the degradation of methylene blue in water	
20:00 – 23:00	<b>GALA DINNER, Hôtel Marriott Jnan Palace</b>	
<b>Day 3 : Friday 12 May 2023</b>		
<b>Plenary Room / Topic 1 : Wastewater treatment and reuse. Circular economy and new paradigms: Zero liquid discharge and low carbon footprint for industrial effluents</b> <b>Chairs : V. Ederly &amp; H. Zaitan</b>		
09:00 – 09:35	<b>PL5 : Mohamed Taky, Université Ibn Tofail, Kanitra, Maroc</b> Wastewater Treatment and Reuse in Morocco: Status, Perspectives and Challenges	
09:35 – 09:50	<b>O47 : Dounia Beqqour, Hassan II University of Casablanca, Morocco</b> Preparation of a composite membrane made of PoPD/PVA ultrafiltration layer on ceramic pozzolan/micronized phosphate support for removal of Congo red dye	
09:50 – 10:05	<b>O48 : Zahira CHAKIR, Ecole Hassania des Travaux Publics, Casablaca, Morocco</b> Traitement biologique membranaire RBM et performances de la station de traitement des eaux usées de Mediouna	

<b>10:05 – 10:20</b>	<b>O49 : Amadou Lamine Diouf, University Assane SECK of Ziguinchor Senegal,</b> Elaboration and characterization of activated carbons from "saba sumensis" shell collected Ziguinchor devoted to the treatment of waste water from health facilities
<b>10:20 – 10:35</b>	<b>O50 : Salaheddine Elmoutez, M6PU, Ben Guerir Morocco</b> Performance of a ceramic MBR pilot plant treating Municipal wastewater subject to gradual salinity increase: water quality and fouling behavior
<b>10:35 – 10:50</b>	<b>O51 : Sarra BEN SALAH, Faculty of science of Sfax, Tunisia</b> Treatment of dye-containing wastewater from textile industries using hybrid treatment integrating membrane technology
<b>10:50 – 11:05</b>	<b>O52 : Farah Lachquer, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Electrocatalytic Removal of Carbon from Wastewater in a Highly Effective Biocell Using Kegging-Type Heteropoly Salts Based Electrodes
<b>11:05 – 11:45</b>	<b>Coffee break / Poster session / Stands visit</b>
<b>11:45 – 12:45</b>	<b>Award of prizes for the best oral and poster</b> <b>Closing ceremony</b>
<b>12:45 – 14:30</b>	<b>Lunch</b>

Liste of posters	
P1	<b>Dabagh Abdelkader, Ibn Zohr University, Agadir, Morocco</b> Preparation and characterization of biomaterial for the adsorption of cationic dye: kinetic, isotherm and thermodynamic
P2	<b>Majdoub Ali, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Self-supporting g-C <sub>3</sub> N <sub>4</sub> /CuO on polyester fabric as "Dip-Catalyst" for synergistic 4-nitrophenol Hydrogenation
P3	<b>Ben Ali Mona, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Enhancing the selective catalytic oxidation of lignocellulosic biomass to formic acid Using Reusable Calcined Mg/Al Hydrotalcite as a Catalyst in a green solvent
P4	<b>Lahrizi Laila, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Contribution to a phytochemical study of aqueous extracts from the aerial part of <i>Ajuga reptans</i>
P5	<b>Zraraa Kenza, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Potential of Flax ( <i>Linum usitatissimum</i> L.) for ecological building materials
P6	<b>Bellouk Hamza, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Optimization Of Sono-photo-Fenton Process Operating Conditions For The Treatment Of The Landfill Leachate Of Fez City (Morocco) And Contact Test With <i>Medicago sativa</i> To Assess The Phytotoxicity
P7	<b>Beroigui Oumaima, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Characterization and selection of soil actinomycetes to improve composting process
P8	<b>Attia Afef, University of Sfax, Tunisia</b> Surface modification of zeolite microfiltration membrane: characterization and application
P9	<b>Attia Afef, University of Sfax, Tunisia</b> Synthesis and characterization of Nano-hybrid materials based on clay /PEI/ ZnO for wastewater treatment
P10	<b>Tahiri Ayoub, Moulay Ismail university, Meknes, Morocco</b> Adsorption Process Of The Eriochrome Black T Dye Onto X Type Zeolite : Kinetic And Thermodynamic Studies
P11	<b>EL Allouche Yassine, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Molecular Modeling for new Drug Discovery
P12	<b>Assouani Abdallah, Ibn Zohr University, Agadir, Morocco</b> Contribution à l'étude des sources des nitrates présentes dans les ressources en eau souterraine de certaines communes rurales de l'Anti-Atlas/ Etude de cas NIHIT

<b>P13</b>	<b>Sakout Youssef, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Structural, optical and dielectric study of hydrothermally synthesized $Pb_{1-x}Ba_xTiO_3$ ( $0.1 \leq x \leq 0.9$ ) perovskite materials
<b>P14</b>	<b>Lahrar El Houcine, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Structural, optical, electrocaloric, and energy storage properties of $Ba_{0.85}Ca_{0.15}Zr_{0.1}Ti_{0.9}O_3$ synthesized by sol-gel method
<b>P15</b>	<b>El Ghzizel Soufiane, Ibn Tofail University, Kenitra, Morocco</b> Fouling study of a nanofiltration membrane of a decentralized demineralization plant: Characterization and modeling
<b>P16</b>	<b>Fahmi El Kahmmar, Ibn Tofail University, Kenitra, Morocco</b> Textiles effluents depollution using adsorption on natural clay of Fes region
<b>P17</b>	<b>Zeggar Hajar, Ibn Tofail University, Kenitra, Morocco</b> Modeling of nitrate ion transfer in nanofiltration and reverse osmosis membranes
<b>P18</b>	<b>Eljaddi Tarik, IFTS, France</b> Contribution of two methods (in-situ and ex-situ) for detecting membrane wetting in membrane distillation for desalination
<b>P19</b>	<b>Ouammou Mohamed, Hassan II University of Casablanca, Morocco</b> Low-cost polysulfone/polystyrene ultrafiltration membrane with efficient azoic dyes removal and excellent antifouling performance for colored wastewater
<b>P20</b>	<b>Alami Younssi Saâd, Hassan II University of Casablanca, Morocco</b> Effective turning fly ash waste into Na-P1 zeolite and its application on the adsorption of Chromium VI
<b>P21</b>	<b>Jellab Mina, Hassan II University of Casablanca, Morocco</b> Manufacturing of new ceramic nano-apatite membrane supported on phosphate/kaolinite support for treatment textile wastewater
<b>P22</b>	<b>Ounouss Ibrahim, Hassan II University of Casablanca, Morocco</b> Valorization of Moroccan geomaterials in the manufacturing of low-cost ceramic membranes for the treatment of industrial wastewaters.
<b>P23</b>	<b>Bouhria Mohamed, Hassan II University of Casablanca, Morocco</b> Development and characterization of a low-cost Glymo-GO layer coated on kaolinite support. Application for waste treatment
<b>P24</b>	<b>Achiou Brahim, Hassan II University of Casablanca, Morocco</b> Fabrication of low-cost composite $MoS_2/PVA$ membrane supported on pozzolan substrate for effective removal of soluble dyes
<b>P26</b>	<b>Benhaiba Saad, Hassan II University of Casablanca, Morocco</b> Détection simple et rapide des ions nitrates par voie électrochimique en utilisant un film de poly 1,8 diaminonaphtalène et d'oxyde de cuivre

<b>P27</b>	<b>Ghadhi Ahmed, ENSEM, Hassan II University of Casablanca, Morocco</b> Performance Simulation of a SWRO System Equipped with two Energy Recovery Devices
<b>P28</b>	<b>Naanaai Lhoucine, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Application des techniques computationnelles dans le domaine de la conception de médicaments
<b>P29</b>	<b>El Rhabori Said, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Discovery of new anti-cancer drugs using green biochemistry approach
<b>P30</b>	<b>Lhassani Abdelhadi, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Desalination using membrane technology: Application to the production of drinking water
<b>P31</b>	<b>Mazigh Nouhaila, Hassan II University of Casablanca, Morocco</b> Assessing surface water quality in drinking water supply and irrigation of el malleh dam reservoir and identification of pollution sources
<b>P32</b>	<b>Ghoumit Asmae, University Sidi Mohamed Ben Abdellah, Fez, Morocco</b> Fabrication, Characterization and Adsorption Performance of a novel Polyniline@SAPO34 composite towards Orange G dye removal
<b>P33</b>	<b>Moukhliiss Mohammed, Hassan II University of Casablanca, Morocco</b> Assessing hydrological modeling in a Mediterranean Watershed using the SWAT model
<b>P34</b>	<b>Ezzahi Amine, Hassan II University of Casablanca, Morocco</b> Elaboration and characterization of novel tubular microfiltration ceramic membranes made from Moroccan geomaterials
<b>P35</b>	<b>Ouzbair Mohamed, Ibn Tofail University, Kenitra, Morocco</b> Pretreatment of vinasses by coagulation-flocculation : comparison and optimization using response surface methodology
<b>P36</b>	<b>El Rhazi Mama, Hassan II University of Casablanca, Morocco</b> Synthesis of new class of materials for sensing application or Direct Alcohol Fuel cell
<b>P37</b>	<b>Chakir Zahira, Ecole Hassania des Travaux Publics, Casablanca, Morocco</b> Wastewater reuse through Soil Aquifer Treatment (SAT): regulations and key elements for feasibility assessment
<b>P38</b>	<b>Bennazha Jamal, Hassan II University of Casablanca, Morocco</b> Novel polypyrrole/zirconium tubular membrane developed for efficient congo red dye rejection and salts desalination
<b>P39</b>	<b>Lalia Khadija, Ibn Tofail University, Kenitra, Morocco</b> Performance evaluation of nanofiltration membranes for dye removal of synthetic water
<b>P40</b>	<b>Ait Ichou Abdeljalil, Ibn Zohr University, Agadir</b> Synthetic nanomaterial Zn <sub>2</sub> [FeAl]-CO <sub>3</sub> layered double hydroxide for removal of heavy metals : characterization of nanomaterial and adsorption study of Cu(II) and Pb(II)

*CV of plenary and keynote Speakers*





**Prof. Roger BEN AÏM**

Ingénieur des industries Chimiques (ENSIC Nancy)

Professeur de génie Chimique de 1972 à 2001 successivement à l'université des Sciences et Techniques du Languedoc -Montpellier, à l'INP Toulouse, à l'UTC Compiègne, à l'INSA Toulouse puis Professeur Emérite à l'INSA Toulouse de 2001 à 2008

Activités de recherche focalisées sur l'application du Génie chimique au traitement et épuration des eaux et notamment sur les techniques séparatives (floculation, décantation, flottation, filtration, techniques membranaires : direction de plus de 50 thèses).

Création de l'IFTS ( centre de recherche technique sur la filtration et les techniques séparatives ) en 1981 à Agen (direction de 1981 à 1986)

Détachement au CNRS de 1986 à 1988 pour diriger le projet inter-laboratoires qui a conduit au développement des premières membranes fibres creuses destinées à la production d'eau potable et qui a abouti à la création de la société Aquasource à Toulouse.

Membre actif de IWA depuis 1970. Distinguished Fellow , Président du groupe international de spécialistes « membrane Technology » depuis sa création en 2000 jusqu'à 2008. Honorary Member

Secrétaire de la société européenne des Membranes ( 1986 - 1990)

Relations internationales : invitations pour des cours ou des conférences : Corée du Sud (Université Nationale de Seoul ) , Australie( UNSW ,UTS) , Thaïlande( AIT) , Singapour ( NUS) , Chine , Taiwan , Viet Nam , Arabie Saoudite ( KAUST) , Afrique du Sud , Algérie , Pakistan.

Membre du comité stratégique de IWA 2013-2019

Actuellement, conseiller scientifique à l'IFTS



**Selma Jariri**

Ingénieur, Chef de la Division Nouvelles Technologies de l'Eau à l'ONEE, Rabat, Maroc

Selma Jariri est Ingénieur et Master en management des services publiques, Chef de la Division des Nouvelles Technologies à l'Office National de l'Electricité et de l'Eau Potable est impliquée dans le développement de projets novateurs, notamment dans le domaine du dessalement d'eau de mer, les traitements d'eau à caractère complexe, avec une expertise dans le montage de projets en PPP, notamment en tant que chef du méga projet de dessalement d'Agadir, et dans le couplage des projets d'eau et d'énergies renouvelables.



**Prof. Anthony Szymczyk**

University of Rennes1, France

Anthony Szymczyk received his Ph.D. in Physical Chemistry in 1999 at the University of Franche-Comté (France). He is currently Full Professor at the University of Rennes 1 and leads the “Chemistry and Process Engineering” research group of the Institute of Chemical Sciences of Rennes (ISCR - UMR CNRS 6226).

Prof. Szymczyk's research lies at the interface of chemical engineering, chemistry of materials and physics of condensed matter. His main research activities focus on the modeling and simulation of membrane separations for desalination and water purification, and on the physico-chemical characterization of membrane materials with applications in functionalization, fouling, ageing... He published about 160 scientific papers and book chapters on these topics. In 2013 he was the recipient of the IUPAC distinguished Award for Novel Materials and their Synthesis for his work on ion transport through nanoporous membranes. He is the current President the European Membrane Society.



**Prof. Noreddine Ghaffour**

KAUST, Saudi Arabia

Noreddine Ghaffour is a Professor at KAUST. He has over 27 years of experience in the field of drinking water treatment technologies, and has specialized in the area of membrane and thermal desalination processes. Over the years, he has made major contributions becoming an internationally recognized expert in desalination technologies and its related fields. He obtained his PhD from Montpellier University, France, in 1995. He is the author of over 450 journal and conference publications, several patents and chapters in textbooks. He is a frequent keynote speaker in international conferences, seminars and workshops. He is Editor of Desalination journal. He also has experience in scaling-up innovative desalination processes and start-ups.



**Prof. Mohamed Taky**

Ibn Tofail University, Kenitra, Morocco

Mohamed Taky received his Ph.D in 1991 at Montpellier II (France). He joined the Faculty of Science - Ibn Tofail University, Kenitra (Morocco) in 1996 where he teaches methods of electrochemical analysis and membrane separation processes. His research activity was first focused on concentration polarization in Electrodialysis and water splitting at the

interface of ion-exchange membranes. His major research field during the last twenty years involves : Environment, Desalination, Water and wastewater treatment, Treatment of industrial effluent, Recovery and valorization of the raw materials, Advanced Membrane technologies. He has more than 80 publications in this field. Today he is the director of the Laboratory of Advanced Materials and Process Engineering (LAMPE) of the Faculty of Sciences of Kenitra.

Mohamed Taky is cofounder member and currently Vice president of the Moroccan Membrane and Desalination Society (MMDS).



**Prof. Courfia Kéba Diawara**

University of Ziguinchor, Senegal

Courfia Kéba Diawara est Docteur d'Etat en chimie. Il est Professeur titulaire des Universités de classe exceptionnelle et Chevalier de l'Ordre National du Lion au Sénégal

- Professeur invité à l'École des Mines de Nantes
- Professeur invité à l'Institut International d'Ingénierie de l'Eau et de l'Environnement (2ie), Burkina Faso
- Professeur associé à l'IUT de Saint-Nazaire, France

Ancien membre du Comité Consultatif Général CCG du CAMES,

Ancien membre du conseil de surveillance de l'Agence Nationale de la Rech. Scientifique Appliquée,

Evaluateur institutionnel en Assurance Qualité (ANAQ-Sup)

Président d'honneur et Membre fondateur de la Société Africaine des Membranes, Siège à Bamako

Président du comité d'organisation de la 1<sup>ère</sup> conférence internationale en Afrique de l'Ouest sur : « membranes, eau et santé » et Chairman du 3<sup>ème</sup> congrès international de la Société Africaine des Membranes,

Lauréat du prix « SEDAR 2010 » pour l'Innovation sur le dessalement et la défluoruration par la mise au point d'un nouveau procédé d'élimination du fluor et de dessalement couplé à l'énergie solaire pour l'eau potable,

Professeur Courfia Diawara, ancien recteur de l'université 'Assane Seck', poursuit la formation de jeunes docteurs dans l'usage de technologies de dessalement en Afrique et auteur d'une cinquantaine d'articles scientifiques, cité dans plus de 500 publications scientifiques internationales.



**Prof. Marc Heran**

University of Montpellier, France

Marc Heran is professor of Chemical Engineering at the European Membrane Institute, University of Montpellier (France). Its fields of expertise concern water and wastewater treatment, separation process, membrane separation, biological process and membrane bioreactors. He is the head of the chemical engineering membrane department. He is involved in IWA's specialist group and UNESCO SIMEV chair management. His research career focuses on process intensification by the help of membranes, membrane energy demand, and circular economy. The objectives are to explore reliable, efficient and sustainable intensive technologies for wastewater treatment tuned to good water quality production, and sustainable by-product generation in order to enhance circular economy.



**Prof. Sudip Chakraborty**  
University of Calabria, Italy

Sudip Chakraborty, is a Doctorate in Chemical Engineering from University of Calabria, Italy. Currently holding Full Professor (ASN) in Chemical Engineering in sector – ING-IND 24 at Laboratory of Transport Phenomena and Biotechnology, University of Calabria, Italy. He was also a visiting researcher at Massachusetts Institute of Technology (MIT), Boston, USA. His major field of interest are membrane separation, plasmonic nanoparticle, composite materials, energy and process intensification. Dr. Chakraborty with h-index-37, published more than 120 research publications in international SCI indexed journals/book chapter as well as many conference proceedings. Dr. Chakraborty is also serving as Chief editor/Associate editor in many scientific international journals published by Elsevier, Springer-Nature as well as Wiley-Gmbh.



**Prof. André DERATANI**  
University of Montpellier, France

André Deratani is Emeritus Research Director at the CNRS (French National Center for Scientific Research). He joined the European Membrane Institute (IEM) in Montpellier (France) in 1995. He is co-author of about 160 refereed publications with h-index-37 and has presented more than 150 communications in national and international conferences. He has also applied for 10 patents.

His main research activities are in the fields of polymer chemistry and physical chemistry for application in functional materials in bead and film form. His current topics include the preparation of nanostructured materials and engineered interfaces using natural and synthetic polymer and block copolymers for the preparation and characterization of novel and advanced membranes, functional membranes for water and wastewater treatment processes.



**Prof. Raja Ben Amar**

University of Sfax, Tunisia

Raja Ben Amar is currently working as full Professor in the chemical department of the Faculty of Science of Sfax and leading the research unit 'Advanced Technologies for Environment and Smart Cities'.

She achieved her master degree in Chemical Engineering from ENSIC (Institut Polytechnique de Lorraine, France) and her PhD in chemical Engineering from IGC (Institut Polytechnique de Toulouse, France).

Her main research interests are wastewater treatment using hybrid processes, water desalination, wastewater treatment, development of new porous ceramic membranes from natural and hybrid materials. She has published more than 120 papers in ISI indexed journals, 5 book chapters and 4 patents. She is a reviewer for several scientific journals.

She is involved in many projects in the frame of cooperation programmes such as joint projects with several countries and European Projects (ERANETMED, PRIMA).

She is currently, the President of the African Membrane Society and member of the Tunisian Desalination Society.

Pr. Raja Ben Amar has supervised to completion several masters (47 candidates) and doctoral candidates (26 PhD candidates). She has also mentored 5 postdoctoral fellows. Currently she supervises 7 postgraduate students in her areas of interest.

She is involved in many projects in the frame of cooperation programmes such as joint project with India, France, participation in joint projects with Morocco and Algeria and on European projects in the frame of ERANETMED, Erasmus and PRIMA programmes. She is also principal Investigator for three National projects supported by Tunisian Ministry of Higher Education and Tunisian Ministry of Industry in collaboration with industrial companies 'Valorisation des Résultats de la Recherche (VRR)' program and 'Programme National de Recherche et d'Innovation (PNRI) related to integration of membranes processes in waste water treatment and reuse.



**Prof. Pierre-Yves Pontalier**

University of Toulouse, France

Pierre-Yves Pontalier is Professor in Process Engineering at the Institut National Polytechnique de Toulouse since 1998. He has been working for 30 years in the field of separation processes, with a particular focus on membrane processes and liquid/solid separation. He is the author of about 50 peer-reviewed papers, 3 patents and 4 book chapters in the field of liquid/solid separation. He has been a member of SF2P since 2010 and president since 2019. He participated to the organization of FPS and FrancoFilt congresses and is in charge of the organization of next World Filtration Congress in 2025 at Bordeaux.

*Abstracts of Plenary session*

## PL1

### **Comment réduire l’empreinte carbone et l’empreinte environnementale de l’osmose inverse, la technologie dominante en dessalement ?**

**Roger Ben Aïm, IFTS, IWA Distinguished Fellow**

*roger.ben.aim@ifts-sls.com*

**Résumé |** Aujourd’hui l’osmose inverse a définitivement supplanté les procédés thermiques pour produire une eau douce à partir d’eau de mer, avec une plus faible consommation d’énergie et un moindre coût. La consommation spécifique d’énergie de l’osmose inverse est encore importante (au mieux 2,5 kWh par m<sup>3</sup> d’eau douce produite) et le rejet de saumure concentrée perturbe localement les écosystèmes marins. Est-il possible de faire mieux ? L’énergie de pompage consommée pour la circulation de l’eau de mer au travers de la membrane est directement proportionnelle à la perte de charge transmembranaire. Cette perte de charge initiale s’accroît au cours du temps à cause du phénomène de colmatage qui accroît la résistance hydraulique de la membrane. Le colmatage dépend des caractéristiques de l’eau de mer qui alimente le module et résulte essentiellement de trois phénomènes :

-Le dépôt sur la membrane des particules contenues dans l’eau de mer : la teneur en particules de l’eau de mer est quantifiée par un test de filtration normalisé qui conduit à la détermination d’un « Fouling Index » également appelé SDI (ou indice de colmatage)

-Le dépôt de cristaux qui résulte de la concentration en sels dans la couche limite au voisinage de la membrane et aboutit à la formation de dépôts cristallins à la surface de la membrane. Ce phénomène peut être contrôlé par l’utilisation de produits antitartre efficaces mais que l’on retrouve dans les rejets de saumure

-La formation d’un biofilm à la surface de la membrane favorisée par la concentration dans la couche limite des fractions organiques dissoutes contenues dans l’eau de mer.

