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Environmental Science and Engineering
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Qualifications

Membrane Separation Technology, Ph.D., Université de Montpellier
1995

Award Date: Jan 1 1995

Process Engineering, M.S., Université de Montpellier
1992

Award Date: Jan 1 1992

Mechanical Engineering and Energy, B.S., M'Hamed Bougara University of Boumerdes
1991

Award Date: Jan 1 1991

2003 → 2010 Senior R&D and Capacity Building Project Manager, Middle East Desalination Research Center (MEDRC),
Oman

2002 → 2003 Engineer-Consultant and Trainer, FiltraTech, France

1998 → 2002 Assistant Professor, Jeddah College of Technology, Saudi Arabia

1995 → 1998 R&D Engineer/Post-Doc Researcher, University of Montpellier, France

Employment

Professor, Environmental Science and Engineering

Professor

Environmental Science and Engineering

King Abdullah University of Science and Technology

Saudi Arabia

Aug 1 2018 → present

Biological, Environmental Sciences and Engineering

King Abdullah University of Science and Technology

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Jan 1 2015 → present

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Research outputs

Optimizing electrocoagulation pre-treatment efficiency during simultaneous treatment of different produced water streams in a FO-MD hybrid system

Saqib Nawaz, M., Alqulayti, A., Torres Serrano, V. M., Soukane, S., Gudideni, V., Al-Qahtani, A., Yan, I. C. & Ghaffour, N., May 25 2024, In: Separation and Purification Technology. 336, 126290.

Renewable energy-driven membrane distillation in the context of life cycle assessment

Kaczmarczyk, M., Mukti, M., Ghaffour, N., Soukane, S., Bundschuh, J. & Tomaszewska, B., Mar 2024, In: Renewable and Sustainable Energy Reviews. 192, 114249.

Solar-driven surface-heating membrane distillation using $Ti_3C_2T_x$ MXene-coated spacers

Almarzooqi, N., Alwan, R. A., AlMarzooqi, F., Ghaffour, N., Hong, S. & Arafat, H. A., Mar 2024, In: Chemosphere. 351, 141129.

Advanced 3D multiscale modeling of forward osmosis-membrane distillation integrated designs

Soukane, S., Nawaz, M. S., Obaid, M., Gudideni, V., Al-Qahtani, A. & Ghaffour, N., Feb 1 2024, In: Desalination. 571, 117089.

Advanced structures of reversal multi-stage flash desalination

Ali, E., Orfi, J., AlAnsary, H., Baakeem, S., Alsaadi, A. S. & Ghaffour, N., Feb 1 2024, In: Desalination. 571, 117095.

Recent progress on the application of capacitive deionization for wastewater treatment

Sayed, E. T., Obaid, M., Olabi, A. G., Abdelkareem, M. A., Al Radi, M., Al-Dawoud, A., Al-Asheh, S. & Ghaffour, N., Dec 2023, In: Journal of Water Process Engineering. 56, 104379.

Combination of advanced coagulation Fe(VI) and UF membrane to effectively remove organic compounds and mitigate biofouling during harmful algal blooms

Alshahri, A. H., Obaid, M., Dehwah, A. H. A., Missimer, T. M., Ali, M. & Ghaffour, N., Nov 1 2023, In: Desalination. 565, 116882.

Emerging MXenes: Revolutionizing oily wastewater treatment - a comprehensive and critical review

Ihsanullah, I., Bilal, M., Sajid, M., Mohammad, A. W., Atieh, M. A. & Ghaffour, N., Sep 26 2023, In: Separation and Purification Technology. 329, p. 125181

Selected physical and chemical cleanings remove biofilm in seawater membrane distillation without causing pore wetting

Amin, N. A., Elcik, H., Alpatova, A., Gonzalez-Gil, G., Blankert, B., Farhat, N., Vrouwenvelder, J. S. & Ghaffour, N., Sep 5 2023, In: npj Clean Water. 6, 1

Understanding the evolution of organic fouling in membrane distillation through driving force and resistance analysis

Ricceri, F., Blankert, B., Ranieri, L., Picioreanu, C., Ghaffour, N., Vrouwenvelder, J. S., Tiraferri, A. & Fortunato, L., Aug 19 2023, In: Journal of Membrane Science. 686, p. 121993

Machine learning and computational approaches for designing membrane distillation modules

Almahfoodh, S., Qamar, A., KERDI, SARAH. & Ghaffour, N., Jul 20 2023, In: Separation and Purification Technology. p. 124627

Evaluating dye recovery and reusability potential from dyebath effluent using forward osmosis membranes for minimum liquid discharge.