Suite à de nombreuses études récentes qui ont nécessité des autopsies de modules, il est maintenant établi que le « biofouling » et la formation de biofilms sont majoritairement responsables de l’augmentation de la résistance à l’écoulement et donc de la nécessité d’interrompre périodiquement la production pour des nettoyages chimiques qui se traduisent par des rejets en mer des produits chimiques utilisés pour le nettoyage et par un raccourcissement de la durée de vie des membranes. Les travaux réalisés à l’Université de Technologie de Sydney (1) puis à KAUST et finalement à L’IFTS en partenariat ont permis de confirmer le rôle du Carbone organique assimilable (AOC) comme le facteur essentiel de la formation du biofilm et de mettre au point une méthode rapide d’analyse.

Si la réduction de l’indice de colmatage est une nécessité et si la réduction de cet indice peut être obtenue par une filtration sur sable ou sur membrane de microfiltration, la baisse de concentration en matière organique assimilable requiert soit une biofiltration soit une adsorption (sur charbon actif par exemple). Les résultats obtenus à l’échelle pilote mettent en évidence l’efficacité de ces prétraitements.

L’ensemble des études réalisées au cours de ces 10 ou 15 dernières années a permis de développer les outils pour concevoir un prétraitement efficace et mieux adapté à l’objectif d’un fonctionnement plus durable des unités d’osmose inverse utilisées pour le dessalement. Les travaux en cours (2) sur la récupération de l’énergie osmotique (entre saumure et eau de mer ou eau douce si disponible), permettent d’envisager, à court terme, une réduction significative de la consommation énergétique nette des usines de dessalement.

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## PL2

### **Novel forward osmosis – membrane distillation (FO-MD) integrated module for produced water treatment**

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**Abstract** | During oil exploration, a wastewater stream is generated as a by-product called produced water (PW). Different PW streams are generated, like WOSEP outlet (WO) with total dissolved solids (TDS) concentration as high as 115,000 mg/L and desalter effluent (DE) with a TDS of 9,000 mg/L. After suitable treatment, the WO can be reused for re-injection or other onsite applications. Forward osmosis (FO) and membrane distillation (MD) are two emerging membrane-based water treatment technologies that complement each other. This study validates the concept of the simultaneous treatment of different real PW streams using a novel FO-MD integrated module. The WO was used simultaneously as FO DS and MD feed solution (FS), and it generated an average FO flux of 13.5 LMH and MD flux of 13.2 LMH with the DE as FS. The main fouling mechanism on FO support layer was monovalent ions induced ICP and CaSiO<sub>3</sub> scale layer. Crystals of CaSO<sub>4</sub> and NaCl were found on FO active layer, causing dilutive ECP and gradual flux reduction. Oil and grease depicted pore-clogging at the MD membrane surface, and no MD membrane wetting was observed during all experiments. The hybrid system showed 100% removal of suspended solids, oil and grease, with 99% inorganics and 93% organics removal. The DE stream is concentrated by 77%, which results in further smaller onsite evaporation ponds. There is no use of fresh water and salts to make artificial DS making the concept sustainable and site application friendly.

**Keywords** | Produced water treatment; Forward osmosis; Membrane distillation; Hybrid system; Hypersaline water treatment.



## **PL3**

### **Le dessalement d'eau au Maroc : Une solution durable pour l'approvisionnement en eau potable**

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**Résumé** | Face à la demande croissante en eau potable et la raréfaction des ressources hydriques conventionnelles dans plusieurs régions du Maroc, l'Office National de l'Electricité et de l'Eau Potable, l'opérateur étatique et historique dans les secteurs de l'Electricité et de l'Eau, s'est lancé dans une démarche proactive et a recouru à d'autres techniques de traitement, notamment le dessalement-déminéralisation qui constitue une alternative pour satisfaire les besoins toujours croissants en eau.

A noter que le dessalement d'eau se présente comme une solution éprouvée à l'échelle internationale et sûre pour la mobilisation des ressources en eau supplémentaires au Maroc, particulièrement au Sud où les ressources en eau douces sont limitées. Le coût du dessalement d'eau devient de plus en plus compétitif par rapport à d'autres alternatives d'alimentation en eau potable.

L'ONEE a, depuis 1976, réalisé plusieurs projets de dessalement d'eau de mer et de déminéralisation des eaux souterraines saumâtres qui lui a permis d'acquérir un savoir-faire indéniable dans le dessalement d'eau utile pour le développement de son futur programme de dessalement.

Actuellement, l'ONEE dispose d'une vingtaine d'unités de dessalement et de déminéralisation, avec une capacité de production globale dépassant les 300 000 m<sup>3</sup>/jour, représentant près de 2% du volume total d'eau produit par l'ONEE. L'Office programme de tripler cette capacité pour atteindre plus d'1 million de m<sup>3</sup>/jour d'ici 2030.

L'ONEE, très actif au niveau du tissu national, des organisations régionales et continentales du secteur, privilégie la coopération tous azimuts comme levier incontournable pour le développement du futur de l'eau et particulièrement le nexus Eau-Energie.

## PL4

### Improving our understanding of organic solvent nanofiltration through molecular simulation

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**Abstract** | Separation is an unavoidable step in most processes used in the chemical, pharmaceutical, biotechnology industries, etc. However, it is the most energy-intensive stage of the overall process and industry is striving to find alternatives to conventional separation techniques such as distillation. In this respect, membrane processes have already proved their worth in many industrial applications, such as seawater desalination, wastewater treatment, etc.

Since the 2000s and the development of polymer membranes that are increasingly resistant to organic solvents, the range of potential applications for membrane processes has increased further and the field known as Organic Solvent Nanofiltration (OSN) is booming in the scientific community.

However, despite years of intense research, the physical phenomena that control transport through OSN membranes and their performance (permeance, rejection) are not yet fully understood, particularly at the molecular level. This lack of understanding largely comes from the complex structure of polymer membranes and the subtle interplay of intermolecular interactions between the membrane material and the solvent molecules.

In this lecture, we will present recent molecular simulation results that shed light on solvent / membrane interactions and discuss their implications for membrane performance in OSN. Several organic solvents with different physicochemical properties (methanol, toluene, acetone) and polymer membranes that have proven effective in OSN (P84 polyimide, PIM-1) will be considered.

**Keywords** | Separation; Membranes; Organic solvent nanofiltration; Molecular simulation.

## PL5

### **Wastewater Treatment and Reuse in Morocco: Status, Perspectives and Challenges**

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**Abstract** | Recurrent droughts in Morocco in recent decades, exacerbated by climate change, and deterioration of the quality of the water are putting the available water resources under heavy pressure. Agricultural water needs more than 70% of the total amount consumed. To cope with this situation, Morocco has launched several plans and programs to diversify the availability of water resources. Among these actions, the priority program of drinking water supply and irrigation 2020-2027, which is part of the national water plan 2020-2050, that governs the national water policy until 2050. In this program, and in order to secure its water availability, Morocco has chosen the use of desalination and the reuse of treated wastewater. Indeed, wastewater (WW) is a potential resource of great interest in this period of scarcity; its availability is constantly increasing due to the demography growth. Moreover, this demographic growth induces enormous water needs in agriculture and industry. In addition, the treatment cost of WW is significantly lower than that of desalination.

The objective is to establish the state of the art on the situation of WW in Morocco, its treatment and the potential for reuse, which will undoubtedly help to achieve water savings and especially to reduce the current excessive pressure on groundwater.

The last objective is to highlight the nature of the challenges facing reuse today and the prospects for this vast programme.

**Keywords** | Water scarcity; Wastewaters; Treatment technologies; Purification; Reuse.

*Abstracts of Keynote Sessions*

## KN1

### **Performance et intégration des membranes en Afrique de l'ouest pour l'accès à l'eau potable**

*Apport des universités ou centres de formation et de recherche*

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**Résumé** | Ce sujet s'intéresse à un environnement riche en ressources hydriques comme la nappe du Maestrichtien estimée à plusieurs milliards de mètres cubes, le fleuve Sénégal, le fleuve Gambie, le fleuve Niger...

Ces ressources abondantes et accessibles nécessitent une amélioration significative de leur qualité avant une mise à disposition pour consommation auprès des populations. Dans un tel contexte, l'expérience des membranes prouve à suffisance qu'il n'est pas nécessaire d'inventer la roue mais plutôt de maîtriser la technologie, l'adapter aux besoins spécifiques et surtout assurer la durabilité par la formation et la recherche de qualité.

Une estimation à plus de 25% de la population Sénégalaise est concernée par une eau de boisson d'une forte salinité au goût désagréable et d'un excès de fluor, source de fluorose dentaire et surtout osseuse. C'est pour cela que nous proposons l'exemple d'une expérience de deux à trois décennies de travaux de recherche de solution pour l'élimination concomitante du fluor et du sel qui démontre les performances de différentes membranes (NF200, NF270, XLE, ESPA3, TFC-SR3, SelRo MPF-34), leurs limites et la mise en service continu durant dix années d'une unité de filtration membranaire à 500 L/h (énergie d'hydratation, colmatage, disc tube).

L'intégration des membranes en Afrique de l'ouest pour la production d'eau potable est un processus irréversible face à la demande d'une qualité de vie de plus en plus exigeante des populations. L'unique socle durable et viable d'un tel système serait la mise en place de curricula et d'équipes de recherche au sein d'établissements d'enseignement supérieur pilotes comme les universités ou centres de formation et de recherche suffisamment structurés.

Les résultats des travaux obtenus et l'analyse faite de la situation pour l'accès à l'eau potable en Afrique de l'ouest sont renforcés par la nouvelle attitude des pays côtiers de la zone qui se projettent vers le dessalement de l'eau de mer.

## KN2

### Impact of treated wastewater on soil bacterial communities

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**Abstract** | The European Union encourages irrigation with treated wastewater by limiting monitoring to a single indicator: faecal contamination (*E. Coli*). Beyond the health protection of the actors, our work focused on the environment (soil plant) that sees and receives this unconventional water resource. In fact, reclaimed wastewater irrigation can cause also advert effects for soil microbiomes. Nevertheless, the positive effects of nutrients and organic matter, contained in reclaimed water, may be counterbalanced by the fluxes and loads of biotic and abiotic contaminants. The objective of this study was to evaluate the impact of irrigation with four different wastewater qualities on soil microbiome structures along two seasons of lettuce crop. The four unconventional water tested were: (1) Tap water, (2) membrane bioreactor effluent (MBR), (3) constructed wetlands (CW) and (4) raw urban wastewater (RW). These Wastewater qualities were evaluated based on their nutrient and microbiological contents. Whereas, the impacts on soils were quantified based on the modifications of content in organic matter and of microbial communities. Microbial community were quantified using high-throughput 16S rRNA gene sequencing and qPCR. A low impact of wastewater types on autochthonous microbial community fate was observed. Interestingly, microbial community structures from samples irrigated with tap water and different reclaimed wastewater level could not be distinguished. In RW, CW and MB microbial contaminants such as *pseudomonas aeruginosa*, *E.coli* and *enterococci faecalis* were concentrated between  $10^2$ - $10^6$ ,  $10^3$ - $10^7$  and  $10^2$ - $10^9$  DNA copies/mL respectively. However, their persistence in soil were very low and close to zero. Overall, the results show an adaptation of microbial communities to the disturbance undergone by reclaimed wastewater. In addition, these practices did not seem to drive significant risks related to pathogenic microorganisms by transfer via the soil due to their low resistance.

**Keywords** | Wastewater reuse; Soil microbiota; Health.

## KN3

### Plasmonic Nanomaterials for Environmental Filtrations

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**Abstract** | Environmental filtrations, along with water reuse, are two critical topics when dealing with the sustainability of industrial systems. Nanomaterials and their related technologies have already acquired great consideration as a favorable way for several environmental applications, starting from contaminants removal to pathogens inactivation. Plasmonic nanomaterials (PNMs) were proven to be able to well serve this scope due to their customizable properties such as conductivity, catalytic activities, thermal, and optical features. These features allowed the design of proficient materials for environmental remediation, with improved light absorption efficiency, high kinetic rates, and enhanced charge separation. Nevertheless, four main challenges in PNMs for environmental remediation remain, being them: the achievement of a complete mineralization of contaminants, the lowering of PNMs costs, the stability of PNMs in the operational conditions, the safety of these materials. PNMs still remain very promising; in fact, many studies reported how well plasmonic photocatalysis behaved in pharmaceuticals remediation, even when treating endocrine disrupting chemicals. PNMs have also been intensively tested for air pollution matters such as VOCs or flue gases treatment, while bacteria inactivation by PNMs is yet considered another wide topic worth investigating. It is to say that, with a more focused view on process optimization, some artificial neural network models should accompany such developments, especially when dealing with industrial scales plants, such as the advanced oxidation processes widely used for wastewater treatments, in which PNMs seem to be well integrating.

**Keywords** | Plasmonic; Nanoparticle; Wastewater; Environmental integration; Membrane.

## KN4

### Renewable energy-powered membrane technology

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**Abstract** | Membrane technology is recognized as a key technology for water treatment owing to their selectivity (production with a stable quality). Pressure- and electrically- riven membrane filtration are the most widely used technologies for this purpose. However, they consume large amounts of energy. For instance, the highly efficient ED, NF and RO are in the same time energy intensive processes.

Renewable energies (REs) are clean, safe, abundant and distributed worldwide. Their use is one of the most practical solutions to limit the fossil fuels use and overcome the associated environmental problems (extraction of finite resource, transportation, storage and greenhouse gas emissions). The integration of RE sources with membrane filtration technology is therefore becoming essential to achieve overall sustainability. Solar and wind energy the two most popular and fastest growing RE sources. Another developing source is the wave power that looks very promising for the future. Feature and integration of each RE sources with membrane technology are briefly discussed in terms of advantages and disadvantages in the first part of the presentation.

Intermittency and fluctuation are the main concerns with RE. This issue is addressed in the second part by examining the case of solar energy-powered membrane desalination of sea and brackish water. The variation in power, which affects the pressure applied to the membrane, is considered in terms of the process performance and the stability of the membrane material.

Thanks to T. Garel and M. Vergnet for providing the data of desalination plants implemented by Mascara (DEMOS PIA project – ADEME).

**Keywords** | Renewable energy; Desalination; Process performance; Membrane material damage.



## KN5

### **Study of performances of low-cost ceramic membranes for oily wastewater treatment**

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**Abstract** | Oily wastewater formed by various species, including fats, lubricants, cutting oils, heavy hydrocarbons, light, hydrocarbons, etc. is quite hard to be completely purified by conventional technologies. Commonly, oily wastewater is widely originated from a large number of industrial and living fields, such as food processing, metal finishing, textile and leather synthesis, oil and gas production, domestic sewage, kitchen residuals, transportation vehicles, and so for. Without proper treatment, oily wastewater would lead to irreversible environmental contamination. The nature of wastewater is a critical consideration in the proposed of suitable treatment method for oil removal. Conventional methods to separate oily wastewater can be used for treating free-floating oils and dispersed oils. However, most of them are not suitable for treating emulsion with microscopic oil droplets smaller than 20  $\mu\text{m}$  due to the high cost or low treatment efficiency. However, membrane separation technology using porous ceramic membranes appears to be a highly promising and efficient method for treating oily wastewater due to ease of processing, long durability and low maintenance cost. The commercial ceramic membranes from alumina, titania and silica are not suitable for large-scale applications because they remain too expensive from a technico-economic point of view. In the last years, ceramic membranes based on natural minerals, such as clay, carbon, phosphate, zeolite and sand have increasingly attracted attention for their low cost.

The fabrication of various ceramic membranes from natural and low-cost materials for oily wastewater treatment will be presented and discussed. The performance of different membrane processes such as Ultrafiltration and membrane distillation will be evaluated.

**Keywords** | Oily wastewater; Low-cost membrane; Ultrafiltration; Membrane distillation; Performances.

## KN6

### Microalgae fractionation

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**Abstract** | The microalgae fractionation constitutes a stepping stone in their valorization journey. To accomplish this, two main steps are involved, the cell lysis for extraction, and the extract purification to get the target biomolecules. Many studies have been performed on different microalgae species, characterized by different cell wall rigidities and compositions. Thus, this work aims to highlight the influence of the extraction conditions on the design of the downstream processing.

Mechanical extraction treatments have been used to evaluate its impact on the cell structures and the extracted biomolecules. These methods are preferred on the industrial scale production, and they include bead milling, high pressure homogenizer and ultrasound. Afterwards, the lysate has been fractionated by a combination of centrifugation and membrane filtration. The studied processes were assessed by an analysis of proteins, carbohydrates and pigments concentrations in each produced fraction.

The results showed that for a weak cell wall like the cyanobacteria *Spirulina sp.*, ultrasound is efficient for proteins extraction, while HPH is preferred for a rigid cell wall. We also noticed that the plate centrifugation requires a concentration lower than 7% DW to achieve the solid-liquid separation. Add to this that for lower concentration, the press filtration is more efficient, but when the cake is compressible, a filtration adjuvant is required. After the centrifugation, an important concentration of pigments was detected in the supernatant, A precipitation step with ammonium sulfate were used to remove them, in order to produce two protein families, in the permeate and in the retentate of the ultrafiltration, with at10 kDa organic membrane.

In the case of *tetraselmis suecica*, the recovery of Exo-PolySaccharides EPS was possible by cell washing: mixing cells with water and separation by centrifugation. Then, the supernatant was purified and concentrated using 3 kDa ultrafiltration membrane. Finally, the concentrated polysaccharide extract was subject to diafiltration for salt removal.

**Keywords** | Separation; Membrane; Microalgae; Cell lysis; Ultrafiltration.

*Oral Sessions*

## O1

### **WASTEWATER MANAGEMENT IMPROVEMENT IN THE UNAMID HEADQUARTERS IN CENTRAL DARFUR, ZALINGEI, SUDAN.**

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**Abstract** | The study took place from 01 January 2019 to 30 June 2020 at the United Nations /African Union hybrid Mission in Darfur (UNAMID) headquarters in Sudan in the locality of Zalingei in the Central Darfur region. It is about the water and wastewater pillar from the Department of Field Service Strategy on Environment Conservation and the main results achieved by the study are: (i) six (6) new wastewater treatment plants are installed and operational; (ii) sanitary facilities access for 1480 inhabitants is improved; iv) 1000 cum of recycled water is available per week for the drip irrigation within the camp. It has also led to an effective and lasting partnership between the Faculty of Agriculture at the University of Zalingei and the UNAMID Office Administration in Central Darfur.

**Keywords** | wastewater; UNAMID; waterborne diseases; water treatment; recycled water.

## O2

### **Coagulation / Flocculation of industrial and urban sludges and wastewaters: challenges and perspectives**

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**Abstract** | Particles flocculation is used on all sewage treatment plants, where many structures use this physicochemical process: settling on the water stream, thickening and dehydration on the sludge stream. It enables to agglomerate the matters to facilitate and accelerate their separation from water, as well as the capture and concentration of solids and to limit the quantity of pollutants returned to the head of the station. For this purpose, reagents are used in large quantities, including mineral coagulants and organic polymers. The separation works are strategic in sanitation because they make it possible to reliably treat water downstream and reduce the volume of sludge disposed. They are now the source of many problems (variability of separation performance, insufficient capture ratio, degradation of the overall performance of the plants due to the head return of the polluted waters generated by dewatering steps, problems of sludges transport, management of excess reagents etc.). There are many challenges to help the operator improve the reliability and control of the water and sludge chemical conditioning stage.

The article describes the new challenges in this field, which involve the development of new synthetic reagents to adapt to the technical challenges of separation, or biosourced to reduce their environmental impact. The development of knowledge on the mechanisms of agglomeration, of new methods of intrinsic and behavioral characterization at multi-scales for flocs to better know and anticipate their behavior in the works are necessary steps. Reducing the consumption of reagents, while guaranteeing and even improving the performance of structures, is a real financial, operational and environmental challenge for the years to come.

**Keywords** | wastewaters; sludges; coagulant; flocculent; separation; dewatering.

### O3

## **Aerobic treatment of fish canning wastewater using a pilot-scale external membrane bioreactor**

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**Abstract** | The performance of a pilot scale aerobic membrane bioreactor (AeMBR) system equipped with external ceramic ultrafiltration (UF) membrane treating fish canning wastewater was evaluated for 270 days of operation. It was operated under ambient conditions (21.5°C), 12 days of sludge retention time (SRT) and for a hydraulic retention time (HRT) of 24 hours. System stability was determined as a function of variation in organic loading rate (OLR), total dissolved solids (TDS) and oxygenation rate, while monitoring transmembrane pressure (TMP) and chemical oxygen demand (COD) removal. The OLR varied in the range of 3-5 kg COD/m<sup>3</sup>.day and the TDS between 2.5 and 5 g/L. The oxygenation rate used was between 1000 and 1500 NL/h, while the applied TMP was in the range of 0.05 to 1.5 bar. These operational variables have a significant effect on the performance and the permeate quality which is evaluated in terms of removal efficiency of COD, biochemical oxygen demand (BOD<sub>5</sub>), total suspended solids (SS), nitrate (NO<sub>3</sub><sup>-</sup>) content, total phosphorus (TP) and total nitrogen Kjeldahl (NTK). The optimal conditions of treatment by AeMBR of this effluent in this study were obtained at oxygenation rate of 1300 NL/h, TMP of 0.35 bar, OLR of 4.27 kg COD/m<sup>3</sup> and TDS of 3 g/L. The treated effluent recovered at the output of the AeMBR meets the quality standards according to the Food and Agriculture Organization (FAO) directive and the Moroccan standards for the discharge and reuse of water for irrigation and watering.

**Keywords** | Aerobic membrane bioreactor; Ultrafiltration; Fish canning wastewater; Total dissolved solids; Aeration rate; Organic loading rate.

## O4

### **Application des procédés membranaires pour le traitement des eaux saumâtres en milieu rural au Sénégal**

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**Abstract** | Au Sénégal, la majeure partie des populations situées dans la zone du bassin arachidier (Diourbel, Fatick, Kaolack) consomment une eau excessivement fluorée et salée. La spécificité du Sénégal par rapport aux autres pays affectés par ce problème d'excès de fluor est qu'en plus de l'excès de fluor (qui dépasse largement 1,5 mg/L, la limite recommandée par l'OMS), il y a aussi une forte salinité (>2 g/L) qui confère à l'eau un goût désagréable. La consommation régulière de telles eaux a des conséquences néfastes sur la santé des populations concernées qui se manifestent par le développement de fluorose dentaire et/ou osseuse. L'efficacité des procédés membranaires, a fait ses preuves à travers le monde pour le traitement de telles eaux afin de produire de l'eau potable. Cependant, l'application de ces procédés est poussive dans les pays en Afrique de l'Ouest et ces technologies sont souvent difficiles à mettre en œuvre dans les zones isolées en milieu rural à cause du manque d'installations comme l'électricité et les entretiens nécessaires. Cependant, au Sénégal nous avons des unités de production à l'échelle communautaire qui fonctionnent depuis 2013 de façon autonome par des personnes formées sur place et avec un minimum d'interventions techniques (nettoyages chimiques, remplacement des membranes). Ce qui démontre de la faisabilité de ces technologies en milieu rural. C'est ainsi que nous sommes en train de tester une unité pilote d'osmose inverse pour le traitement des eaux saumâtres dans les localités isolées comme les îles situées dans la région de Ziguinchor au sud du Sénégal.

**Keywords** | Eaux saumâtres ; Membranes ; Milieu rural.

## O5

### OCEAN WAVE-POWERED STAND-ALONE ONEKA BUOY FOR SUSTAINABLE DESALINATION SOLUTION

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**Abstract |** Wave energy is considered one of the most promising renewable energy sources in coastal areas. It is more persistent and spatially concentrated than most renewable energy resources [1]. For example, wave energy is available up to 90% of the time at a given site, whereas solar and wind energy are only available 20-30% of the time [2]. Second, traditional sustainable power plants have to go through several energy conversion steps, which is complicated and costly in terms of CAPEX and OPEX. Wave energy is a mechanical energy that is easily convertible to high-pressure seawater. Because it does not require an initial conversion step to electricity, wave energy is therefore more energy efficient for reverse osmosis seawater desalination. Oneka Technologies is developing wave-powered, on-board seawater desalination systems to produce drinking water. Oneka's floating buoys require no land space and use waves as the sole source of energy to pressurize seawater through reverse osmosis membranes. The fresh water produced is then delivered to land through a submerged pipeline.

A number of demonstrators on three ranges of buoys with an average production capacity of 1 to 50 m<sup>3</sup> of fresh water have been built and operated in the Pacific (Chile) and Atlantic (Florida and North Carolina) Oceans. The quality of the fresh water produced meets the standards of the World Health Organization and/or local standards.

In conclusion, Oneka buoys provide a sustainable, cost-effective and 100% environmentally friendly supply of drinking water to coastal communities and remote islands that do not have access to electric grid or have expensive and limited land reserves.

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**Keywords |** Renewable energy; Seawater desalination; On-board and stand-alone reverse osmosis unit; Ocean Wave energy.



## O6

### **Fouling investigation of ceramic ultrafiltration membranes: influence of transmembrane pressure**

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**Abstract** | The identification of the ultrafiltration (UF) membranes fouling mechanism helps to minimize the effect of this phenomenon and to find the best method to regenerate the fouled membranes. The membrane fouling of UF membranes could be described using a single fouling mode or a combined mode. The aim of this work is to study the effect of transmembrane pressure (TMP) at constant flow velocity ( $V=2\text{m/s}$ ) on the fouling mechanism of three UF ceramic membranes (UF20, UF50 and UF100) with different porosities 20, 50 and 100 nm. The tests were performed on a synthetic solution of glyucose at 60 g/L. Two mathematical models were used, the Hermia and Bolton models. The Hermia model gives four equations translating the four modes of fouling (cake formation, intermediate blockage, pore constriction and complete blockage). This model was used to determine the most probable mechanism. In addition, the combined Bolton model was used to demonstrate whether there is a combination of these different modes. The results show that TMP has an influence on the limiting flux, but it does not have any influence on the rejection rate. However, for the three membranes types tested and according to the Hermia model, fouling was superficial and cake formation or intermediate blockage were the main fouling mechanisms. The Bolton model equations application shows that, for both membranes (UF20 and UF50), fouling at different TMP was described using the combined equation of cake formation and complete blockage. Furthermore, for the UF100 membrane, fouling was described by the combined equation of cake formation and intermediate blockage.

**Keywords** | Ultrafiltration; Ceramic membrane fouling; Modeling; Hermia model; Bolton model; Transmembrane pressure.

## O7

### **Recent advances in photocatalytic application in industrial wastewater treatment: principle, latest advances, challenges and perspectives**

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**Abstract** | Water pollution by industrial waste is becoming a major environmental problem, presenting real risks to the environment and human health. The pollution of industrial wastewater and the sanitation of drinking water supplies are today a primary concern, among the most recent advances in water treatment and photocatalytic processes. Photocatalysis is one of the advanced water treatment processes that allows the complete mineralization of pollutants in mild treatment conditions. This advanced technique, exploiting solar energy, is becoming a promising technology for treating industrial wastewater. This work presents the latest advances in photocatalytic treatment applications of industrial wastewater. Solutions and strategies are proposed in this document, such as the development of hybrid processes and their coupling with conventional biological treatments, to overcome certain specific constraints of this process and thus facilitate their insertion in the water treatment sectors and industrial effluents. This paper aims to study photocatalyst synthesis and its operation principle in supported media. Also, we focus on determining the various governing parameters during the treatment of water and industrial effluents. The enhancement of process performances, challenges, and prospects of this promising field is also being explored.

**Keywords** | Photocatalysis; Industrial wastewater; Water treatment; Pollution.

## O8

### **Leachate anaerobic treatment: the case of Mohammedia-Benslimane landfill**

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**Abstract** | Landfill leachate is generated from the degradation of organic matter in landfills. This wastewater is characterized by high concentrations of organic and inorganic pollutants, making it a major environmental concern. One of the most effective methods for treating landfill leachate is anaerobic treatment, which has been shown to effectively remove the majority of the pollutants present in this wastewater. The study aimed to evaluate the efficiency of this treatment method in removing pollutants from landfill leachate and to assess the environmental impact of the treated leachate. The results of the study showed that anaerobic landfill leachate treatment was able to achieve high removal efficiencies for several pollutants. The turbidity was reduced by 50%, while the absorbance at 254 nm was reduced by 98%. The chemical oxygen demand (COD) was also reduced by 64%, indicating the effective removal of organic matter from the leachate. To evaluate the environmental impact of the treated leachate, the leachate pollution index (LPI) was calculated. The LPI is a tool that is used to assess the potential environmental impact of landfill leachate on groundwater and surface water resources. The results of the study showed that the LPI was lower for the treated leachate than for the raw leachate, indicating that the anaerobic treatment had reduced the potential environmental impact of the leachate. In conclusion, anaerobic landfill leachate treatment is an effective method for treating landfill leachate, as it is able to remove a range of pollutants and reduce the potential environmental impact of the leachate. The study conducted on the landfill of Mohammedia demonstrated the efficiency of this treatment method, with high removal efficiencies achieved for several pollutants and a reduction in the LPI of the treated leachate.

**Keywords** | Landfill leachate; Anaerobic treatment; Leachate pollution index.

## O9

### **Development of a novel glasses based on phosphate and its application as a promising adsorbent for crystal violet dye removal**

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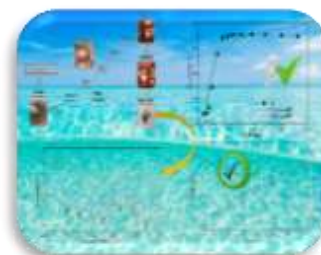
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**Abstract** | The present study is about the use of glasses all by themselves and for the first time as adsorbents to improve their adsorption capacity for the removal of crystal violet dye from aqueous solutions. New samples of glasses based on phosphate were synthesized using conventional melt quenching method and characterized by X-Ray analysis, which confirms the amorphous structure of our samples, Fourier Transform Infrared (FT-IR) shows that  $V_2O_5$  behaves as a network former at high concentrations, density and molar volume indicates the formation of new interconnections and destabilization in the structure of our glasses. Confirming the IR spectroscopy results as a function of  $V_2O_5$  content. The glasses based on phosphate were efficiently employed for the first time as an adsorbent crystal violet (CV) dyestuff from water. These glasses showed an interesting capacity to absorb the crystal violet dye by a removal efficiency of about 98% after 1h of stirring. The CV dye adsorption performance was investigated as a function of several operating conditions. Isothermal and kinetic adsorption modeling indicates a good fit between the Langmuir isotherm and pseudo-second order models. Kinetic approach studies for crystal violet dye removal clearly indicated that the results of the adsorption process followed the pseudo second order and Langmuir models. From a thermodynamic point of view, the CV adsorption process occurred spontaneously and exothermically. These findings revealed that the synthesized glasses based on phosphate exhibited a high potential for wastewater treatment containing CV.

**Keywords** | Glasses; Phosphate; Surface chemistry; Cristal violet; Adsorption.



**O10**

**Fabrication of low-cost kaolinite/perlite membrane for microfiltration of dairy wastewater**

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**Abstract** | Water scarcity issues are raising social concerns around the globe. As the sources are very limited, the removal of contaminants from industrial and municipal effluents is recommended. Dairy wastewaters (DW) are among the effluents that are causing harm to the environment, thus, their treatment is difficult due to their high organic contaminants. This work is addressing this issue by preparing a microfiltration membrane (MF) made from a mixture of clay and volcanic material using a dry uniaxial pressing. Twelve experiences with different percentages (25, 50, and 75wt.%) were realized. Techniques such as XRD, SEM, and FTIR were carried out to characterize the prepared membranes. The results showed that the optimized membrane is the one made from 50/50 wt.%, having a mechanical strength of 20 MPa and a permeability up to 1700 L.h<sup>-1</sup> m<sup>-2</sup> bar<sup>-1</sup>. This membrane showed enhanced results compared to the membrane manufactured from unique clay and that is explained by the microstructure heterogeneity that leads to the creation of a looser packing arrangement and increases the permeability. This study highlighted the fabrication of a green MF with the removal of 98.5 % of DW using natural materials and without adding hazardous additives to enhance the performance of the membrane.

**Keywords** | Ceramic membrane; clay; geomaterial; sintering; industrial wastewater.

**O11**

## **Selection of a study area for desalination of brackish water by hybrid processes**

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**Abstract** | Climate change induces strong disturbances in the global water cycle. This leads to rainfall repercussions, particularly long periods of severe drought, which subsequently impacts the economic and social aspects of communities. Morocco, a country of interest, is not spared. The country is currently in a situation of water stress. This reality pushes decision makers and researchers to turn to alternative solutions such as the desalination of sea and brackish water. However, the performance of this solution depends on the efficiency of the pre-treatment processes for better results in terms of water quality and energy consumption.

The objective of this study is the use of hybrid processes for the desalination of brackish water based on renewable energy. To do this, the choice of the geographical area in Morocco to carry out sampling and analysis of water quality is a primary task. To achieve this goal, the selection criteria are determined and the total score of each area is calculated after normalizing the values to find the optimal area. The results obtained after the application of this method will give us an indication of the scores of each zone and will serve as a basis for decision making.

**Keywords** | Hybrid process; Desalination; Decision support; Climate change.

**O12**

**Contribution to the study of fluoride ion transfer in nanofiltration and reverse osmosis membranes**

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**Abstract** | The study of solute transport (charged or neutral) through nanofiltration (NF) or reverse osmosis (RO) membranes is complicated, especially for NF membranes. Therefore, many mathematical models have been applied to illustrate the different mechanisms of ion transfer across these membranes. The aim of this work is to study the influence of the initial concentration of fluoride ion on the transport in two types of membranes, RO (TW30) and NF (NF270) by determining the different constants of the applied models. Kedem-Katchalsky (KK) and Speigler-Kedem (SK) models, which neglect the effect of the concentration polarization layer (CPL) and electrostatic effect, were used to determine the convective concentration ( $C_{conv}$ ), the diffusive flux ( $J_{diff}$ ), and the fluoride ion permeability ( $P_s$ ), as well as the reflection coefficient ( $\sigma$ ), which gives insight into the contribution of convection and diffusion in the transport. The Nernst-Planck model coupled with film theory (NP-FT) which neglects the electrostatic effect but allows the determination of the thickness ( $\delta$ ) of the CPL in addition to  $P_s$  and  $\sigma$ . The pore radius of the membranes and the Molecular Weight Cut-Off (MWCO) of the fluoride ions were also determined mathematically. The tests were performed on distilled water doped at different NaF concentrations. The  $\sigma$  values obtained show that F<sup>-</sup> ion transport is mainly diffusive in TW30, whereas in NF270 both mechanisms are present. The parameters  $C_{conv}$  and  $J_{diff}$  increase with the initial F<sup>-</sup> concentration for both membranes, but more pronounced for the NF270 membrane compared to the RO.  $P_s$  decreases with the initial concentration. On the other hand,  $\delta$  of CPL for NF270 decreases slightly with increasing F<sup>-</sup> concentration. For TW30 the values found are negligible

**Keywords** | Fluoride removal; Transfer mechanism; Nanofiltration; Kedem-Katchalsky model; Speigler-Kedem model; Nernst-Planck model coupled to the film theory.

**O13**

## **Comparison of response surface method and artificial neural network in predicting fluoride removal by nanofiltration**

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**Abstract** | The present study aims to compare the predictive efficiencies of the response surface methodology (RSM) and the artificial neural network (ANN) models applied to the removal of fluoride ions from NaF-doped groundwater by nanofiltration (NF) using three membranes (TR60, NF270 and NF90). An RSM-based central composite model (CCD) and ANN-based on Feed-Forward, Back Propagation Network (FFBBN) are used in which the effects of input variables are initial fluoride concentration (IC) and transmembrane pressure (TMP) on the fluoride rejection that is considered as a response. The two methodologies are compared for their predictive abilities in terms of root mean square error (RMSE), coefficient of determination ( $R^2$ ) and average absolute deviation (AAD). For RSM model, a regression coefficient  $R^2 > 0.83$  is obtained for fluoride rejection efficiency for all three membranes and both parameters (IC and TMP) have a significant effect on fluoride rejection for both membranes (TR60 and NF270), whereas for the NF90 membrane they have a slight effect. The ANN model shows excellent prediction of fluoride rejection with correlation coefficient values close to unity ( $R^2 > 0.998$ ) for the three membranes. In terms of comparison and based on the estimation parameters (RMSE,  $R^2$  and AAD), both models show good predictions for fluoride rejection. While, the ANN model proves to be more accurate compared to the RSM model. Furthermore, RSM has the advantage of providing a regression equation for prediction and shows the effect of experimental factors and their interactions on the response compared to ANN.

**Keywords** | Response surface methodology (RSM); Artificial neural networks (ANN); Nanofiltration; Fluoride removal; Modelling; Prediction.



## O14

### Characterization of water-soluble ions of PM<sub>2.5</sub> in Kenitra, Morocco

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**Abstract** | A healthy economy depends on having good air quality, which is a crucial feature of the quality of life. Health problems can be exacerbated by poor air quality. One of the air pollutants that pose the greatest health threat is PM<sub>2.5</sub> (particulate matter with an aerodynamic diameter of less than 2.5 μm). Daily PM<sub>2.5</sub> and water-soluble ions (Na<sup>+</sup>, SO<sub>4</sub><sup>2-</sup>, Cl<sup>-</sup>, NO<sub>3</sub><sup>-</sup>, K<sup>+</sup>, Ca<sup>2+</sup>, NH<sub>4</sub><sup>+</sup>, F<sup>-</sup>, and Mg<sup>2+</sup>) were collected at an urban site in Kenitra, Morocco, during 2020-2021 period. A total of 60 effective PM<sub>2.5</sub> samples were collected for 24 hours on 37-mm diameter Nuclepore track-etched polycarbonate filters using a dichotomous sampler. The content of anionic and cationic ions was determined by ion chromatography.

A comprehensive investigation has been conducted on the chemical characteristics of PM<sub>2.5</sub>. The average mass concentration of PM<sub>2.5</sub> was  $17.2 \pm 7.4 \mu\text{g m}^{-3}$ , and the order of concentration of the ions was: Na<sup>+</sup>>SO<sub>4</sub><sup>2-</sup>>Cl<sup>-</sup>>NO<sub>3</sub><sup>-</sup>>K<sup>+</sup>>Ca<sup>2+</sup>>NH<sub>4</sub><sup>+</sup>>F<sup>-</sup>>Mg<sup>2+</sup>. Secondary inorganic (NO<sub>3</sub><sup>-</sup>, SO<sub>4</sub><sup>2-</sup> and NH<sub>4</sub><sup>+</sup>) and sea salt species (Na<sup>+</sup> and Cl<sup>-</sup>) were the major components of water-soluble ions in PM<sub>2.5</sub>, with an average contribution of 78% to the total PM<sub>2.5</sub> ions. The ratio of [NO<sub>3</sub><sup>-</sup>]/[SO<sub>4</sub><sup>2-</sup>] was lower than the unity, indicating that the main source of sulfur and nitrogen in the Kenitra atmosphere was prioritized from a fixed source.

**Keywords** | Fine particulate matter; Water-soluble ions; Nitrate-to-sulfate ratio; Chemical characteristics; Kenitra.

O15

## **Fluoride removal by electrodialysis: Competition of fluoride ions with other anions through ACS membrane**

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**Abstract** | Electrodialysis (ED) is one of the membrane processes used for removing fluoride ions from brackish water (BW). However, the efficiency of this removal is influenced by the chemical composition of the water being treated because the fluoride ion competes with other anions during passage through the ion exchange membranes (IEMs). In this study, the competition of fluoride ion with  $HCO_3^-$ ,  $NO_3^-$ ,  $Cl^-$  and  $SO_4^{2-}$  ions through ACS membrane at different concentrations (50, 100, 200 and 300 ppm) is studied. In addition, the removal rate of ions by ED is influenced by the thickness of the polarization layer (PL) which reduces the ion transfer and provides an additional barrier. The greater the thickness  $\delta$  of the PL, the longer the passage time and consequently the removal rate is small. Therefore, using the unstirred layer model, the thickness  $\delta$  for each ion will be determined. For ACS membrane, both the demineralization rate (DR) and  $\delta$  of fluoride ions are influenced by the nature and the initial concentration of the other anions according to the following order:  $NO_3^- > Cl^- > HCO_3^- > SO_4^{2-}$ .

**Keywords** | Fluoride removal; Electrodialysis; Modeling; Concentration Polarization; Polarization layer; Ion-Exchange Membranes.

**O16**

## **Natural Generation, Characterization and Membrane Filtration of Nanoplastics in water**

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**Abstract** | Nanoplastics (NP) are increasingly being accepted as a global environmental concern due to their potential to cause harm to both aquatic and terrestrial ecosystems. The presence, distribution, and quantity of NP in aquatic environments can be difficult to ascertain, as they are often present in low concentrations and are difficult to detect.

In addition, their small size makes them resistant to conventional filtration and extraction techniques. The use of membrane filtration for the removal of NP from water has recently been explored as a viable solution to the mounting global issue of plastic pollution. In this study, we present a comprehensive review of the current state of knowledge on this topic and discuss the various membrane filtration processes used for the removal of NP.

In addition, we present the results of an experimental study conducted to determine the effectiveness of several organic and inorganic membrane, pore sizes, MWCO, operating conditions, and pretreatment steps that have been used to effectively remove NP from ultra-pure water. We used a combination of dynamic light scattering (DLS) and nanoparticle tracking analysis (NTA) to characterize the NP in the samples prior to and after filtration. We found that some membrane was effective at removing NP from water, but another one was not successful concerning with structural or functional values previously obtained. Our results demonstrate that membrane filtration is a promising solution for the removal of NP from water and could be used in a wide range of applications.

Finally, we suggest potential directions for future research and provide recommendations for the development of more effective membrane filtration systems for NP removal.

**Keywords** | Nanoplastics; Membrane separation; Characterization; DLS; NTA.

**O17**

**Preparation of low-cost ultrafiltration membrane  
made from purified pyrophyllite**

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**Abstract** | Recently, membrane separations have been widely adopted as green separation technology due to their attractive advantages including high separation efficiency. They are viewed as an efficient and environmentally friendly method that can handle the largest amount of liquid while maintaining a controlled transmembrane pressure.

This work aims to develop novel ceramic ultrafiltration membranes made from purified pyrophyllite. Natural pyrophyllite was purified via an optimized physicochemical protocol. The purified pyrophyllite and some additives were used to prepare a slip to be deposited as a thin selective layer on pyrophyllite support via spin-coating method. Thereafter, the membrane was sintered at different temperatures to investigate its influence on membrane characteristics. The prepared membrane was deeply investigated using scanning electron microscopy, pore size, water permeability and antifouling characterizations. The obtained membrane was applied for tangential filtration of textile wastewater containing soluble dyes under pressure of 3 bar. More importantly, the preliminary filtration results show that the pyrophyllite-based membrane could be effective for treatment of colored wastewater.

**Keywords** | Ultrafiltration; Pyrophyllite; Ceramic membrane; Textile wastewater; Sintering.

O18

**Kinetic, equilibrium and thermodynamic studies for Chrome (VI) removal by magnesium aluminum layered double hydroxides (MgAl-LDH), synthesized by urea hydrolysis method**

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**Abstract** | Layered double hydroxides (LDHs), known as a class of anionic clays, have attracted considerable attention recently due to their potential applications in different areas as catalyst materials, energy materials, and adsorbent materials for environmental remediation, especially for anionic pollutants removal. In this study, magnesium aluminum layered double hydroxides (MgAl-LDH) was synthesized by urea hydrolysis method. Its textural property and morphology were examined by X-ray powder diffraction (XRD), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), fourier transform infrared spectroscopy (FTIR), thermogravimetry (TG) and differential (DTG) analysis, and point of zero charge (pHpzc). The results showed that MgAl-LDH was synthesized with good crystallinity and regularity.