Yasmeen, M., Nawaz, M. S., Manzoor, K., Khan, S. J. & Ghaffour, N., Jul 5 2023, In: Chemosphere. p. 139433

Airfoil-shaped filament feed spacer for improved filtration performance in water treatment.

Qamar, A., Kerdi, S., Vrouwenvelder, J. S. & Ghaffour, N., Jul 4 2023, In: Scientific Reports. 13, 1

Deployment of Superhydrophilic and Super-antifouling Cr-soc-MOF-1-Based Membrane for Ultrafast Separation of Stabilized Oil-in-Water Emulsions

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Improved modelling and simulation of once-through and reverse multi-stage flash desalination configurations

Ali, E., Orfi, J., AlAnsary, H., Alsaadi, A. S., Ghaffour, N. & Khennich, M., Jun 1 2023, In: The Canadian Journal of Chemical Engineering.

Calibrating and Validating the MFI-UF Method to Measure Particulate Fouling in Reverse Osmosis

Abunada, M., Dhakal, N., Andyar, W. Z., Li, Y., Ajok, P., Ghaffour, N., Schippers, J. C. & Kennedy, M. D., May 22 2023, In: Membranes. 13, 5, p. 535

Sulphate removal from aqueous solutions: State-of-the-art technologies and future research trends

Chatla, A., Almanassra, I. W., Abushawish, A., Laoui, T., Alawadhi, H., Atieh, M. A. & Ghaffour, N., Apr 24 2023, In: Desalination. 558, p. 116615

Co-TiO₂ supported on reduced graphene oxide as a highly active and stable photocatalyst for hydrogen generation

Moustafa, H. M., K.Velisoju, V., Omar Mohamed, H., Obaid, M., Datoo Kolubah, P., Yao, X., Ghaffour, N. & Castaño, P., Apr 15 2023, In: Fuel. 338, 127232.

Inventions, innovations, and new technologies: Solar Desalination

Wijewardane, S. & Ghaffour, N., Mar 4 2023, In: Solar Compass. p. 100037

The evolution of feed spacer role in membrane applications for desalination and water treatment: A critical review and future perspective

Sreedhar, N., Thomas, N., Ghaffour, N. & Arafat, H. A., Feb 28 2023, In: Desalination. 554, p. 116505

Prediction of particulate fouling in full-scale reverse osmosis plants using the modified fouling index – ultrafiltration (MFI-UF) method

Abunada, M., Dhakal, N., Gulrez, R., Ajok, P., Li, Y., Abushaban, A., Smit, H., Moed, D., Ghaffour, N., Schippers, J. C. & Kennedy, M. D., Feb 22 2023, In: Desalination. 553, p. 116478

Solar desalination: A review of recent developments in environmental, regulatory and economic issues

Goosen, M., Mahmoudi, H., Alyousef, Y. & Ghaffour, N., Feb 19 2023, In: Solar Compass. 5, p. 100034

A Fouling Comparison Study of Algal, Bacterial and Humic Organic Matters in Seawater Desalination Pretreatment Using Ceramic UF Membranes

Al Namazi, M., Li, S., Ghaffour, N., Leiknes, T. O. & Amy, G., Feb 2023, In: Membranes. 13, 2, 234.

Recent advances and future prospects in direct solar desalination systems using membrane distillation technology

Bamasag, A., Almatrafi, E., Alqahtani, T., Phelan, P., Ullah, M., Mustakeem, M., Obaid, M. & Ghaffour, N., Jan 20 2023, In: Journal of Cleaner Production. 385, 135737.