Chromium removal by MgAl-LDH was studied at different values of time contact, initial concentration, temperature and pH. The results showed that the pseudo second-order model is the most suitable for describing the kinetic data. Regarding the equilibrium data, Langmuir model was found to be the best-fitting model for the adsorption of chromate ions on MgAl-LDH nanomaterial. The maximum adsorption capacity is about 26.7mg/g. Calculation of the thermodynamic parameters revealed that the adsorption process is spontaneous ( $\Delta G^\circ < 0$ ), endothermic ( $\Delta H^\circ > 0$ ). The disorder increase at the solid-liquid interface ( $\Delta S^\circ > 0$ ) during the adsorption process. This study demonstrates that MgAl-LDH nanomaterial could be used for removing anionic pollutants, like chromium, phosphates and nitrates, especially for wastewater treatment.

**Keywords** | Adsorption; Layered double hydroxide; Chromium, wastewater treatment.

O19

## **Purification of Drinking Water Using Highly Selective Catalytic Reduction of Nitrates into Nitrogen over Keggin-Type Polyoxometalates Materials**

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**Abstract** | Nitrates removal from domestic water is a serious issue taking into account the negative impacts of the nitrates compounds on the environment and human health. Numerous research works based on catalysis have been developed to reduce the nitrates content in consumed water. In this context, a series of HPW heteropolyacids based catalysts using various metal modifiers (Fe, Co) and supports (TiO<sub>2</sub>, ZnO, and CeO<sub>2</sub>) were synthesized and characterized by several techniques. Dispersive X-ray energy was employed for the surface composition, N<sub>2</sub> adsorption for the texture, X-ray diffraction, infrared spectroscopy and Raman to check Keggin structure and scanning electron microscopy for the morphology of POMs materials. The catalysts were tested for nitrate reduction by two routes, the first one is a chemical redox reaction assisted by the formic acid as a source of H<sub>2</sub> reducing species, and the second one is an electrochemical route using nitrates as oxygen acceptors in the presence of heteropolyacids based catalysts as cathodic components in a microbial fuel cell. The highest performance found (99.16% of nitrates conversion into N<sub>2</sub>) was attributed to a synergetic effect of three collaborating agents: (i) metal promoter, (ii) HPW precursor and (iii) metal oxide support.

**Keywords** | Catalytic selective reduction; nitrate; kegg-in-type polyoxometalates; metal promoter; HPW; support; microbial fuel cell.

**O20**

**Growing trend for advanced liquid filtration capabilities in cleanroom facilities**

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**Abstract** | The semiconductor industry heavily relies on ultrapure water and aggressive liquids to mitigate defect formation and occurrence during the manufacture of microprocessors. Over the past 50 years, the size of electronic features formed on silicon wafers has shifted from micron length scale to sub-nanometer dimension - consistent with Moores' law prediction. By packing increasingly smaller integrated circuits on semiconductor surfaces better performing electronic devices can be built. As microchip design gained in complexity over time, the need for introducing high purity process/cleaning fluids has become more pressing. This study will investigate the relevance of liquid filtration and high efficiency/high compatibility membranes in cleanroom facilities – i.e., recycling of costly chemicals, purification of cleanroom incoming raw materials/discharged fluids, leverage of ultrapure cooling water for operating powerful computing systems etc.

**Keywords** | microchip; semiconductor; liquid filtration; high purity components.

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N. Narasimhan, Advanced filtration for advanced chip production <https://www.filtsep.com/content/blog/advanced-filtration-for-advanced-chip-production>, Filtration + Separation, Dec. 2022.

**O21**

## **Anaerobic digestion of vinasse derived from ethanol manufacturing using a continuous stirred tank reactor pilot plant**

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**Abstract |** The energy crisis and the climate problems that the world has been experiencing in recent years have led to an energy adaptation towards clean processes with a lower carbon impact on the environment, among them anaerobic digestion (AD). AD is a natural process of biogas production from waste heavily loaded with organic matter by the intervention of micro-organisms in an anaerobic environment. The biogas produced is essentially methane and carbon dioxide.

In this research, the AD of vinasse derived from bioethanol manufacturing is studied on a laboratory-scale using a continuous stirred tank reactor pilot plant at mesophilic conditions (37°C). The AD of vinasse was carried out under different operating parameters: pH, agitation, electric conductivity and hydraulic retention time (HRT) using the inoculum/vinasse ratio of 0.7. The obtained results show that under these operating conditions, the removal effectiveness of pollution abatement is close to 88% for chemical oxygen demand (COD) and 70% for total suspended solids (TSS) which correspond to maximum biogas production up to 75% of methane for an optimal HRT of 25 days, under the average pH of 8.

This study allows us to suggest that for the Inoculum/vinasse ratio of 0.7 shows a good efficiency in the elimination polluting load with a large quantity of biogas produced which translates into a good stability of the digester operating parameters during the AD process.

Anaerobic digestion; Mesophilic conditions; Continuous stirred tank reactor; Vinasse; Biogas; Pollution load

**Keywords |** Anaerobic digestion; Mesophilic conditions; Continuous stirred tank reactor; Vinasse; Biogas; Pollution load.



## O22

### **Design and validation of a locally assembled sand filter to remove iron and manganese from drinking water in Mali**

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**Abstract** | There is an urgent need for action at global and local levels to achieve safe and sustainable management of water, sanitation and hygiene for all in order to prevent the devastating impact of poor management to the health of millions of people. The findings from WHO and UN-Water Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) report [1] show that acceleration is needed in many countries to achieve the United Nations Sustainable Development Goal (SDG) 6 (to ensure access to water and sanitation for all by 2030). Sometimes, water is available, but it contains substances that are undesirable or harmful for human consumption, as it has been observed with borehole water sources in Mali. The water contains high concentrations of iron and manganese. The aim of this work is to find a local, sustainable, cost-affordable and effective solution to eliminate these undesirable substances [2]. To solve this issue, a sand filter was assembled locally in Bamako, Mali. The filter contains sand originating from the Niger River and clay that comes from a region close to the source of the water. The objective of this study is to validate the formulation of the sand filter, understand the filtration process operation and establish the role of each component. Finally, to streamline their operation by optimizing the operating parameters of the sand filter. More data will be displayed during the congress.

**Keywords** | Sand filter; borehole water; Deferrization; Demanganization; Local solution.

**Acknowledgement** | The authors would like to thank the *Nouvelle Aquitaine ID (Innovation Development) NGO with DEFIS (Développons Ensemble une Fabrique à Innovations Solidaires) projects with the participation of University of Bordeaux as a partner and its Agenais Master's in Sustainable provided by the Agen branch of the INSPE (Institut National Supérieur du Professorat et de l'Éducation) and supported by "Nouvelle-Aquitaine" Region.*

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**O23**

## **Comparison of diverse direct and hybrid membrane processes for nitrate removal from brackish water**

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**Abstract** | The purpose of this paper is to evaluate the efficiency of nitrate removal from ground water with membrane processes, including direct: electrodialysis (ED), reverse osmosis (RO), nanofiltration (NF), and hybrid process coupling NF with RO/ED. Both energy consumption and water product quality were considered to assess process efficiency of direct and hybrid systems. The blending strategy was adopted only for permeates that are lower than the standards for drinking water in terms of nitrate by mixing the permeate with brine. Results indicate that the nitrate removal efficiency in RO system and ED was about 95%, 3% and 91%, 48% more than that of the NF system. Thereby, the energy and cost efficiency of ED is relatively higher than RO. Considering the nitrate removal efficiency of NF-RO and NF-ED hybrid system, the results show that the NF-ED quality of nitrate content is better than that of NF-RO. In addition, the water recovery of NF-ED is relatively higher. However, the energy consumption and energy cost of both NF-ED and NF-RO hybrid systems are similar with a particular benefit of NF-ED. However, the portion of blending rate with NF-RO permeate is equal to 65% and to 45% of RO. Having said that, the NF-RO hybrid system is technically more attractive than others to obtain water with 50 ppm of nitrate and a target recovery rate of 95.42%, despite their moderately higher energy cost. At the same time, NF-RO hybrid minimizes the fraction of brine disposal dumping to sewage, making it environmentally friendly.

**Keywords** | Nitrate ; Nanofiltration ; Recovery rate ; Hybrid system ; Energy consumption ; Electrodialysis.

**O24**

**Elaboration de nouveaux catalyseurs hybrides à base d'un alliage Ni-Cu/Polymère conjugué pour le suivi de la réaction d'évolution de l'hydrogène**

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**Résumé** | L'utilisation intensive des combustibles fossiles tels que le charbon, le pétrole et le gaz naturel, a des grandes répercussions sur notre environnement, ce qui se traduit par une élévation de la température du globe terrestre de 1.5 °C et un réchauffement climatique aussi rapide que dangereux [1]. Il est donc impératif de trouver des alternatives durables aux combustibles fossiles pour assurer une transition énergétique. L'hydrogène est considéré comme un vecteur énergétique des piles à combustible non polluant et est considéré comme une solution prometteuse. Il permet de convertir l'énergie des réactions chimiques des combustibles directement en énergie électrique. Cependant, les catalyseurs permettant la production de l'hydrogène sont à base de platine et restent extrêmement coûteux [2]. L'objectif de travail est de préparer des catalyseurs à base de métaux de transition pour l'étude de l'évolution de la réaction de l'hydrogène. (HER) Pour cela, Une étude comparative a été menée avec trois polymères conducteurs à base de phénylenediamine connues par une conductivité importante [3], sont utilisés comme support avant le dépôt de l'alliage Ni-Cu par voie électrochimique. Nous avons étudié plusieurs paramètres comme l'effet de la concentration et le mode de déposition de l'alliage ainsi que le potentiel de déposition. La morphologie et la structure des catalyseurs préparés ont été caractérisées par microscopie électronique à balayage à émission de champ (FE-SEM) et la diffraction des rayons X (DRX). La performance du catalyseur pour la réaction d'évolution de l'hydrogène a été examinée en milieu alcalin par la voltamétrie à balayage linéaire (LSV), la voltamétrie cyclique (CV) et la spectroscopie d'impédance électrochimique (EIS).

**Mots clés** | Energie propre ; Energie renouvelable ; La réaction d'évolution de l'hydrogène ; Electrocatalyseur ; Electrodeposition.

**O25**

## **Green membrane to remove Cd<sup>2+</sup> from aqueuse solutions**

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**Abstract** | Selectivity Performance of two different membranes (cordierite/ ZrO<sub>2</sub>) and (cordierite/ ZrO<sub>2</sub>/ISBM), has been investigated using Cd<sup>2+</sup>. The filtration experiments was carried out by a ceramic tubular membrane cordierite/ ZrO<sub>2</sub> (pore size 0,2µm), this membrane has been modified by formation of a dynamic layer at the surface of the microfiltration membrane during the circulation of the vegetal suspension (inert solid biomaterials). The retention of Cd<sup>2+</sup> ions by the cordierite/ZrO<sub>2</sub>/ISBMA was > 40%. Nevertheless, it is < 8% for cordierite/ZrO<sub>2</sub>.

The influence of concentration was also studied. The images obtained by Scanning electron microscopy (SEM) of the surface and the transverse section of the modified membrane are commented.

the retention of Cd<sup>2+</sup> increase with increasing pressure, this behaviour is in agreement with appearance of the complexant (Cd(OH)<sub>2</sub>) and caused to the ions adsorption on the membrane surface.

**Keywords** |Cordierite/ZrO<sub>2</sub>/membrane;inertsolidbiomaterial; Microfiltration; Retention.

## O26

### Prediction of multi-cycle fouling of hollow fiber ultrafiltration membranes using time series analysis.

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**Abstract** | This study aims to develop an algorithm for online prediction of the evolution of transmembrane pressure (TMP) during multi-cycles filtration (filtration/backwash) using a time series analysis called "exponential smoothing" (ETS). The prediction algorithm was developed based on laboratory-scale multi-cycle filtration experiments using various surrogates (alginate, BSA, bentonite), and it was applied to predict the filtration performance of a surface and underground resources from Poitiers and Paris.

An example is shown in figure 1 where a Clain River water sample (TOC = 1.87 mgC/L, UV<sub>254</sub>abs = 0.042 cm<sup>-1</sup>, Turbidity = 2.9 NTU) is filtered. An ETS model (A, A, M) is selected by the algorithm and showed a good fit with the experimental data and a precise prediction of TMP with 95% prediction intervals. The algorithm was executed once at the end of each cycle during 24 hours of filtration, and the comparison between the predictions and the actual TMP showed an average R<sup>2</sup> value of 0.984 and a root-mean-square error (RMSE) value of 0.046 bars. The ETS models were able to predict the TMP variation even when a chemical cleaning was performed. The proposed methodology could provide an efficient solution for predicting the performance of membrane filtration systems and reducing operational costs by minimizing downtime and optimizing backwash intervals. The next step is to test this methodology on industrial-scale TMP data and create a web application for membrane users to access the prediction algorithm online.

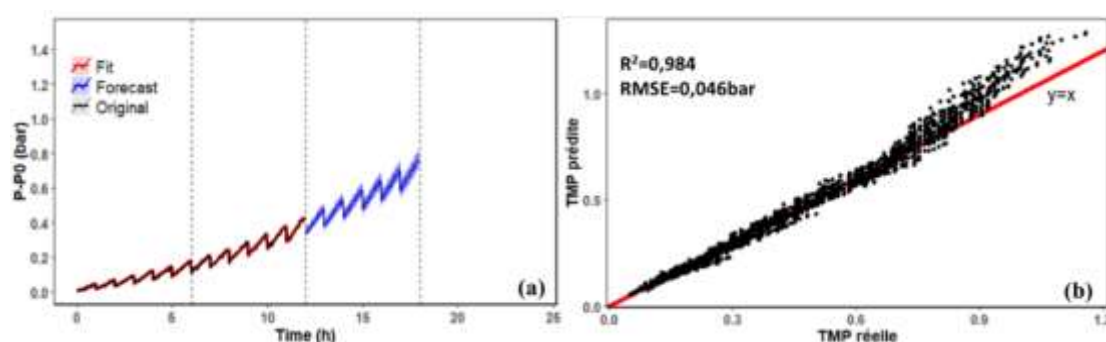


Figure 1: (a) Real-time prediction of TMP with the actual filtration curve in black, the model in red, and forecasts with prediction intervals in blue. (b) Comparison between actual pressure and predicted pressure.

**Keywords** | Time series analysis; Ultrafiltration; Multi-cycle fouling.

**O27**

## **A Comprehensive study of nitrate and ammonium removal from water by membrane technology**

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**Abstract** | the drinking water production industry is facing a growing number of difficulties in water treatment. The waters are often contaminated by micropollutants, such as nitrates and ammonium which their concentration may be higher than the legal norm (50ppm for NO<sub>3</sub><sup>-</sup> and 0.5 for NH<sub>4</sub><sup>+</sup>).

Nanofiltration has been reported as a suitable method for water treatment. In Morocco as in other countries the pollution of water by nitrates and ammonium is a trouble of great importance, this pollution is caused by industries rejections, human activity and especially by fertilizers used for the intensive agriculture.

In this work Ammonium, nitrate ions and salt (NaCl, Na<sub>2</sub>SO<sub>4</sub>) were removed from synthetic solutions by three different nanofiltration membranes NF270, NF20 and NF90. Knowing the characteristics of each membrane ;such as hydraulic permeability, surface charge, wettability and scanning electron microscopy; we have studied the ions retention at different concentrations (25ppm, 50ppm, and 75ppm) with the selected membranes, the results obtained confirm that the NF membranes were found more effective in removing these ions (>80% for NH<sub>4</sub><sup>+</sup> by NF90 at 25ppm and about 70% for NO<sub>3</sub> by NF20 at 50ppm) that mean the degree of separation depends on the size of salt molecules.

These results justify the effect of concentration on the membrane performance.

**Keywords** | Nitrate; Ammonium; Nanofiltration; Synthetic solutions; Membrane.

## O28

### **Application of Mg(Al)O mixed metal oxides (MMO) nanoparticles in the preparation of sustainable mixed matrix membranes for water treatment**

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**Abstract** | Due to the fact that the majority of toxins put into the aquatic environment are resistant to degradation, it is now crucial to develop procedures to successfully reduce water contamination. Membrane technology has many benefits including great efficiency, low energy costs, and ease of use. Despite the polymeric membranes' undeniable significance in water treatment, major drawbacks such as fouling still exist. Due to their improved selectivity, permeability, and antifouling properties, mixed matrix membranes (MMM) have become a field of interest. The trend to substitute traditionally employed hazardous solvents, like dimethylacetamide (DMAc) or N-methyl pyrrolidone (NMP), with non-toxic alternatives for the production of membranes is also growing.

One of the intriguing nanoparticles (NPs) that might be employed in membrane modification is Mixed Metal Oxides (MMO) derived from Layered Double Hydroxides (LDHs) precursors. These NPs are gaining more interest in the environmental field as a result of their unique properties, including hydrophilic nature, intrinsic positive charge, limited cytotoxicity, thermal stability, high surface area, and low cost. The foundation for evaluating Mg(Al)O as nanofillers was laid by encouraging results as adsorbents obtained in earlier work. To the best of our knowledge, they have not yet been investigated as MMM nanofillers for wastewater treatment.

In this study, MgAl-LDH precursors were pyrolyzed in a single step to produce Mg(Al)O MMO NPs. Then, at 80°C, homogenous dope solutions were prepared with Rhodiasolv® PolarClean acting as an alternative green solvent. The membranes were obtained using a non-solvent induced phase separation (NIPS) method using water as a coagulation bath. The impacts of various NP concentrations (0.1-1 wt%) and different additives (PEG200 and PVPK90) were investigated. The produced Mg(Al)O@PES membranes' shape, porosity, thickness, pore size and distribution, contact angle, and pure water permeability were all assessed. Furthermore, rejection and antifouling capabilities were investigated employing Acid Red 4 as a feed solution. The optimal Mg(Al)O loading was found to be in the range of 0.5 to 1 wt%.

**Keywords** | Sustainable Mixed Matrix Membrane; Mixed Metal Oxides; Rejection.

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**O29**

## **Removal of Malachite Green (MG) using low cost adsorbent: Isotherm, Kinetics and Thermodynamic Studies**

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**Abstract** | Dyes can be classified as toxic contaminants such as Malachite Green. This work aims to investigate the possibility of using a low-cost waste material as an adsorbent material in order to remove Malachite Green (MG) from aqueous phase. The material was subjected to different characterization methods before and after adsorption by various techniques. such as Fourier transform infrared spectroscopy (IR), X-ray diffraction (XRD), scanning electron microscopy (SEM), besides point of zero charge (pHpzc). Optimal experimental conditions were conducted for different parameters such as dye concentration, contact time, adsorbent dose and solution pH were performed in a batch system. The adsorption results showed that the removal of Malachite green was favorable in a basic pH. Adsorption kinetic and its mechanism were studied using pseudo first order kinetic equation, and second order kinetic equation, while the experimental data were analyzed using the linear form of Langmuir, and Freundlich isotherm models. It has been found that the pseudo first order as well as the Freundlich isotherm model were best adapted to describe the adsorption kinetics. Thermodynamic parameters were also evaluated in this study.

**Keywords** | Dye; adsorption; Isotherm; Kinetic.



**O30**

## **Removal of ammonium ions for drinking water by electro dialysis: Feasibility and optimization**

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**Abstract** | Ammonium is one of the major water pollutants that impairs the quality of water resources. Its effects on human health and the environment are well known. Indeed, several studies have shown that the ammonium content of water in certain regions of Morocco and the world greatly exceeds acceptable standards. This increase is mainly due to the excessive use of chemical fertilizers in agriculture and by industrial organic discharges. As a result, several methods have been developed to remove ammonium from water, including physico-chemical methods, biological methods, and electromembrane methods. Electrodialysis is an electromembrane process that offers several advantages and does not require the addition of chemicals. During this work, the electro dialyser used is a laboratory pilot and the pair of ion-exchange membranes (IEMs) used is AXE/CMX. The first tests were carried out with synthetic solutions, consisting of tap water from the city of Kenitra, doped with ammonium. The influence of various experimental parameters, including the initial ammonium concentration, the initial conductivity, the hydrogen potential, the circulation velocity, the applied voltage and the rate of demineralization was studied to show the optimal operating conditions. The influence of various experimental parameters, including the initial ammonium concentration, the initial electric conductivity of the solutions, the hydrogen potential, the voltage applied and the rate of demineralization was studied to show the optimal operating conditions. The results showed an ammonium ion removal efficiency of up to 90% for an initial concentration of 3 ppm.

**Keywords** | Removal of ammonium; Electrodialysis; Optimization; Demineralization rate; ion-exchange membranes.

## O31

### **Oak acorn treated with citric acid and its application as biosorbent for the removal of crystal violet dye in aqueous solutions**

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**Abstract** | The present study shows that oak acorn pericarp powder OAPP can be used as a potential adsorbent after their activation (surface modification) by citric acid, for the removal of crystal violet (basic dye) in aqueous solutions. The developed adsorbent was characterized using various analytical techniques such as Fourier transforms infrared spectroscopy (FT-IR), Energy-Dispersive X-ray Spectroscopy (EDS) and Scanning electron microscopy (SEM). Experiments were carried out according to dosage, pH, contact time, concentration and temperature. The amount of dye adsorption was found to vary with the increase in the initial pH of the solution and the maximum adsorption at pH = 6. The balance was reached in 2 hours. The amount of dye absorption (mg/g) increased with increasing dye concentration and contact time. The kinetics of crystal violet on the adsorbent can be well described by a pseudo-second-order equation. The Freundlich model fitted the experimental data much better than the Langmuir model, and optimum multilayer uptakes of OA@CA for CV dye were 135,9 mg.g<sup>-1</sup>. Thermodynamically, the biosorption process was found to be endothermic ( $\Delta H^\circ > 0$ ), spontaneous ( $\Delta G^\circ < 0$ ) and the disorder at the CV dye solution/OA@CA interface ( $\Delta S^\circ > 0$ ). The electrostatic driving force pathway mainly manifested the CV binding mechanism toward OA@CA surface sites.

**Keywords** | Adsorption; Biosorbent; Citric acid; Crystal violet; Wastewater.

O32

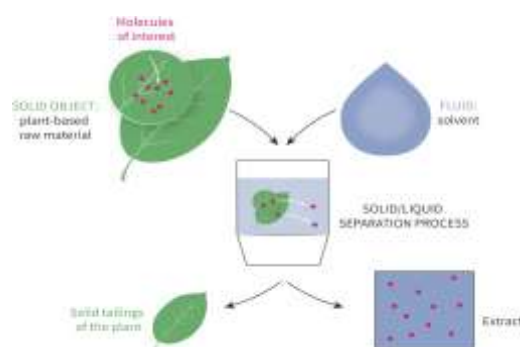
## The role of filtration and other separative techniques in plant extraction: new challenges, new techniques to meet industrial needs

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**Abstract** | Current environmental concerns such as the depletion of fossil resources, the emission of greenhouse gases or global warming require manufacturers to reduce their impact on the environment and to take a more eco-responsible approach. This has been reflected for several years by the development of a greener chemistry and an increasingly strong orientation towards natural products. The extraction of new plant molecules thus finds many applications in the food industry, cosmetics, biotechnology and pharmaceuticals. New challenges are emerging for separation and filtration in particular for the removal of impurities in pre-treatment or for the recovery and purification of extracts and the concentration of active molecules in post-treatment.



**Figure 1:** Role of separation in plant extraction

The article presents examples of industrial cases using separative techniques upstream/downstream of extraction and presents innovations in coupling separation and extraction to intensify processes. In particular, it shows extraction R&D results combined with centrifugal filtration to extract volatile or non-volatile compounds. The challenges are the improvement of the yields, the reduction of the energy consumption, the use of alternative solvents and not petrosourced, and the obtaining of an undenatured product, without presence of contaminant and with high quality.

**Keywords** | extraction; filtration; separation; active molecules; purification.

O33

## Zéro gap electrolysis used to produce bleach

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**Abstract** | Nobody ignores that to combat the coronavirus that causes the disease commonly known as COVID-19, it's essential to know how to create and use effective cleaning solutions. The centers for Diseases Control and Prevention (CDC) and the World Health Organization (WHO) recommend using bleach solution as one way to disinfect areas contaminated with the novel coronavirus [1]. The Chlor-alkali industry produces chlorine, hydrogen and sodium hydroxide (caustic soda) from concentrated solutions (300g.L<sup>-1</sup>) of sodium chloride using three routes: electrolyte cells made of mercury, diaphragms or membranes [2-4].

The aim of this study is to develop a new process to reach higher chlorine levels up to 3.6%, i.e. 12° chlorometric degree. To do that, we have experimented with a device composed of a zero-gap electrolysis cell, having three compartments separated by a pair of membranes which can be porous or ion exchange. The objective is to produce high levels of hypochlorous acid (HClO) in the anode compartment by constantly controlling its pH to a value in the range of 4.5 to 5.5 (see Figure 1). In the cathode compartment, hydroxide is obtained, while brine is supplied to the central compartment. The hypochlorous acid solution is subsequently chemically neutralized with a concentrated solution of sodium hydroxide to obtain bleach. In this study, we have investigated several different membrane pairs that allowed us to perform an optimization of the operating conditions and to produce a bleach with a content close to 1.8 wt% of active chlorine. The results have been discussed as a function of membrane properties, durability and electrochemical conditions imposed.

**Keywords** | Bleach; electrolysis cell; hypochlorous acid; membrane composite.

[1]: COVID-19 – Disinfecting with Bleach Elisabeth Anderson, Jinpeng Li-March 13, 2020. Center for Research on Ingredient Safety.

[2]: IOSR Journal of Applied Chemistry (IOSR-JAC) e-ISSN: 2278-5736. Volume 7, Issue 1 Ver. II. (Feb. 2014), PP 19-23 www.iosrjournals.org. Bleach (sodium hypochlorite).

[3]: US-4432860-A - Porous Diaphragm for Electrolytic Cell | Unified Patents Available online: <https://portal.unifiedpatents.com/patents/patent/US-4432860-A> (accessed on 7 April 2022).

[4]: Membranes 2022, 12, 602. <https://doi.org/10.3390/membranes12060602>

## O34

### **Etude électrochimique des propriétés inhibitrices de la corrosion du colorant organique : Jaune de Méthanile sur l'acier XC38 en milieu acide chlorhydrique 1M**

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**Résumé** | Le contrôle de la corrosion des métaux tels que l'acier XC38, qui est largement utilisé dans de nombreux domaines industriels, présente un grand intérêt pour les chercheurs et les scientifiques. Ainsi, les inhibiteurs de corrosion représentent un domaine de recherche interdisciplinaire qui peut aider à inhiber et à mieux contrôler l'acier pendant le processus de corrosion. Dans ce contexte, cette étude se concentre sur l'utilisation de Jaune de Méthanile comme inhibiteur de corrosion de l'acier XC38 dans une solution HCl 1M.

Des analyses par des techniques de spectroscopie d'impédance électrochimique (EIS) ont été réalisées. Le taux d'inhibition est assez important et il excède 90 % à 1g/L, ce qui suggère son utilisation comme inhibiteur temporaire de la corrosion de l'acier. Les résultats électrochimiques ont montré que cet indicateur plasmatique coloré étudié transmettait des niveaux élevés de résistance inhibitrice.

Cette étude montre que ce colorant organique, présente de bonnes propriétés dans le domaine d'inhibition de la corrosion pour l'acier doux en milieu acide chlorhydrique 1M.

**Mots-clés** | Acier XC38 ; Jaune de Méthanile ; colorant organique ; inhibiteur de corrosion ; EIS.

**O35**

**Efficiency of aluminum pillared clay for the removal of phenol from aqueous solution: Characterization, kinetics and adsorption isotherm**

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**Abstract** | Wastewater that are polluted by chemicals of industrial origin (hydrocarbons, phenols, dyes...), has become an important issue. Phenol's toxicity leads to the destruction of fauna and flora. The present work aims at removing phenol by adsorption on a natural raw clay and pillared clay. Both adsorbents are characterized by different techniques (XRD, XRF, ATR/IRTF, SEM, DTA/GTA and BET) that determines their mineralogical, structural and textural properties.

The kinetic reaction was studied using the pseudo-first-and-second-order models, and it was observed that the pseudo-second-order model accurately describes the adsorption kinetics. The adsorption isotherms of this adsorbate on the two samples were analyzed using the Langmuir, Freundlich, and Redlich-Peterson models, and the results obtained show that the Freundlich adsorption isotherm model is the most appropriate to describe the adsorption of phenol on the two clays. The calculated specific surface areas are of the order of 39 m<sup>2</sup>/g for the raw clay and 71 m<sup>2</sup>/g for the pillared clay, confirms the increase in the quantity of phenol adsorbed from 10.11 mg/g for the raw clay to 19.70 mg/g for the pillared clay.

Both adsorbents showed good regeneration capacity with a percentage of 67% (raw clay) and 84% (pillared clay). After five adsorption-desorption cycles, the pillared clay still had better adsorption performance and higher desorption rate than the raw clay. These results show that pillared clay could be considered as potential low-cost adsorbent for phenol removal from aqueous solutions.

**Keywords** | Phenol; Adsorption; Natural clay; Pillar clay; Kinetics; Adsorption isotherm.

**O36**

**Extraction and Characterization of Antioxidant properties of Mucilage from Flax (*Linum usitatissimum* L.)**

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**Abstract** | Recently, application and demands of bio-degradable materials escalated briefly all over the world. Morocco has an important multitude of wild flax that remains unexplored and therefore unprofitable. Flax seeds are known for being one of the richest sources of omega-3 fatty acids and  $\alpha$ -linoleic acid. This composition is very promising for its application in several food products and in the treatment of several human pathologies. Recent work in our laboratory underline rheological study of flaxseed mucilage, as well as its antioxidant and anti-inflammatory effects. This biopolymer establishes specific interactions with water and can thicken, stabilize or gel a solution, even at low concentration. The extraction of this biopolymer from five varieties (LF, LK, LM, LC, LE) was carried out according to the traditional method most commonly used in the laboratory because of its economic nature and its practical use. The yield of this extraction is relatively high in the order of 5.47 to 6.67%. Results of the antioxidant activity evaluation of the mucilage reveal a high antioxidant potential for the Moroccan variety. This will be strongly exploited in the cosmetic, pharmaceutical and food industry.

**Keywords** | Mucilage; Flaxseeds; Rheology; Omega 3 & Antioxidant activity.

## O37

### **Étude de la cinétique de dégradation thermique des coquilles de noix et leur application dans la rétention de l'orange de méthyle**

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**Résumé** | La dégradation quotidienne de l'environnement par différents polluants, constitue actuellement un souci majeur pour l'humanité. Dans ce sens plusieurs efforts aussi bien dans l'établissement des normes de rejets que dans le domaine de la recherche, sont déployés afin de préserver les différentes composantes de notre environnement. Ainsi, l'utilisation des déchets agricoles comme source de matériaux fonctionnels pour des applications environnementales a suscité un intérêt croissant ces dernières années. Les coquilles de noix, un sous-produit de l'industrie alimentaire, ont été identifiées comme une source potentielle de matériaux pour la rétention des contaminants environnementaux tels que les colorants azoïques.

L'objectif de ce travail est d'étudier la cinétique de dégradation thermique des coquilles de noix en mode dynamique, ainsi que leur utilisation comme adsorbant à l'état brut pour l'élimination de l'orange de méthyle. En effet, le matériau adsorbant utilisé a été caractérisé par les différentes méthodes physicochimiques, à savoir l'Analyse Thermogravimétrique (ATG), la spectroscopie Infrarouge à Transformée de Fourier (IRTF), la Diffraction des Rayons X (DRX) et le Microscopie Electronique à Balayage (MEB). Les résultats issus de l'étude thermique montrent que les coquilles de noix présentent une stabilité thermique élevée par rapport à d'autres polymères et peuvent être utilisées comme source de chaleur. Les essais d'adsorption en batch ont montré que les conditions opératoires telles que le pH, la concentration initiale en colorant, la concentration en adsorbant et la température influent sur le mécanisme d'adsorption.

**Mots clés** | Adsorption; Cinétique; Dégradation thermique; Orange de méthyle.



O38

## Elaboration of low-cost ceramic membrane from physicochemical water treatment sludge and its application to wastewater filtration

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**Abstract** | In the last decades, microfiltration (MF) process has shown to be effective in many industrial applications such as water and wastewater treatment, juice clarification, protein separation, etc. The main advantages of MF membranes are directly linked to their excellent separation performance and their *large pore size which enables operation at relatively low transmembrane pressures*. Thanks to their excellent thermal and chemical stability, good mechanical strength, and long-life performance, researchers have been interested to use ceramic membranes compared to polymer ones. These membranes are made from expensive metal oxides such as alumina and silica. For these reasons, the use of low-cost raw materials has attracted much interest.

In this work, drinking water treatment sludge (DWTS) was used for the preparation of flat ceramic MF membrane. This material is alumina and silica-rich material, and it is a likely suitable candidate for ceramic membrane elaboration. Also, the use of such waste in advanced ceramic technology would contribute to managing the problem of their final disposal. The DWTS powder was firstly characterized to determine its chemical and mineralogical composition and to understand its thermal behavior. DWTS powder was mixed with clay as binder and starch as porosity agent, then pressed to shape a flat membrane, and sintered at different temperatures ranging from 950°C to 1150°C. Experimental results highlighted that the evolution of membrane microstructure, porosity, and pore size is strongly dependent on the applied sintering temperature. The optimal sintering temperature (1050°C) provides a ceramic membrane with a porosity of 46.7%, a pore size of 0.92 µm, a mechanical strength of 14.5 MPa, and a permeability of about 724.5 L/h.m<sup>2</sup>.bar. This membrane was successfully used to clarify a synthetic baking powder suspension and a textile effluent. The DWTS-based membrane was able to remove completely the turbidity from feeds, to reduce significantly the chemical oxygen demand (COD), and to discolor completely textile wastewater.

**Keywords** | Drinking water treatment sludge; Ceramic membrane; Characterization; Microfiltration; Wastewater treatment.

**O39**

## **Vertical transfer of bacteriological and parasitological pollutants from irrigation water to soil eggplant and cardoon**

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**Abstract** | In response to food needs and the growing desire to exploit local food, urban and peri-urban agriculture is meeting these needs by producing vegetables, fruits and other foods in cities and their suburbs. In addition to the increasing need for water due to droughts, this agriculture provides wastewater (WW) and treated wastewater (TWW) that is used for irrigation. This study was conducted to compare urban irrigation water: water from Oued Fez upstream and well water. As well as peri-urban irrigation water: water from Oued Fez downstream considered as WW and TWW from the treatment plant of the city of Fez. These in comparison with the rural irrigation waters: waters of Oued Bitit. The microorganisms investigated are total and thermotolerant coliforms, helminth eggs, Salmonella and cholera vibrio. The study took into account the transfer of these pathogenic bacteria at the level of soils and cultivated plants, cardoon and eggplant. The results showed a contamination out of national and international standards of the two types of coliforms that it is in winter or in summer in the TWW, WW, the water of Oued Fez and the water of wells located upstream of the city. This fecal contamination was found in soils and crops irrigated by urban and peri-urban water. The same was true for helminth eggs, but the number of eggs was greater in winter than in summer for soils. Cholera Vibrio was present in the different types of irrigation water in summer. But still in winter in WW and TWW. This bacterium was also present in soils, cardoons and eggplants irrigated by WW, TWW and Oued Fez waters upstream. Salmonella was present only in the TWW in summer. Only the plot irrigated with water from Oued Bitit in the rural zone was within the norms on the three levels of irrigated water, soil and plants and in both periods.

**Keywords** | Microbiological; contamination; wastewater; treated wastewater; soil; crops.

**O40**

## **Streptomyces as vital additives for solid waste composting**

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**Abstract** | Accelerated urbanization creates solid waste with a negative impact on the environment. Composting is a controlled fermentation process that transforms organic matter into stable humic and pre-humic compounds called "compost". Since microorganisms, and more precisely actinomycetes, play a key role in this biotransformation. Their potentiation is proposed to over-amplify composting process.

Our study consists of introducing competent streptomyces strains in a compost using a pilot bioreactor. In this regard, we have developed a bioreactor for composting where competent actinomycetes strains were isolated, characterized and identified to be inoculated with a substrate containing plant waste, fruit waste and sawdust compared.

The bioreactor allow us to study physicochemical parameters evolution (temperature, humidity and pH). A significant difference was observed in produced compost quality with bioinoculants when compared to control.

**Keywords** | Streptomyces; Compost; Inoculum; Bioreactor.

## O41

### **A piezoelectric electrospun nanofiber mat (PVDF/ Kaolin) for the degradation of methylene blue in water**

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**Abstract** | Organic dyes are toxic and carcinogenic pollutants found in aquatic systems. As a potential solution, piezoelectric polyvinylidene fluoride/kaolin clay (PVDF/kaolin) fiber mats were synthesized by electrospinning for the degradation of methylene blue dye in water. The PVDF was added to induce the  $\beta$ -phase formation while the clay was for polar crystalline phase which both increase the piezoelectric current for the degradation of dyes. The electrospinning technique is best suited for synthesizing piezoelectric nanofibers because of its concurrent electric field poling and mechanical stretching while spinning assists in enhanced degradation of dyes. The characterization techniques such as scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR), piezocurrent response, electrochemical impedance spectroscopy, X-ray diffraction spectroscopy (XRD) and Energy-dispersive X-ray spectroscopy (EDS) were applied to the PVDF/kaolin fiber mats. SEM results showed that the fibers at optimum parameters (18% PVDF concentration, 60% DMF:40% acetone solvent, 16 cm tip to collector distance, 0.8 ml/h flowrate and 15kV voltage, 0.5% KA/PVDF and 1% KHWPVDF) were well dispersed with a uniform size of  $137.7 \pm 27.7$ ,  $113.5 \pm 28.6$ nm and,  $107.0 \pm 23.6$ nm for Pristine PVDF, 0.5% KA/PVDF, and 1% KHW/PVDF respectively. XRD revealed the coexistence of both  $\alpha$ - and  $\beta$ -phases in the electrospun nanofiber mats with the samples peak at  $40.8^\circ$  correlating to the reflection of the (020) plane of the  $\alpha$ -phase and the increase in intensity at the peak at  $2\theta = 20.5^\circ$  which corresponds to the (200/110) plane of the  $\beta$ -phase showed the incorporation of kaolin clay on the PVDF nanofibers. The incorporation of the nanoclay on the PVDF was confirmed with EDX, the results showed peaks attributed to kaolin on the nanoclay composites which were not available on the pristine PVDF. The application of the electrospun nanofiber mats for piezo-catalytic degradation of methylene blue (MB) in synthetic water samples and real wastewater samples were carried out for a period of 150 min. A degradation efficiency of 50%, 100 and 100% for pristine PVDF, 0.5% KA/PVDF and 1% KHW/PVDF respectively was observed. These results revealed that the PVDF/kaolin nanofiber mats have potential in enhancing wastewater treatment methods through piezo-catalytic degradation of organic pollutants (dyes).

**Keywords** | Electrospinning; Kaolin clay; Methylene blue; Polyvinylidene fluoride; Piezoelectric nanofiber mats.

## O42

### **Development of ultrafiltration ceramic membranes based on purified natural clays**

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**Abstract** | This work aims to develop new ultrafiltration ceramic membranes based on purified natural Moroccan clays. Two raw clays, namely clay A (smooth appearance) and clay B (rough appearance) were purified by physico-chemical treatment. The chemical and mineralogical characterizations demonstrated that the purified clays obtained are richer in clay minerals such as smectite, kaolinite and illite. A thin selective layer was deposited on a pozzolan support via a spin-coating method using clay suspensions purified and sintered at 800°C. The prepared membranes were studied in terms of morphology by scanning electron microscopy, pore size, water permeability. As a result, the average pore size is 75 and 90 nm respectively for the Clay A and Clay B membranes, while the permeability is equal to 14.7 and 16.4 L/h.m<sup>2</sup>.bar respectively for the Clay membranes. A and Clay B. The membranes obtained were applied for the tangential filtration of the solution of Direct Red 80 with a concentration of 50 ppm under a pressure of 3 bars. The experimental results demonstrate that the dye retention can reach a value of 99 and 97% for the clay A and clay B membranes respectively. Based on these promising filtration results, it can be predicted that the UF membranes prepared could be effectively applied for the removal of dyes from colored wastewater generated by textile industries.

**Keywords** | Moroccan geomaterials; clay purification; spin-coating; ceramic membrane; soluble dyes.

## O44

### N, P co-doped carbocatalyst from olive pomace obtained by catalytic hydrothermal carbonization for persulfate-based advanced oxidation process

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**Abstract** | The doping carbocatalysts strategy through heteroatoms such as nitrogen and sulfur has proven its effectiveness in degrading organic pollutants by persulfate-based advanced oxidation processes (PS-AOPs). However, research on the effect of doping phosphorus atoms on degradation performance remains very limited. In this work, a new N, P-doped carbocatalyst (N, P-HC) designed by hydrothermal carbonization (HTC) followed by pyrolysis at 700 °C using a bio-waste (olive pomace) as a carbon source to degrade organic pollutants in the presence of peroxydisulfate (PDS). Experimental results showed that N,P-HC, with its large specific surface area (871.73 m<sup>2</sup>.g<sup>-1</sup>), high N-Pyridinic and N-Pyrrolic content, as well as the existence of P-O-C and O-P-C bonds, provides high degradation performance (98% degradation of Rhodamine B (RhB) in 40 min with apparent rate constant ( $k_{app}$ ) of 0.055 min<sup>-1</sup> and an excellent turnover frequency (TOF) of 0.275 min<sup>-1</sup>. The quenching study coupled with EPR analysis revealed that singlet oxygen generation (<sup>1</sup>O<sub>2</sub>) and direct electron transfer were the main reaction ways for the non-radical pathway in the degradation of RhB. The improved catalytic efficiency in the system N, P-HC/PDS/RhB can attributed to the synergistic effect created between N and P atoms in the graphitic structure of the carbocatalyst, high surface area, and oxygenated functional group in the surface of the N, P-HC. Furthermore, heat treatment at 500 °C of the used N,P-HC carbocatalyst provides recovery efficiently their performance. Overall, this study provided a facile and clean method for efficiently synthesizing a high-performance N,P co-doped olive pomace-based carbocatalyst for water decontamination by PS-AOPs process.

**Keywords** | Dye; Hydrothermal carbonization; Nitrogen Phosphorus co-doped Carbocatalyst; Olive pomace; peroxydisulfate.

O45

## Ethnobotanical study on the use of the plant "*Ajuga Iva*" by the Moroccan populations

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**Abstract** | In Morocco, phytotherapy is an integral part of the local culture, the population has long been the repository of endogenous knowledge that it has acquired empirically through generations. Medicinal and Aromatic Plants (ART) are a priceless treasure offered by mother nature, and are considered a good source of multiple functional substances. These are widely used in traditional therapy and can be exploited for the development of conventional medicines.

The musk Ivette "*Ajuga Iva*" is one of the aromatic and medicinal plants well known for its beneficial properties in folk medicine. It is used in the treatment of many diseases including digestive disorders, diabetes and others. In this work, we were interested in understanding the therapeutic nature of this plant among local Moroccan populations in the region of Fez Meknes. To do this, we developed a questionnaire to collect information on the use of different parts of the plant from informants of the various population categories.

The results obtained from a total of 207 informed women showed that the plant is used more by women than by men (54.60%) and that the aerial part of the plant, especially the leaves are the most used. Regarding the instructions for use, decoction is the best method of preparation. A good percentage of the populations studied (80.20%), use *Ajuga iva* to remedy digestive disorders, while 23.20% of the informed indicated its use against fever.

From these results, it appears that the species *Ajuga Iva* shows great therapeutic interest for local populations. The realization of certain biological tests of the species, seems to us necessary to confirm or refute the therapeutic effects manifested by the populations studied.