Concept and analysis of hybrid reversal multi-stage flash and membrane distillation desalination system

Ali, E., Orfi, J., AlAnsary, H., Baakeem, S., Alsaadi, A. S. & Ghaffour, N., 2023, (Accepted/In press) In: Environmental Technology (United Kingdom).

Recovering and reuse of textile dyes from dyebath effluent using surfactant driven forward osmosis to achieve zero hazardous chemical discharge.

Yasmeen, M., Nawaz, M. S., Khan, S. J., Ghaffour, N. & Khan, M. Z., Dec 28 2022, In: Water Research. 230, p. 119524

Performance and implications of forward osmosis-membrane distillation hybrid system for simultaneous treatment of different real produced water streams

Saqib Nawaz, M., Alamoudi, T., Soukane, S., Soo Son, H., Jin, Y., Medina, S. C., Mustakeem, M., Gudideni, V., Al-Qahtani, A. & Ghaffour, N., Dec 15 2022, In: Chemical Engineering Journal. 450, 138479.

Optimization of osmotic backwashing cleaning protocol for produced water fouled forward osmosis membranes

Alamoudi, T., Nawaz, M. S., Obaid, M., Jin, Y., Soukane, S., Son, H. S., Gudideni, V., Al-Qahtani, A. & Ghaffour, N., Dec 5 2022, In: Journal of Membrane Science. 663, 121013.

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Desalination at ambient temperature and pressure by a novel class of biporous anisotropic membrane

Qtaishat, M. R., Obaid, M., Matsuura, T., Al-Samhoury, A., Lee, J. G., Soukane, S. & Ghaffour, N., Dec 2022, In: Scientific Reports. 12, 1, 13564.

Freeze desalination: Current research development and future prospects.

Janajreh, I., Zhang, H., El Kadi, K. & Ghaffour, N., Nov 28 2022, In: Water Research. 229, p. 119389

Understanding the effect of membrane interfacial wetting properties on membrane distillation flux

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A deep neural networks framework for in-situ biofilm thickness detection and hydrodynamics tracing for filtration systems

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Computational fluid dynamics modelling of air-gap membrane distillation: Spacer-filled and solar-assisted modules

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Computational fluid dynamics simulations of solar-assisted, spacer-filled direct contact membrane distillation: Seeking performance improvement

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Materials for energy conversion in membrane distillation localized heating: Review, analysis and future perspectives of a paradigm shift

Soukane, S., Son, H. S., Mustakeem, M., Obaid, M., Alpatova, A., Qamar, A., Jin, Y. & Ghaffour, N., Oct 2022, In: Renewable and Sustainable Energy Reviews. 167, 112702.

Novel multistage flash reversal Concept: Modelling and analysis

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Advanced coagulation with liquid ferrate as SWRO desalination pretreatment during severe algal bloom. Process performance, environmental impact, and cost analysis

Alshahri, A. H., Giagnorio, M., Dehwah, A. H. A., Obaid, M., Missimer, T. M., Leiknes, T. O., Ghaffour, N. & Fortunato, L., Sep 1 2022, In: Desalination. 537, 115864.

Elucidating biofouling over thermal and spatial gradients in seawater membrane distillation in hot climatic conditions

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Improving MFI-UF constant flux to more accurately predict particulate fouling in RO systems: Quantifying the effect of membrane surface porosity

Abunada, M., Dhakal, N., Andyar, W. Z., Ajok, P., Smit, H., Ghaffour, N., Schippers, J. C. & Kennedy, M. D., Aug 9 2022, In: Journal of Membrane Science. 660, p. 120854

In situ conductive spacers for early pore wetting detection in membrane distillation

Alpatova, A., Qamar, A., Alhaddad, M., Kerdi, S., Soo Son, H., Amin, N. & Ghaffour, N., Aug 1 2022, In: Separation and Purification Technology. 294, 121162.