**Keywords** | *Ajuga iva*; Medicinal and Aromatic Plants; local populations; Therapeutic use; Decoction.

**O46**

**MEMBRANE FOULING CHARACTERIZATION OF A FULL-SCALE  
BRACKISH WATER REVERSE OSMOSIS DESALINATION PLANT IN  
MOROCCO: MEMBRANE AUTOPSY**

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**Abstract** | Reverse osmosis (RO) technology is increasingly deemed as one of the promising technologies for the seawater (SW) and brackish water (BW) desalination worldwide. Nevertheless, the performance of this process is substantially limited by the membrane fouling. In this paper, the fouling of RO membrane elements used in a BWRO plant in Morocco was investigated to find out the source of the second stage membrane fouling. The aim of this study is to identify membrane foulants, evaluate the fouling degree inside the same pressure vessel, and assess the foulants distribution inside the same element. Wherefore, two membrane elements were extracted from the second stage: the first element on the feed side and the last element on the concentrate side. The membrane autopsy was carried out using scanning electron microscope (SEM), Fourier transform infrared spectroscopy (FTIR), inductively coupled plasma atomic emission spectrometry (ICP-AES) and X-ray diffraction (XRD). The results highlight the presence of significant amount of aluminum, silica, calcium carbonate and calcium sulfate. Hence, it is crucial to optimize the pretreatment process to reduce aluminum concentration and choose the adequate antiscalant type.

**Keywords** | Reverse Osmosis; Brackish water; Fouling; Membrane autopsy; antiscalant.



**O47**

**Preparation of a composite membrane made of PoPD/PVA ultrafiltration layer on ceramic pozzolan/micronized phosphate support for removal of Congo red dye**

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**Abstract** | This work presents the development of a composite ultrafiltration membrane based on poly(o-phenylenediamine) and poly(vinyl alcohol) on flat ceramic support made from pozzolan and micronized phosphate. The active layer was coated on the ceramic support using the dip-coating technique. The developed membrane was characterized by fourier transform infrared spectroscopy, water contact angle, permeability, scanning electron microscopy, energy dispersive X-ray analysis, pore size, as well as filtration performance. The ultrafiltration membrane has a pore diameter of 45 nm, a water permeability of 37.28 L/h.m<sup>2</sup>.bar and a water contact angle of 50°. Finally, the performance of the composite membrane was assessed by the filtration of Congo red dye by varying the operating conditions including the applied pressure (1 - 3 bar), the feed concentration (20 - 600 ppm) as well as the feed pH (4 - 10). The membrane is highly effective for removal of soluble Congo red dye: the rejection was 99.79% under a pressure of 3 bar, a concentration of 600 ppm and a pH of 4.

**Keywords** | Composite membrane; Poly(o-phenylenediamine); Poly(vinyl alcohol); Pozzolan/micronized phosphate; Ultrafiltration; Congo red dye.

**O48**

## **Wastewater reuse through Soil Aquifer Treatment (SAT): regulations and key elements for feasibility assessment**

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**Abstract** | Soil Aquifer Treatment (SAT) is a Managed Aquifer Recharge technology that utilizes treated wastewater as source. Widely implemented in countries like Australia, Israel, Spain, SAT offers technical (flexibility), economic (lower investment cost) and environmental (lower energy consumption) advantages that which invite to assess its potential in other countries. There is a multitude of research and experimental studies of SAT on the process level, and their effects on elimination of pollutants and improving water quality. To increase the range and use of these techniques, several obstacles must be overcome. One of major concern is the absence of clear guideline, and detailed evaluation presenting clearly and explicitly the key elements to consider when implementing a SAT project. This limits its application, especially in developing countries. The objective of this paper is to present the fundamental components that must be considered in SAT project. This paper suggests an approach for the selection and assessment of water treatment options, that will be useful to orient the future deployment of SAT scheme. It requires specific techniques, and reliable knowledge to describe the functioning of the hydro-system. Maintenance and monitoring of the device also seem essential in order to anticipate stressful situations, and then implement if necessary appropriate preventive and corrective measures. Then, the regulations component is often decisive for the effective establishment of SAT project and cannot be neglected. The main objective of regulations for water recycling is to save the health of people and limit environmental effects. Finally, the social aspect, far from the least, should be considered with the greatest caution, and it is advisable to ensure a perfect transparency and communication to end users upstream of the project. These main elements are inextricably related, and one is not secondary to another.

**Keywords** | Soil aquifer treatment; Artificial recharge; Water reuse; Regulations; Guideline.

**O49**

**Elaboration and characterization of activated carbons from "saba senegalensis" shell collected Ziguinchor devoted to the treatment of waste water from health facilities.**

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**Abstract** | Agricultural waste is an environmental problem, especially in our countries where waste collection systems are not well developed. In order to protect the environment from these agricultural residues, we collected the Saba senegalensis hulls and then we transformed them into activated carbon. The activated carbon production protocol was carried out in a single carbonization and chemical activation step with the activating agent of phosphoric acid  $H_3PO_4$  on Saba senegalensis precursor. Thus 16 activated carbons were developed by adjusting parameters such as the impregnation ratio (1/1 and 1/2), the contact time (40 and 60 minutes) and the temperature (500 to 800° C). We characterized these activated carbons by the analysis methods such as CHNOS, IRTF, pHpzc, BET (porosity), ATG. Our choice is based on the two most microporous activated carbon for the wastewater treatment from sanitary structures.

The best activated carbon obtained were tested for treatment of organic pollutants like ibuprofen by using kinetics of adsorption models described by Freundlich and Langmiur.

**Keywords** | Agricultural waste; Environnement; activated carbon; waste water.

## O50

### **Performance of a ceramic MBR pilot plant treating Municipal wastewater subject to gradual salinity increase: water quality and fouling behavior**

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**Abstract** | This study aims at evaluating the effects of salinity on the performance and membrane fouling of a ceramic membrane bioreactor pilot plant. Municipal wastewater containing varying concentrations of NaCl was treated in pilot scale (12 L) MBR under the conditions of 30°C, 150 kPa transmembrane pressure (TMP) and chemical oxygen demand (COD) of 470-710 mg/L. With this purpose, four different salt concentrations (5, 10, 15 and 20 g NaCl/L) were tested monitoring removals of carbon and nitrogen pollution. Increasing salt concentrations did not significantly alter the efficiency of COD removal in MBR except that for the first salinity level, there was a decrease (96% to 92%) in removal due to the adaptation of biomass to the saline environment. However, a decrease (96% to 75%) in total nitrogen (TN) removal was observed in the second salinity level. The results showed that nearly 96% removal of COD and TN was obtained for the other salinity levels. On the other hand, increased salinity significantly affected the production of mixed liquor suspended solids (MLSS) and soluble microbial product (SMP). A higher content of SMP (820 mg/L) in the MBR was released, which deteriorated the permeability of the membrane module. This study provides a good information to understand the effect of continuously increasing salt concentration in the treatment of saline wastewater in a MBR process. Thus, allowing to establish the basic operational data to model the salt shock load on MBR system and to predict an optimal operation.

**Keywords** | Aerobic membrane bioreactor; wastewater treatment; salinity; Organic removal; membrane fouling.

**O51**

## **Treatment of dye-containing wastewater from textile industries using hybrid treatment integrating membrane technology**

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**Abstract** | Wastewater from the textile industries contains different types of dyes and other organic and inorganic pollutants. The discharge of these effluents into the environment without treatment causes serious problems. In general, the treated wastewater can be discharged into the municipal sewerage in compliance with local legislations.

On another hand, in countries with water scarcity, the reuse of secondary effluents represents an interesting solution to save water.

In order to achieve efficient color and other pollutants removal from textile wastewater, a large number of researches have focused on hybrid treatment technologies. Among the different hybrid treatments, membrane technology associated with adsorption or electrocoagulation can represent a suitable combinaison for treatment and recycling of textile wastewater.

In this work, adsorption (ADS), ultrafiltration (UF) and electrocoagulation (EC) were studied as a pretreatment to nanofiltration (NF) in the reuse of secondary treated coming from different processes in the textile industry.

The results showed that the pre-treatment step was mainly applied to remove impurities such as color, COD and turbidity. The combinaison (UF/NF) enhanced the permeate quality by increasing the retention values of the majority of parameters. Thus, COD retention exceeds 95%, chlorides and sulphates retention were about 97% and conductivity retention values exceeds 95%.

In the case of ADS/NF and EC/NF, permeate flux remained constant until a volume reduction factor (VRF) reaching 1.5 (30 L/h.m<sup>2</sup>). After coupling UF with NF process, a stable NF permeate flux was observed until a VRF equal to 2.6 (52 L/h.m<sup>2</sup>). This result showed that using UF process as pretreatment for NF improved the efficiency of textile effluent treatment by increasing the membrane running-time.

**Keywords** | Textile waste water ; Ultrafiltration ; Nanofiltration ; Electrocoagulation.

**O52**

## **Electrocatalytic Removal of Carbon from Wastewater in a Highly Effective Biocell Using Kegging-Type Heteropoly Salts Based Electrodes**

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**Abstract** | Water and energy resource management is currently considered as an interconnected process in which carbon removal by oxidation and oxygen reduction reaction can be integrated as a bifunctional wastewater treatment technology. This contribution reports a new series of polyoxometalate materials as innovative multifunctional materials in the field of environmental and energy technology using biosourced process. The work presented includes structure analysis, electrochemical properties and catalytic activity. The materials newly developed consisted in HPMo derived polysalts modified by Cu and Zn, which were synthesized and characterized by several techniques, X-ray diffraction, infrared spectroscopy and Raman to check Keggin structure, dispersive X-ray energy was employed for the surface composition and scanning electron microscopy for the morphology of POMs materials. The POMs materials were successfully tested in a single-chamber Microbial Fuel Cells fed with wastewater under UV-Visible irradiation leading to a considerable amount of carbon removal which exceeded 90%. Simultaneously to the carbon oxidation, the electrocatalysts deposited on the cathode performed very well for oxygen reduction reaction producing a remarkable output power beyond 300 W/m<sup>3</sup>.

**Keywords** | Electrocatalyst; carbon removal; polyoxometalates; microbial fuel cell.

*Poster Sessions*

## P1

### **Preparation and characterization of biomaterial for the adsorption of cationic dye: kinetic, isotherm and thermodynamic**

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**Abstract** | The aim of this study is to investigate the effect of basic pretreatment on the adsorption capacity towards the methylene blue dye of the Mediterranean plant *Carpobrotus edulis* (noted as *C. edulis*) and to estimate the contents of soluble organic matter that can be released by this biomaterial into the aqueous solution. The biomaterial used was characterized by FT-IR, pH<sub>Z</sub>, SEM-EDX, COD, and BOD<sub>5</sub>. A complete study of the removal of methylene blue dye (MB) on this biomaterial was carried out and the effect of physico-chemical parameters including initial pollutant concentration, contact time, adsorbent dosage, pH and temperature were studied. After adsorbent treatment, the soluble organic matter was reduced by a decrease in BOD<sub>5</sub> levels of 97%, COD of 96% and OM of 96%. kinetics and equilibrium studies of MB adsorption onto the bioadsorbents were predicted by pseudo-second order kinetic model and Langmuir model, respectively. The maximum adsorption quantity of modified *C. edulis* plant toward MB was found to be 153.9 mg/g. The thermodynamic parameters reveal that the adsorption process was feasible and spontaneous in nature. The NMCE biomaterial was easily regenerated with aqueous HNO<sub>3</sub> solution with slight decrease of adsorption capacity up to five cycles.

**Keywords** | Adsorption; Basic pretreatment; *Carpobrotus edulis* plant; Dye; Thermodynamic.



## P2

### **Self-supporting g-C<sub>3</sub>N<sub>4</sub>/CuO on polyester fabric as "Dip-Catalyst" for synergistic 4-nitrophenol Hydrogenation**

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**Abstract** | It's still problematic to figure out how to employ homogeneous catalysts and recycle heterogeneous catalysts in a way that works well together. The primary concern in this work is how to create a competent, affordable, heterogeneous catalyst with great recyclability, easy recovery, and straightforward retrieval and monitoring between reaction cycles. Despite significant work put into developing Copper nanoparticle-based catalysts for the 4-nitrophenol hydrogenation process, the aforementioned parameters are rarely present in a given system. Here, we present a new emerged heterogeneous catalyst by in situ deposition using graphitic carbon nitride g-C<sub>3</sub>N<sub>4</sub>/CuO nanoparticles as the active catalyst and polyester (PE) as the inert support. An effective and reusable "dip catalyst" for the reduction of 4-nitrophenol in the presence of NaBH<sub>4</sub> has been created by covering the PE matrix with graphitic carbon nitride (g-C<sub>3</sub>N<sub>4</sub>) using sonication, followed by the deposition of copper oxide nanoparticles CuO. The prepared fabric PE/g-C<sub>3</sub>N<sub>4</sub>/CuO showed very prominent results which displayed in having a great catalytic activity in the reduction of 4-nitrophenol into 4-aminophenol. Further evidence that this catalyst based on prepared PE support can be a good contender for long-lasting chemical catalysis comes from the remarkable stability at recycling that has been achieved up to 10 reaction cycles without noticeably degrading the catalytic activity.

**Keywords** | 4-aminophenol; 4-nitrophenol; polyester fabric; graphitic carbon nitride; copper oxide nanoparticles.

P3

## Enhancing the selective catalytic oxidation of lignocellulosic biomass to formic acid Using Reusable Calcined Mg/Al Hydrotalcite as a Catalyst in a green solvent

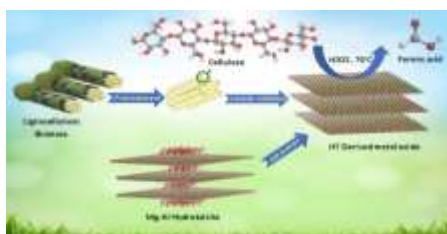
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**Abstract** | Biofuels or liquid fuels derived from natural matter, are one of the most intriguing yet divisive alternatives for petroleum-based fuels. The most common approach to producing biofuels is to transform plant sugars and other carbohydrates into oxygen-deficient chemicals. A growing relevance has been devoted to the direct synthesis of platform molecules from biomass resources, using one-pot or cascade techniques via adequate catalytic system. Tuning and improving the reaction conditions of the above-mentioned bio sourced processes makes this approach as beneficial strategy from an economic and ecological standpoint. In a similar vein the major goal of this contribution was to investigate and enhance the conditions for a selective oxidation of lignocellulosic biomass to yield formic acid (FA), one of the most coveted liquid hydrogen carriers and among the key compounds used in the pharmaceutical, cosmetic, and leather industries. Both oxidizing aqueous hydrogen peroxide and calcinated heterogeneous hydrotalcite catalyst have been employed at an atmospheric pressure for this purpose. The effect of reaction time, temperature, amount of catalyst and oxidant on the product's yield and selectivity have been investigated. The oxidation of a plant-derived cellulosic fibers at 70°C using 0.2 g of catalyst provided an impressive result with a high yield and specific activity of 59.8%, 1.14 (g FA/g cellulose/g catalyst) respectively, the latter was confirmed to be relatively close to the one from the oxidation of pure cellulose. Furthermore, the reusability of the catalyst has also been studied which was demonstrated to result in the same yields for 2 consecutive runs.



**Keywords** | lignocellulosic biomass; heterogenous catalyst; hydrotalcites; selective catalytic oxidation; formic acid; biofuels; optimization.

**P4**

**Contribution to a phytochemical study of aqueous extracts from the aerial part of *Ajuga iva***

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**Abstract** | The musk Ivette "*Ajuga iva*", called, *Chendgora*, is a small perennial plant of bitter taste, widely distributed in the Mediterranean region: southern Europe and northern Africa, especially in Morocco, Algeria and Tunisia. This species is widely used for its therapeutic virtues. In Morocco, it is used, whole without roots, after aqueous maceration of several days, to treat diabetes and hypertension. It is also eaten in dry powder or with honey to overcome its bitter taste, to treat gastrointestinal disorders and against stomach ulcer. This shows the interest of the Moroccan populations for the use of this medicinal and aromatic plant.

In this work, we were interested in the valorization of this plant from the different sites in the region of Fez-Meknes, by a determination of the chemical composition of the derivatives extracted from the aerial part of the plant and a study of the yield of its phenolic compounds. Thus, the samples are harvested and dried in the shade, and then they are ground into powder. The extraction of essential oils was carried out using the hydrodistillation technique.

The results obtained showed that musk Ivette is rich in polyphenolic compounds, which are the best antioxidants; Flavonoids and tannins are also found in large quantities. In addition, it is home to other substances, such as anthocyanins and phenolic acids. Flavonoids represent between (2.31 ± 0.63 g / l EAQ 5gMS), the yield of phenolic compounds is estimated at (232.03 ± 46.19ug / ml EAT 5gMS).

The richness of Ivette in these chemical compounds seems to be one of the reasons why this plant has long been used by a large segment of the population as an essential means of medication.

**Keywords** | *Ajuga iva*; therapeutic effect, extraction, phenolic compounds; Yield, valuation.

**P5**

## **Potential of Flax (*Linum usitatissimum* L.) for ecological building materials**

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**Abstract** | Morocco has a plant diversity in wild flax (*linum usitatissimum* L.) not valued in industrial application. This work aims to highlight virtues of this Moroccan plant heritage to develop sustainable biological building materials. To this purpose, we conducted a morpho-metric and biochemical study of three varieties (Morocco, Spain and Kazakhstan) to identify the most adequate one in the field of sustainable construction. The biochemical analysis aims to evaluate contents of proteins, total sugars and mineral elements, to highlight the difference between these three varieties.

The Moroccan variety presents the highest morpho-metric parameters, namely Stem length (L) (101.65 cm), Stem thickness (e) (0.365), Number of branches (NR) (2.9), Stem weight (m) (2.045), Root length (Lr) (6.125), Maximum root thickness (em) (0.46), Average root thickness (em') (0.29), Root weight (mr) (0.2196). Kazakhstan variety has the largest amount of Cellulose (73,5%) and Hemicellulose (14,3). The highest protein content was recorded in the french variety (25,3%). Results of the mineral analysis showed that all studied varieties were rich in trace elements, especially calcium, potassium, magnesium, iron and phosphorus, these results can justify the use of this plant as a food supplement. Preliminary results obtained have encouraged us to move on to the development of sustainable building materials to reduce heat loss therefore, energy saving.

**Keywords** | Flax; Fiber; Bio-concrete; energy saving.

## P6

### **Optimization of sonophoto-fenton process operating conditions for the treatment of the landfill leachate of Fez city (Morocco) and contact test with medicago stavia to assess the phytotoxicity**

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**Abstract** | A novel advanced oxidation process (AOP) using sonophoto-Fenton was used to treat stabilized landfill leachate from Fez City (Morocco). The landfill leachate treatment was statistically evaluated and the optimal conditions were identified. Furthermore, the process conditions were optimized by Box-Behnken Design (BBD) combined with a surface response methodology that was used to evaluate the effect of five operational variables (pH, Fe<sup>2+</sup>, H<sub>2</sub>O<sub>2</sub>, US and UV) on three target responses: COD, color removal and ABS<sub>254</sub>. The optimal conditions of the Fe<sup>2+</sup>/ H<sub>2</sub>O<sub>2</sub>/UV-A/US process included an initial [Fe<sup>2+</sup>] of 400 mg/L, [H<sub>2</sub>O<sub>2</sub>] of 250 mg/L, and pH= 3, which resulted in a COD, ABS<sub>254</sub> and CN removal efficiencies of 70%, 60% and 91%, respectively. In order to evaluate the effectiveness of the treatment from an ecotoxicological point of view. Untreated and Sonophoto-Fenton treated leachate samples were examined using a phytotoxicity test based on *Medicago sativa* seed germination. The germination percentage results suggest that the treated leachate did not significantly influence the germination percentage. However, untreated leachate significantly inhibited germination rate and seedling growth. Overall, Fenton -US -UV process is promising method for the treatment of landfill leachate.

**Keywords** | Leachate treatment; Fenton; Ultrasonic ; Phytotoxicity ; *Medicago sativa*.

## P7

### **Characterization and selection of soil actinomycetes to improve composting process**

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**Abstract** | Actinomycetes have a considerable importance in biotechnological processes thanks to their capacity to produce a great number of high value added metabolites. The present work aimed in a first step, to isolate strains of actinomycetes from samples of a soil irrigated with margines at a rate of 5 and 10 liters per square meter. In a second step, this study focused on the inventory of hydrolytic and antimicrobial activities of the collection of isolated and characterized strains. In order to select the most competent actinomycetes strains for composting, a selection pressure was exerted on the strains in order to choose those which have the capacity to metabolize several carbon sources. For this purpose, several enzymatic activities were evaluated. The results of the antimicrobial activity revealed that the different strains have a good inhibitory activity against several bacteria, mainly Gram positive, pathogens and yeasts. The isolated and characterized actinomycetes recorded a biodegradation power of different substrates through the production of hydrolytic enzymes.

**Keywords** | Actinomycetes, Antimicrobial activity, Composting and hydrolysis of biopolymers.

**P8**

## **Surface modification of zeolite microfiltration membrane: characterization and application**

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**Abstract** | The surface of zeolite microfiltration membrane, with average pore diameter of 0.55 $\mu$ m, was chemically modified to change its hydrophilic character into hydrophobic by grafting with 1H,1H,2H,2H-perfluorodecyltriethoxysilane molecule (C8). Various characterization methods and techniques, including scanning electron microscopy (SEM), nitrogen adsorption/desorption isotherm (BET), flexural strength and contact angle were used to check the properties of the membranes before and after grafting.. The grafted membrane's pore size and porosity was reduced as evidenced by SEM images and determination of opening pores. The contact angle of the modified membrane increased from 0° before grafting to 99° after grafting, indicating an increase in hydrophobicity.

The determination of the water permeability shows a reduction from 1218 l/h.m<sup>2</sup> to 221 l/h.m<sup>2</sup>. The application of grafted hydrophobic membrane to the treatment of textile wastewaters was investigated to evaluate the performances of this membrane. The filtration results revealed a good retention of color exceeding 95%.

Therefore, it is interesting to recommend this new low cost membrane for the treatment of industrial wastewater containing recalcitrant pollutants such as color. In addition, the germination tests confirm the low toxicity of the treated water compared to the deionized water and non treated wastewater.

**Keywords** | Natural zeolite; ceramic low cost membrane; grafting process; microfiltration; textile wastewater.

**P9**

## **Synthesis and characterization of Nano-hybrid materials based on clay /PEI/ ZnO for wastewater treatment**

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**Abstract** | The last decade, it has seen a lot of interest in advanced oxidation processes (AOPs). The efficiency of metal and metal oxide catalysts for AOPs has been reported to be improved by a variety of solid supports. The use of clay as a support has received more attention for wastewater treatment. In this study, new hybrid photo catalysts based on montmorillonite clay (MMT) - polyethyleneimine (PEI) - Zinc oxide (ZnO) were synthesized. Therefore, Nanosized ZnO intercalated in MMT was successfully prepared by two methods: The first one is by impregnation method and the second one is in situ.

The PEI coating not only provide a surface for ZnO nanoparticle immobilization, but also create a restricted and strong medium for adsorption of organic molecules. The Clay-polymer around the nanocomposite is crucial for photo-catalysis because it stimulates contacts between reacting molecules and active sites and enhances local concentration via the cooperative effect.

The morphologies and particle sizes of the synthesized nanomaterials were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS) and Fourier transform infrared (FTIR) spectroscopy.

The results indicated that low doses of zinc oxide on MMT have a positive effect; however, increased weight ratios have a negative effect.

**Keywords** | Wastewater treatment; ZnO; hybrid-Nanoparticles; polyethyleneimine; montmorillonite clay.



## P10

### **Adsorption Process Of The Eriochrome Black T Dye Onto X Type Zeolite : Kinetic And Thermodynamic Studies**

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**Abstract** | Removal of textile dyes from wastewater have recently attracted much attention, due to the toxicity, difficult visibility, and thereby the negative consequences on the aqueous environment. Therefore, there have been diverse promising new techniques such as adsorption for dyes removal from industrial wastewater. Compared to the highly cost treatment techniques, removal of dyes using the adsorption process is relatively simple and requires less cost. Synthetic zeolite was used in this research as a high capacity nano-adsorbent for the removal of reactive dyes from coloured wastewater.

The removal performance of Eriochrome black t dye, in aqueous solution was investigated by adsorption process on zeolite X. The zeolite X were synthesized from aluminosilicate gel followed by the hydrothermal treatment at 100°C. The zeolite X was analyzed using XRD, SEM/EDX, FTIR, surface area measurement (BET method), thermal analysis (TGA/DTA), then used in adsorption experiments.

The adsorption of Eriochrome black t dye on the zeolite X was studied as a function of temperature, pH of the solution, adsorbents dosage.

**Keywords** | Francofilt; zeolite X; Eriochrome black t; Adsorption; kinetics; isothermes.

## P11

### Molecular Modeling for new Drug Discovery

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**Abstract** | The World Health Organization (WHO) considers cancer to be the deadliest disease, due to rising deaths during the 21st century. In the search for new therapeutic molecules, scientific research regards proviral integration kinases (Pim) as promising therapeutic targets for the treatment of haematological cancers. A series of thirty two 3,5-disubstituted indole derivatives as potent Pim1 kinase inhibitors were studied using 2D-QSAR. Q<sub>2</sub> value of 0.71, R<sub>2</sub> value of 0.82 and r<sub>test2</sub> value of 0.96. The models were generated using 26 compounds as training set and 6 compounds as test set. Furthermore, the QSAR model has been constructed with the help of the multiple linear regression (MLR) method used to rationalize the principal structural requirement responsible for the activity. As results, three new compounds were designed in silico.

**Keywords** | Drug; 3,5-Disubstituted indole derivatives; 2D-QSAR; Pim-1; Inhibitor.

## P12

### **Contribution à l'étude des sources des nitrates présentes dans les ressources en eau souterraine de certaines communes rurales de l'Anti-Atlas/ Etude de cas NIHIT**

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**Résumé** | La Depuis plusieurs décennies et notamment avec les perspectives du changement climatique, la gestion des ressources en eau devient une priorité surtout dans les zones arides et semi-arides caractérisées le stress hydrique important et par une forte variabilité des paramètres climatiques.

Les nitrates figurent parmi les polluants les plus problématiques des eaux souterraines. Cette contamination peut être d'origine naturelle ou anthropique mais elle est liée principalement à l'agriculture intensive, les rejets des eaux usées domestiques et les rejets des effluents industriels et agro-alimentaires, riches en matière organique.

La quantité des nitrates dans les eaux souterraines la région de Souss est en continuelle augmentation mettant en danger son développement en matière d'eau potable, d'assainissement et d'autosuffisance alimentaire rendant la gestion de cette ressource une priorité incontournable.

Notre travail entre dans cette démarche, il a pour but la caractérisation de la qualité de l'eau souterraine de certaines communes rurales du sud marocain (Aval de l'Anti-Atlas) en identifiant le taux des nitrates de ces eaux et son évolution dans le temps.

Il vise également à déterminer les facteurs naturels ou anthropiques amplifiant le taux de ces nitrates en analysant la géochimie du milieu et l'activité humaine essentiellement l'impact des rejets des eaux domestique et de l'agriculture.

L'étude s'est concentrée sur la sélection de six zones différentes de douze points de prélèvements.

D'après ces résultats, la communes de Nihit de la province de Taroudant, se trouvant dans des zones montagneuses; qui présentant des taux hautement élevés en nitrates qui dépassent 100mg/l

**Mots clés** | Nitrates; Contamination; zones montagneuses; géochimie; eau souterraine.

## P13

### Structural, optical and dielectric study of hydrothermally synthesized $\text{Pb}_{1-x}\text{Ba}_x\text{TiO}_3$ ( $0.1 \leq x \leq 0.9$ ) perovskite materials

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**Abstract** | Perovskite-type materials are highly studied because of their relatively simple structure and the possibility of modifying their physicochemical characteristics by ionic substitutions on the different sites A and B of the  $\text{ABO}_3$  structure. These materials are of great interest because of the existence of a large number of ferroelectric phases. Moreover, these materials are likely to be applied in many uses such as microelectronics, FeRAM memories, Photocatalytic and photovoltaic areas because of their effective dielectric properties and semi-conductive behavior. The most studied perovskite-type materials are  $\text{BaTiO}_3$ ,  $\text{SrTiO}_3$ ,  $\text{PbTiO}_3$ ,  $\text{Pb}(\text{Zr}_x\text{Ti}_{1-x})\text{O}_3$  (PZT) which have given rise to numerous studies concerning their properties, in particular, their ferroelectric character.

In this work, the effect of Barium (Ba) insertion on the structural, optical and dielectric properties of  $\text{PbTiO}_3$  material was investigated. A series of powders of composition  $\text{Pb}_{1-x}\text{Ba}_x\text{TiO}_3$  ( $0,1 \leq x \leq 0,9$ ) were synthesized by hydrothermal method. the reaction mixture taken in stoichiometric quantity is milled then sealed in an alkaline environment inside an autoclave system then heat treated at  $180^\circ\text{C}$  for 24 hours. The analysis by X-Ray Diffraction (XRD) shows that the obtained compounds crystallize in a phase of perovskite type. All the peaks are indexed in a phase of quadratic symmetry. Characterization by the Scanning Electron Microscope (SEM) of the different pellets indicates a heterogeneous microstructure of the grains and that the size of the grains decreases according to the doping rate. A study by Uv-Visible spectroscopy also carried out to show the band gap and to investigate the optical properties of these materials. The study by spectroscopy of impedance in the frequency range [500Hz-2MHz] highlighted the effect of the Barium insertion on the transition temperature and the dielectric constant value.

**Keywords** | Perovskite; ferroelectric; relative permittivity; bandgap.

## P14

### **Structural, optical, electrocaloric, and energy storage properties of $\text{Ba}_{0.85}\text{Ca}_{0.15}\text{Zr}_{0.1}\text{Ti}_{0.9}\text{O}_3$ synthesized by sol-gel method**

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**Abstract** | Perovskite-type materials are highly studied because of their relatively simple structure and the possibility of modifying their physicochemical characteristics by ionic substitutions on the different sites A and B of the  $\text{ABO}_3$  structure. These materials are of great interest because of the existence of a large number of ferroelectric phases. Moreover, these materials are likely to be applied in many uses such as microelectronics, FeRAM memories, Photocatalytic and photovoltaic areas because of their effective dielectric properties and semi-conductive behavior. The most studied perovskite-type materials are  $\text{BaTiO}_3$ ,  $\text{SrTiO}_3$ ,  $\text{PbTiO}_3$ ,  $\text{Pb}(\text{Zr}_x\text{Ti}_{1-x})\text{O}_3$  (PZT) which have given rise to numerous studies concerning their properties, in particular, their ferroelectric character.

In this work, Lead-free  $\text{Ba}_{0.85}\text{Ca}_{0.15}\text{Zr}_{0.1}\text{Ti}_{0.9}\text{O}_3$  (referred to as BCZT) ceramic powders were synthesized using sol- gel method. Dielectric, ferroelectric, energy storage and electrocaloric properties were investigated and compared with other methods of synthesis. Indeed, pure crystalline structure and homogenous microstructure are identified by XRD analysis and SEM measurement. The dielectric measurements in a frequency range of [100Hz-1MHz] and in a temperature range [20-200°C] reveal a maximum dielectric constant which is associated with ferroelectric-paraelectric phase transition. The dielectric constant  $\epsilon_r$  at 1kHz was 18177 around 78°C which indicates that the sol-gel method has displayed important electrical properties. The electrocaloric adiabatic temperature variation ( $\Delta T$ ) and responsivity ( $\zeta$ ) were indirectly determined via Maxwell approach and the measured ferroelectric polarization  $P(T,E)$  extracted from the P-E hysteresis loops. The electrocaloric response was also modelled by exploiting the Landau-Ginzburg-Devonshire (LGD) phenomenological theory.

**Keywords** | BCZT ceramics; sol-gel method; dielectric; electrocaloric effect; energy storage.

## P15

### **Fouling study of a nanofiltration membrane of a decentralized demineralization plant: Characterization and modeling.**

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**Abstract** | In 2014, the first demineralization plant, using nanofiltration (NF) process powered by renewable energies was realized at Al Annouar high school of Sidi Taibi, Kenitra, Morocco. This plant has revealed difficulties related to the membrane performances loss (transmembrane pressure (TMP) increase, flux decline and increase of energy consumption), as consequences of membrane fouling. This phenomenon is generally due to deposition of suspended or dissolved substances on its external surfaces, at its pore openings, or within its pore. In order to determine the nature and origin of fouling, an autopsy of the fouled NF membrane was done. The samples of the fouled membrane were then analyzed by scanning electron microscopy using a scanning electron microscope (SEM) connected with an energy dispersive X-ray (EDX) detection system, X-ray diffractometer (XRD) and Fourier Transform Infrared Spectroscopy (FTIR) Analysis. Moreover, this study is completed by a fouling investigation which is based on two different experiments. The first one is performed by studying the permeate flux decline vs. time. Based on the insight gained from these experiments, Hermia model is applied to determine exactly the type of fouling phenomenon. The second experiment is based on the determination of different pure water permeability. The experimental data of this part is applied to the resistance in series model to calculate the different resistances related to the NF membrane. The results of this study will be presented and discussed.

**Keywords** | nanofiltration; decentralized desalination plant; fouling; autopsy; demineralization; modeling; Hermia; resistance in series.

## P16

### **Textiles effluents depollution using adsorption on natural clay of Fes region**

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**Abstract** | The water sector remains characterized by the acuteness of certain problems, notably the qualitative and quantitative degradation of water resources, to which are added those caused by climatic conditions and the proliferation of pollution sources. The world's industry continues to grow and expand, leaving behind organic contaminants as it develops. These discharges are generally very harmful to the environment and human health, or even non-biodegradable in water. Various types of synthetic dye pollutants, widely used in industries such as textiles, paper, leather, printing inks and many others are released into the natural environment. The removal of these organic pollutants by conventional physical-chemical treatments only accumulates the components of these dyes and cannot transform them into harmless compounds. Therefore, the development of new and effective treatment methods for synthetic dyes has become a scientific challenge of considerable interest.

To overcome these problems, several solutions have been proposed such as membrane techniques, coagulation-flocculation and anaerobic degradation using various microorganisms. Some of these techniques have proven to be effective, but are limited to the excessive use of chemicals and the accumulation of concentrates. The technique of adsorption on natural clay is better than other techniques of dye removal in terms of initial cost, simplicity of concept of use and non-toxicity of the adsorbents used.

The present study has for objective to treat the textile dye "methylene blue" by adsorption process on clay coming from the city of Fes

The experiments of adsorption of the methylene blue on the raw clay and treated by washing (ED, NaOH, HCl, thermally) according to the pH showed a capacity of notable adsorption reaching a rate of abatement of the order of 90 % in particular by the treated clay.

**Keywords** | Depollution; Adsorption; Textile dyes; Clay; COD.

## P17

### Modeling of nitrate ion transfer in nanofiltration and reverse osmosis membranes

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**Abstract** | The aim of this work is to compare and understand the transfer of nitrate ions in nanofiltration (NF) and reverse osmosis (RO) membranes. For this, three mathematical models: Kedem-Katchalsky (KK), Spiegler-Kedem (SK) and the Nerst-Plank model coupled with film theory (NP-FT) were used. The first two models (KK and SK) neglect the effect of the concentration polarization (CP) and allow determining the convection concentration ( $C_{conv}$ ), the diffusive flux ( $J_{diff}$ ) and the permeability ( $P_s$ ) of nitrate ions in addition to the reflection coefficient ( $\sigma$ ) which gives the contribution of convection and diffusion in the transfer. On the other hand, the NP-FT model takes into account the CP layer and allows to evaluate the thickness of this layer ( $\delta$ ) in addition to the  $P_s$  and  $\sigma$ . This study was performed on real groundwater doped with  $NaNO_3$  with different initial nitrate concentrations (IC) (50, 100, 200, 300 and 400 ppm) with NF90 membrane for NF and (NP-FT) for RO. The results obtained show that for IC below 200 ppm, the rejection increases but beyond that for RO it stabilizes and for NF it decreases. In addition, the increase in the applied transmembrane pressure (TMP) increases nitrate rejection for both NF and RO membranes. The behavior of the two membranes with respect to the IC of nitrate in terms of  $C_{con}$ ,  $J_{diff}$ ,  $P_s$  and  $\sigma$  is similar. Indeed, the transfer by convection increases with the IC, however this increase is more marked for NF than for RO. The thickness layer  $\delta$  decreases with increasing IC of nitrate for RO and remains stable for NF.

**Keywords** | Nitrate removal; Membrane; Kedem-Katchalsky model; Spiegler-Kedem model; Nernst Plank equation; Film theory.



## P18

### Contribution of two methods (in-situ and ex-situ) for detecting membrane wetting in membrane distillation for desalination

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**Abstract** | Membrane distillation (MD) is a promising technique for desalination or juice concentration. It can treat very concentrated solutions because it is not limited by osmotic pressure as is the case with reverse osmosis and can be coupled with solar energy. This process requires the use of a porous and hydrophobic membrane which ensures contact between the liquid (feed) and the vapor (permeate). Under the effect of the partial pressure difference between the two membrane sides, the water vaporizes ideally at the pore entrance, and then diffuses in the form of vapor in the pores before being condensed. However, the industrial development of MD technologies is limited by the fear of membrane wetting, defined as an intrusion of water in liquid form into membrane pores. Different forms of wetting have been defined (surface, partial, total), of which the easiest to detect is the most problematic, total wetting [1]. This phenomenon appears under certain operating conditions and for certain membranes, and results in a drastic loss of membrane performance in terms of permeate quality [2]. The prevention of wetting by a relevant choice of membranes is a major challenge for the industrial development of MD and there is a need of pertinent tools to detect wetting at its early stage for supporting this development.

The aim of this work is to compare two methods previously developed in our group: the detection of dissolved tracer intrusion (DDTI) [2] and an optical method allowing in operando dynamic study of wetting [3,4]. The experiments were carried out in the same condition with a vacuum membrane distillation (VMD) pilot plant [2]. under standard operating conditions ( $T_{\text{feed}} = 42.5^{\circ}\text{C}$ ,  $P_{\text{permeate}} = 60 \text{ mbar}$ ). The use of the two methods made it possible: to elucidate the mechanisms of wetting, to obtain a mapping of the wetting at the surface of the membrane, to visualize the dynamics of wetting, to identify the critical areas in a module, to compare membranes with each other under reference conditions [5]. The two methods are complementary and their advantages and limitations will be discussed in detail in the presentation.

**Keywords** | membrane distillation; DDTI; optical tool; wetting mechanism; wetting; desalination.

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## P19

### **Low-cost polysulfone/polystyrene ultrafiltration membrane with efficient azoic dyes removal and excellent antifouling performance for colored wastewater**

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**Abstract** | A new low-cost composite ultrafiltration membrane made of polysulfone (PSf) and polystyrene (PS) blend was effectively achieved on the ceramic pozzolan support using dip-coating method. The effect of PS content (5–20 wt%) on membrane properties such as microstructure and filtration performances was investigated. The Fourier-transform infrared spectroscopy, nuclear magnetic resonance, and differential scanning calorimetry analyses confirm that the two polymers lead to physical blend. The morphology analysis shows that PSf/PS membrane layer is homogeneous and strongly adherent on the pozzolan support. Furthermore, the developed membrane was applied for filtration of direct red (DR80) and methyl orange (MO) solutions at a pressure of 3 bar. It was proven that the PS addition significantly enhances the rejection of the membrane accompanying with a decrease of permeate flux to meet the trade-off selectivity-permeability. The optimized PSf/PS membrane containing 5 wt% of PS has a water permeability of 24 L h<sup>-1</sup> m<sup>-2</sup> bar<sup>-1</sup>, and could reject 91% and 76%, respectively for DR80 and MO. Beside the promising filtration results, the developed membrane is also low-cost thanks to using pozzolan support, and it could be consequently scaled up for the treatment of colored wastewater generated from textile industries.

**Keywords** | composite membrane; polymer blend; pozzolan; textile industry; ultrafiltration.

## P20

### Effective turning fly ash waste into Na-P1 zeolite and its application on the adsorption of Chromium VI

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**Abstract** | Fly ash is an industrial waste that is generated by thermal power plants, it has been considered as one of the major pollutants posing a serious issue due to its negative effects on air, water and soil. During the last two decades, great effort has been made to valorize fly ash in a large spectrum of applications. For instance, it has been used as cement additive, catalyst, adsorbent, membrane material, etc. On the other hand, many studies have attempted to convert fly ash waste to useful materials. Recently, fly ash has been used as a potential source to synthesize zeolite-based materials that could be used for heavy metals removal from industrial wastewaters.

The current study aims at synthesis of zeolite-based material from fly ash using hydrothermal process, and then it was used as an absorbent for the recovery of Cr(VI) from aqueous solutions. The obtained material was characterized by various analytical techniques such as XRF, XRD, FTIR and BET. The results confirm the synthesized Na-P1 zeolite exhibits high crystallinity (96.87%) and high surface area (87.20 m<sup>2</sup> g<sup>-1</sup>). It was proved that the prepared zeolite shows an encouraging adsorption capacity of Cr(VI) of 13.5 mg g<sup>-1</sup> which demonstrates that a waste material such as fly ash can be used in the preparation of an efficient adsorbent.

**Keywords** | Synthesis; Zeolite; Fly ash; Adsorption; Cr(VI).

## P21

### **Manufacturing of new ceramic nano-apatite membrane supported on phosphate/kaolinite support for treatment textile wastewater**

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**Abstract** | Ceramic membranes exhibit many advantageous characteristics in comparison to the membranes made from polymer materials. For instance, they are characterized by a good mechanical strength, an excellent thermal resistance in addition to a high chemical stability. However, commercial ceramic membranes are costly due to the use of expensive industrial oxides like alumina, titania, zirconia, etc., and they require higher energy for sintering. Therefore, it is very promising to use local geomaterials such as phosphate and clays to prepare low-cost ceramic membranes with competitive performances [1].

The goal of this work is the synthesis of nanostructured hydroxyapatite via a green chemistry approach. Then, the synthesized nanoparticles were employed to prepare an ultrafiltration layer on the low-cost phosphate/kaolinite support. Both nanoparticles and ultrafiltration membrane were characterized using techniques such as X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), and zeta potential and contact angle measurements. Finally, the optimized membrane was subjected to the treatment of wastewater coming from the textile industry in order to assess its performance.

**Keywords** | Ceramic membrane; Natural phosphate; Nano-apatite; Ultrafiltration; Textile wastewater.

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## P22

# Valorization of Moroccan geomaterials in the manufacturing of low-cost ceramic membranes for the treatment of industrial wastewaters

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**Abstract** | Ceramic membranes are thin, porous filters made from inorganic materials such as alumina or titania. They have high chemical stability and thermal resistance, which makes them suitable for filtration in harsh environments. They are often used for microfiltration, ultrafiltration and nanofiltration in industries such as pharmaceuticals, biotechnology, and food and beverage processing. Ceramic membranes have a high pore density and a small pore size, providing high filtration efficiency. Additionally, they have a long lifespan and can be cleaned and reused several times. However, they also have higher production and operating costs compared to organic membranes.

This present work focuses on the valorization of Moroccan geo-materials in ceramic membrane technology. The selected aluminosilicate-based material was systematically characterized using elemental, thermal and structural techniques to well understand its features. Then the raw material was dried, crushed and sieved at 45  $\mu\text{m}$ . Thereafter, the membrane was shaped using dry pressing method, and sintered at different temperatures. The effect of sintering temperature on porosity, shrinkage, mechanical strength pore size and permeability of membrane was investigated in the range of 700-1000  $^{\circ}\text{C}$ . Furthermore, the optimized ceramic membrane was subjected to the filtration of industrial wastewaters in order to evaluate its performance as a microfiltration membrane.

**Keywords** | Ceramic membranes; Microfiltration; Aluminosilicates; Sintering; Geo-materials.

## P23

### **Development and characterization of a low-cost Glymo-GO layer coated on kaolinite support. Application for waste treatment.**

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**Abstract** | Although the GO has shown encouraging results in the membrane field, it has a huge issue with stability when coated on ceramic supports, particularly those formed of geomaterials.

This work aims to prepare stable graphene oxide (GO) layer deposited on a low-cost ceramic support membrane made of Moroccan kaolinite. GO was prepared through the modified hummer's technique. The grafting technique was used to prepare the GO membrane (GOM). The siloxane functions on the support surface were activated using two different approaches to study the effect of the activation step on the membrane performances. The surface was chemically modified by 3-Glycidoxypropyltrimethoxysilan (GLYMO) to fasten the GO layer firmly. The dip-coating method was applied to deposit the GO nanosheets on the surface support. Different characterizations were done to the prepared membrane. The existence of GLYMO functions on the modified support was confirmed by FTIR, indicating that the grafting was successfully done. SEM images showed a layer free from defects and well attached to the support. The stability test on the GOM demonstrated a highly stable deposited layer using piranha solution in different pH contrary to the non-grafted membrane and HCl grafted membrane that peeled off from the support. The rejection at 3 bar for 50 ppm of dyes reached values above 87 % for anionic dyes and 81% with a cationic dye suggesting that the rejection through the membrane is controlled by both steric and charge effects.

**Keywords** | Membrane process; graphene oxide; low-cost membrane; wastewater treatment; dyes removal.

## P24

### **Fabrication of low-cost composite MoS<sub>2</sub>/PVA membrane supported on pozzolan substrate for effective removal of soluble dyes**

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**Abstract** | Molybdenum disulfide (MoS<sub>2</sub>), as a promising alternative 2D material, has become an alternative membrane material for water purification thanks to its interlayer nanochannels beside its excellent hydrophilic character. This work aims at the preparation of new composite membrane made of MoS<sub>2</sub> and polyvinyl alcohol (MoS<sub>2</sub>/PVA) for dyes removal. The MoS<sub>2</sub>/PVA layer was coated on low-cost ceramic support made from natural pozzolan via a vacuum filtration method. The PVA was incorporated into the membrane not only to enhance the interfacial adhesion between adjoining MoS<sub>2</sub> sheets but also to strongly adhere MoS<sub>2</sub> layer to pozzolan support. The structure and properties of the prepared membrane were systematically investigated using scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX), X-ray diffraction (XRD), atomic force microscopy (AFM) and zeta potential measurement. Importantly, preliminary results reveal that the obtained MoS<sub>2</sub>/PVA composite membrane displays outstanding performances in the removal of soluble dyes such as direct red 80 and methylene blue.

**Keywords** | Composite membrane; Molybdenum disulfide; Poly(vinyl alcohol); Dye removal.

**Acknowledgments** | The authors greatly acknowledge the financial support of funding from the Hubert Curien Program through the PHC TOUBKAL/23/166 Project.

## P26

### **Détection simple et rapide des ions Nitrates par voie électrochimique en utilisant un film de poly 1,8 diamidonaphtalène et d'oxyde de cuivre**

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**Abstract** | La contamination des nappes phréatiques, des rivières et des lacs contaminés par les nitrates est devenue un problème préoccupant. Ces derniers, issus principalement de l'activité agricole, à titre d'exemple utilisation d'engrais chimiques, nuisent à l'écosystème aquatique et l'approvisionnement en eau potable. Dans certaines régions du Maroc, les concentrations en nitrates des eaux souterraines et les eaux potables dépassent les 100 mg/L<sup>-1</sup> de NO<sub>3</sub><sup>-</sup>. En revanche, l'Organisation Mondiale de la Santé (OMS) recommande un niveau maximal de 50 mg/L de NO<sub>3</sub><sup>-</sup> dans les eaux, mais ce seuil est souvent dépassé, ce qui rend l'eau potable impropre à la consommation dans de nombreuses régions. Dans ce contexte, des méthodes de détection sensibles et fiables sont devenues une priorité absolue.

Dans ce travail, nous avons développé et caractérisé des électrodes à base de pâte de carbone modifiées par un composite à base de poly 1,8 Diamidonaphtalène (1,8 DAN) et les particules métalliques de cuivre-oxyde de cuivre, le temps de synthèse de l'électrode est de 2 minutes. Le capteur électrochimique développé est nommé poly 1,8-DAN /Cu/CPE. L'électrode préparée a montré une électroactivité envers les ions nitrates dans une gamme de concentration entre 1-100 µM avec une limite de détection de 0,4 µM. Le poly (1,8-DAN /Cu/CPE) a montré une très bonne répétabilité et une bonne reproductibilité et a été testé avec succès dans des échantillons environnementaux et alimentaires.

**Keywords** | Nitrates ; capteur ; détection ; électrode.



**P27**

## **Performance Simulation of a SWRO System Equipped with two Energy Recovery Devices**

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**Abstract** | The reverse osmosis is the dominant technology among the desalination technologies with a worldwide production capacity of 65% due to its best performances in quality and quantity of permeate product. But in a RO system, pumping specific energy pumping (PSE) represents approximately 65% of the specific energy consumption of all the plant.

Moreover, the energy cost represent up to 50% of the total cost of fresh water product so the studies is going on to find the solutions to reduce the energy cost. Among the solutions, exploiting the concentrate brine that exist with some important pressure with an energy recovery device is an excellent solution that was studied by the researches and introduced in the desalination market.

There are many types of energy recovery devices but the three main types are: the Pressure exchanger, the turbocharger and the Pelton turbine.

This research aims to study the performances of a 30 m<sup>3</sup>/h sea water reverse osmosis ( SWRO) system equipped with two different energy recovery devices (ERDs) to know : the Turbocharger and the pressure exchanger. To do that, a simulator, IMS Design, is used to simulate the performances of the system in three configurations: without ERD, with Turbocharger ( TC) and with Pressure Exchanger (PX). The results show that PX provides a PSE savings in the range of [30.6%; 69%] more higher than [ 20.2%; 46.5%] for TC. On the other hand, PX increases the permeate salinity, but the increase rate in TDS remains below 5% and, so, it have not a significant influence on the permeate quality.

**Keywords** | Reverse osmosis; Energy recovery device; TDS; Pumping specific energy.

## **P28**

### **Application des techniques computationnelles dans le domaine de la conception de médicaments**

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**Résumé** | Actuellement, la conception de médicaments assistés par ordinateur (computer- Aided Drug Design) est devenue un outil incontournable pour les chercheurs spécialisés en découverte de médicaments. En effet la CADD met en œuvre une puissance de calcul dans l'espace chimique et biologique combiné, afin de rationaliser la conception, le développement et l'optimisation de médicaments.

Dans notre étude, nous nous basons sur un ensemble de méthodes de la CADD, pour la prédiction et développement de nouveaux inhibiteurs. Un certain nombre d'hybrides 2-acétylphénol-rivastigmine ont été créés de manière rationnelle comme médicaments multifonctionnels pour le traitement des troubles du comportement, en particulier la dépression. Nous avons donc utilisé des techniques de relation quantitative structure-activité 3D (3D-QSAR) et de Docking moléculaire. L'objectif de cette étude consiste à obtenir de nouveaux inhibiteurs avec des activités inhibitrices élevées.

**Mots clés** | conception de médicament ; CADD ; Docking ; QSAR.

**P29**

## **Discovery of new anti-cancer drugs using green biochemistry approach**

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**Abstract** | The problem of environmental pollution resulting from certain practices (experiences) is a clear indication of unregulated biochemical science or bioethical negligence in the field of biochemistry. The adoption of a green biochemistry approach, which combines biomedical ethics with environmental chemistry ethics, is anticipated to serve as a means of regulating the application of science and technology, promoting eco-friendliness, and prioritizing human health protection. In the context of sustainable development, we have presented and validated a stepwise bioinformatics-guided strategy to discover new anti-breast cancer drug-candidates. To suggest the current scenario of quinoline derivatives as antitumor agents and to evaluate the path of these derivatives to discover and develop new treatments for breast cancer, three-dimensional quantitative structure-activity relationships (3D-QSAR) and a molecular docking study with the aromatase enzyme (PDB: 3S7S) were successfully performed. Comparative Molecular Similarity Indices Analysis (CoMSIA) was used to construct the 3D-QSAR model. The best CoMSIA model (with statistically significant results for  $Q^2$ ,  $R^2$  and  $R^2_{pred}$ ) was also used to achieve the high degree of predictability. To verify the developed model's prediction abilities, external validation using a test set has been employed. The results showed a considerable influence of the electrostatic, hydrophobic, hydrogen bond donor and acceptor fields on anti-breast cancer activities. In light of these findings, we developed a number of efficient aromatase inhibitors and then we used the best model to predict their inhibition. The efficacy of novel drug candidates was also investigated using ADMET properties.

**Keywords** | Green biochemistry; Breast cancer; Quinoline; 3D-QSAR; Molecular docking; ADMET.

**P30**

## **Desalination using membrane technology: Application to the production of drinking water**

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**Abstract** | Desalination of seawater and brackish water, for drinking water production, is often the way to deal with the water crisis. In addition to reverse osmosis (RO), several research works indicate that nanofiltration (NF) is also a promising technology to deal with salinity removal, e.g. brackish water treatment. Herein, a study on commercial NF and RO membranes was performed in terms of their productivity through experiments of hydraulic permeability, and their performance regarding salts rejection according to different operating conditions of synthetic solutions (pH, ionic strength, water matrix, etc.). Pilot-scale testing was performed at brackish water on three different feed TDS concentrations of 4, 6 and 10 g.L<sup>-1</sup>. The NF and RO Membranes provided variable rejection rates depending on feed water salinity. The required pressures for brackish water desalination with NF membranes were 50% lower than the RO membrane to produce the same average flux rate. The specific energy consumption which is proportional to feed pressure is then reduced to half. This work should lead to a better prediction of the possibilities of using nanofiltration process as means of brackish water desalination with the optimal operating conditions.

**Keywords** | Desalination; Drinking water; Reverse osmosis; Nanofiltration.

**P31**

**ASSESSING SURFACE WATER QUALITY IN DRINKING WATER SUPPLY AND IRRIGATION OF EL MALLEH DAM RESERVOIR AND IDENTIFICATION OF POLLUTION SOURCES**

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**Abstract** | The El Malleh dam is located in the Benslimane region, 30 km from its outlet in Mohammedia and 25 km north of Casablanca. It was built in 1927 to develop agriculture, irrigation and to protect Mohammedia city against flooding. However, these uses were not ensured as before, due to its silting (2.5M tons per year) intensified by water erosion. For this reason, the General Directorate for Water took charge of raising the El Malleh dam height in 2012, which increased its storage capacity and its lifespan. Nevertheless, the evolution of siltation over time is growing much faster than the initial state. This has impacted the quality of the reservoir. In this context, we carried out a Spatio-temporal evaluation of the contamination of the water of the El Malleh dam by conservative and non-conservative elements. To carry out this study, we selected 20 sampling sites. The physicochemical analyses were carried out according to the AFNOR standards, and the major elements were analysed using the ICP AES method. The obtained results allowed us to quantify the degree of pollution by the above-mentioned elements. We noted the predominance of the major elements (N, Ca, Mg, and K) and the low quantity of nutrients. which explains the absence of organic pollution, and shows that the origin of this pollution is water erosion and geology of El Malleh.

**Keywords** | Silting; Water Erosion; Spatio-temporal evaluation; Contamination; Pollution.

## P32

### **Fabrication, Characterization and Adsorption Performance of a novel polyaniline@SAPO-34 composite towards Orange G dye removal**

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**Abstract** | In this study, we have successfully synthesized a polyaniline@SAPO-34 composite via in situ interfacial polymerization procedure as a potential adsorbent for treating the textile effluents. The Azo dyes are considered the largest group of dyes used in textile. They are non-biodegradable contaminants that represent a risk to water pollution as well as to human health. The Orange G (OG) was used as a model textile pollutant. The as-developed PANI@SAPO-34 composite compound was analyzed by X-Ray diffraction (XRD), scanning electron microscopy (SEM) and Fourier-transform infrared (FTIR) spectroscopy. The hybrid composite was efficiently investigated for the first time as an adsorbent of OG dye from water. The adsorption of OG on the composite depends significantly on different physico-chemical conditions including pH of the solution, composite dose, contact time, OG dye concentration and temperature. The highest OG dye removal efficiency reached a maximum of 97.87 % at pH 6, 0,25g/L of the PANI@SAPO-34 amount, 50mg/L concentration of OG, 120 min as a contact time and 25°C of temperature. The OG dye adsorption mechanism was owing to electrostatic interactions between anionic OG dye and positively charged hybrid composite surface. The findings of this work demonstrated that the SAPOs could be used along with polyaniline as an effective alternative adsorbent of OG in industrial effluents.

**Keywords** | Polyaniline; SAPO-34; Composite; Adsorption; Orange G dye.

**P33**

## **Assessing hydrological modeling in a Mediterranean Watershed using the SWAT model**

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**Abstract** | Nowadays, the development of remote sensing and GIS techniques has made it possible to use spatial and physical hydrological models to simulate the functioning of watershed systems most simply and realistically achievable. Indeed, the primary constraint that hindered the expansion of these tools, especially in developing countries, was the unavailability or scarcity of data. In this context, the objective of this study is to seek a physical rainfall-flow model that describes the behavior of the Bouregreg basin using the Bouregreg basin using the Soil and Water Assessment Tool (SWAT). It aims to determine the flow of the streams and the water balance at the outlet of the basin. The ArcSWAT interface implemented in ArcGIS software delineated the watershed and its subcomponents, combined the data layers, and edited the model database. The model parameters were analyzed, ranked, and adjusted using daily time series data for hydrological modeling purposes. They were calibrated using a self-calibration method (SWAT-CUP) to optimize sensitivity and uncertainty analysis operations. The basin is calibrated using six years of data (January 2009 to December 2014), and a 2-year warming period (January 2007 to December 2008) was chosen during which the model could be initialized. The model calibration is performed for monthly periods at the station level (Ras EL Fathia), using the Sequential Uncertainty Fit 2 (SUFI-2) in SWAT-CUP (Auto-calibration). Based on statistical indicators, the evaluation shows that the SWAT model has performed well for the calibration period in the Bouregreg watershed. The model showed a good correlation between the observed and simulated monthly discharge with  $R^2$  and NSE values of 0.73 and 0.72, respectively. Thus, in light of the results, the SWAT model can effectively support water management policies.

**Keywords** | Hydrological modeling; Water balance; Bouregreg watershed; SWAT, SWAT-CUP; performance.

## P34

### **Elaboration and characterization of novel tubular microfiltration ceramic membranes made from Moroccan geo-materials**

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**Abstract** | Membrane filtration is increasingly used as a separation process in many fields, especially in the water cycle (water purification, effluent treatment, water reuse, softening, desalination...).

The technology of tangential filtration by membranes is known as an important industrial step in the process lines of the food industry, dairy industries.[1] Its ability to achieve very specific separations, without phase change, at low or ambient temperatures makes membrane filtration a much more cost effective solution than conventional methods in many applications.[2]

Membrane separation processes fall into several classes. Microfiltration, ultrafiltration nanofiltration and reverse osmosis. These techniques have potential applications in all branches of industry. The advantages of this technology compared to other physicochemical processes are mainly the ease of control of the system and the respect of the environment (the membrane separation does not require the addition of chemicals).[3]

Ceramic products are extremely interesting in the field of membranes because of their great chemical and mechanical stability. Their use is mainly limited by their fragility. As the use of a material is linked to its manufacturing cost, it is necessary to direct the current research towards the exploitation of low cost materials such as clays.

This project aims at the realization of composite ceramic membranes based on Moroccan red clay. The innovative character of this project is the choice of the ceramic materials used. This project also aims to reduce costs and increase productivity. The raw clay was characterized in terms of chemical composition (XRF), mineralogical composition (XRD), Thermal analysis (TGA), and spectroscopic analysis (FTIR).

**Keywords** | Red Clay; membrane; microfiltration; effluent.

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## P35

### **Pretreatment of vinasses by coagulation-flocculation : comparison and optimization using response surface methodology**

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**Abstract** | Coagulation-flocculation (CF) is a proven technique for treating wastewater with high total suspended solids (TSS). In this study, the Centered Composite Design (CCD) using response surface methodology (RSM) was applied to optimize the three most important operating variables : pH, coagulant dose, and flocculant dose in the CF treatment of vinasse at the Gharb Molasses Processing Company (Sotrameg) SOTRAMEG in Morocco. The main objectives of the CF process were to achieve high removal of TSS and chemical oxygen demand (COD) using two different coagulants: FeCl<sub>3</sub> and Al<sub>2</sub>SO<sub>4</sub>. The results show that the percentages of COD and TSS removed were 88.91%, 93.32% and 55.19%, 75.51% for FeCl<sub>3</sub> and Al<sub>2</sub>SO<sub>4</sub>, respectively. In addition, the R<sup>2</sup> values for TSS and COD removal for the two coagulants FeCl<sub>3</sub> and Al<sub>2</sub>SO<sub>4</sub> were 0.9834, 0.9891, 0.9947, and 0.9852, respectively, as obtained from the analysis of variance (ANOVA), indicating a sufficient regression for model development. In addition, linear model values ( $X_1, X_2, X_3$ ), quadratic model value ( $X_1^2, X_2^2, X_3^2$ ) and interactive model values ( $X_1X_2, X_1X_3, X_2X_3$ ) are found to be significant, with P-values <0.05. The optimum conditions for pH, coagulant dose, and flocculant dose were 5.5, 10 g/L, and 0.93 g/L for FeCl<sub>3</sub>, and 6.64, 5 g/L, and 0.83 g/L for Al<sub>2</sub>SO<sub>4</sub>.

**Keywords** | Coagulation-flocculation; Analysis of variances; Centered Composite Design (CCD); Response surface methodology (RSM).

## P36

### Synthesis of new class of materials for sensing application or Direct Alcohol Fuel cell

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**Abstract** | Hybrid materials based on bismuth and poly (p-Phenylenediamine) (Bi@PpPD) have been synthesized by combining monomer and metal for the first time. The synthesis was carried out via one-pot potentiostatic electrodeposition method applying an appropriate potential in only 90 seconds in a solution containing both the monomer and  $\text{Bi}^{3+}$ . The prepared film was characterized by the scanning electron microscopy showing a uniform dispersion of bismuth particles on the electrode surface. Square wave voltammetry (SWV) suggested that the combination of bismuth and pPD enhances the sensitivity towards the target ions and especially towards  $\text{Cd}^{2+}$ . The modified electrodes were then applied for the simultaneous electrochemical detection of traces  $\text{Cd}^{2+}$  and  $\text{Pb}^{2+}$ . The proposed sensor exhibited excellent analytical performance, and very low detection limits for  $\text{Cd}^{2+}$  and  $\text{Pb}^{2+}$ . The proposed method is very useful for the sustainable synthesis of metal-conducting polymer-based nanocomposites with high economy of time and reagents and can be applied for oxidation of alcohol.

**Keywords** | Smartphone-assisted electrochemical sensor; Bisphenol A; Magnesium-Cobalt phosphates; Carbon black.

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## P37

### **Traitement biologique membranaire RBM et performances de la station de traitement des eaux usées de Mediouna**

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**Abstract** | Le royaume est menacé par les pénuries d'eau, selon le dernier rapport du World Resources Institute (WRI), et de l'Institut pour l'économie et la paix (IEP) qui prédit des problèmes de pénurie d'eau et d'instabilité régionale au Maroc en 2040.

Ainsi il est indispensable de s'orienter vers des technologies de traitement et de recyclage des eaux usées et d'opter pour un développement intégré et durable.

La réutilisation est un axe stratégique du PNE et elle a été intégrée récemment aux politiques d'épuration des eaux usées pour promouvoir les projets intégrés Collecte-Epuration-Réutilisation.

La station d'épuration des eaux usées de Mediouna a été programmée dans le cadre du schéma d'assainissement liquide de la Lydec à Casablanca. Lancée en Avril 2013, la station est d'une capacité de 40000 équivalents habitants, avec une extension future, à l'horizon en 2030, de 80000 équivalents habitants. La capacité de traitement quotidienne de la station est de 2800 m<sup>3</sup> pouvant atteindre, 3800 m<sup>3</sup> avec un débit de pointe de 300 m<sup>3</sup>/h. Cette STEP adopte un système compact de traitement intensif de type RBM qui permet une élimination drastique des matières en suspension et une désinfection/hygiénisation des eaux épurées qui peuvent être réutilisées en irrigation agricole.

Ce travail se propose d'évaluer les performances épuratoires de ladite station sur la base des analyses et de suivi couvrant la période 2013 – 2021.

Les résultats obtenus montrent que malgré une montée de débit (ayant doublé de 560000 en 2013 à 1256000 m<sup>3</sup> en 2021), la STEP n'a enregistré aucun dépassement des valeurs limites de rejets (VLR) depuis 2013.

La station d'épuration de Mediouna a également gardé ses performances épuratoires en termes de DCO, DBO<sub>5</sub>, MES, NTK et Phosphore total malgré l'augmentation de la charge.

Les taux d'abattement sont élevés pour une moyenne de 98% pour DBO<sub>5</sub>, DCO et MES, 80% pour NTK et 53% pour PT durant la période 2013-2021.

**Keywords** | RBM; Membrane; Mediouna; Ultrafiltration; Performance.

**P38**

**Novel polypyrrole/zirconium tubular membrane developed for efficient congo red dye rejection and salts desalination**

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**Abstract** | Ultrafiltration process with composite membrane (ceramic/polymer) has attracted interesting attention in wastewater treatment. In this regard, the present research has successfully developed a novel tubular ultrafiltration membrane using the carbon-based zirconium support and the selective layer of polypyrrole. The chemical synthesis of the polypyrrole polymer is confirmed by the Infrared Spectroscopy and X-Ray Diffraction analyzes, while the Scanning Electron Microscopy and contact angle techniques have shown the coherence, homogeneity and hydrophobicity (138°) with 4 µm in thickness of the polypyrrole layer surface. In order to study the efficiency of the resulting membrane, we measured its permeance and its rejection capacity for the congo red dye, and salts as Na<sub>2</sub>SO<sub>4</sub>, MgSO<sub>4</sub> and NaCl. The experimental results have shown at optimized conditions that the polypyrrole tubular membrane has a water permeability reaches 5.6 L/h.m<sup>2</sup>.bar, it efficiently removes the congo red (99.7%) and sulfates from Na<sub>2</sub>SO<sub>4</sub> (92.6%), while it can moderately reject sulfates from MgSO<sub>4</sub> (59.8%) and chlorides from NaCl (38.8%).

**Keywords** | Polypyrrole ; Tubular membrane ; Ultrafiltration ; Congo red ; Desalination.

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