Unraveling the role of feed temperature and cross-flow velocity on organic fouling in membrane distillation using response surface methodology

Ricceri, F., Blankert, B., Ghaffour, N., Vrouwenvelder, J. S., Tiraferri, A. & Fortunato, L., Jul 28 2022, In: Desalination. 540, p. 115971

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Effect of colder stream temperature control on energy utilization, flux, RSF, and membrane integrity in asymmetric temperature FO systems

Nawaz, M. S., Alamoudi, T., Soukane, S., Obaid, M. & Ghaffour, N., May 2022, In: Process Safety and Environmental Protection. 161, p. 67-77 11 p.

Colloidal silica fouling mechanism in direct-contact membrane distillation

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MXene-Coated Membranes for Autonomous Solar-Driven Desalination

Mustakeem, M., El Demellawi, J. K., Obaid, M., Ming, F., Alshareef, H. N. & Ghaffour, N., Jan 21 2022, In: ACS Applied Materials & Interfaces.

Development in forward Osmosis-Membrane distillation hybrid system for wastewater treatment

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Corrigendum to "Experimental investigation of a solar-heated direct contact membrane distillation system using evacuated tube collectors" [Desalination Volume 487, 1 August 2020, 114,497] (Desalination (2020) 487, (S0011916420304471), (10.1016/j.desal.2020.114497))

Bamasag, A., Alqahtani, T., Sinha, S., Ghaffour, N. & Phelan, P., Jan 15 2022, In: Desalination. 522, 115407.

Downstream variations of air-gap membrane distillation and comparative study with direct contact membrane distillation: A modelling approach

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Hybrid desalination technologies for sustainable water-energy nexus: Innovation in integrated membrane module development

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Comprehensive insights into performance of water gap and air gap membrane distillation modules using hollow fiber membranes

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Investigations of crude-oil emulsions at the micro-to-nano scales

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Pulsating CO2 nucleation radically improves the efficiency of membrane backwash

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Salt-solution-infused thin-film condenser for simultaneous anti-frost and solar-assisted atmospheric water harvesting

Jin, Y., Soukane, S. & Ghaffour, N., Sep 10 2021, In: Cell Reports Physical Science. p. 100568

Real-time membrane fouling analysis for the assessment of reclamation potential of textile wastewater processed by membrane distillation

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Ultrasound-assisted membrane technologies for fouling control and performance improvement: A review

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Economics and Energy Consumption of Brackish Water Reverse Osmosis Desalination: Innovations and Impacts of Feedwater Quality

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Preparation of fouling resistant and highly perm-selective novel PSf/GO-vanillin nanofiltration membrane for efficient water purification.

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Cost analysis of multiple effect evaporation and membrane distillation hybrid desalination system

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Dynamic feed spacer for fouling minimization in forward osmosis process

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Textile dye wastewater treatment by direct contact membrane distillation: Membrane performance and detailed fouling analysis

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Potential Pitfalls in Membrane Fouling Evaluation: Merits of Data Representation as Resistance Instead of Flux Decline in Membrane Filtration

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Towards sustainable circular brine reclamation using seawater reverse osmosis, membrane distillation and forward osmosis hybrids: An experimental investigation

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Facile fabrication of superhydrophilic and underwater superoleophobic nanofiber membranes for highly efficient separation of oil-in-water emulsion

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Treatment of high-strength synthetic textile wastewater through anaerobic osmotic membrane bioreactor and effect of sludge characteristics on flux

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Transforming an end-of-life reverse osmosis membrane in a cationic exchange membrane and its application in a fungal microbial fuel cell

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Investigation of flux stability and fouling mechanism during simultaneous treatment of different produced water streams using forward osmosis and membrane distillation.

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Novel hole-pillar spacer design for improved hydrodynamics and biofouling mitigation in membrane filtration.

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State-of-the-art of renewable energy sources used in water desalination: Present and future prospects
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Assessment of Wastewater Quality of Paharang Drain and its Impact on the Ground Water Quality of Adjacent Areas
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Organic fouling control in reverse osmosis (RO) by effective membrane cleaning using saturated CO₂ solution
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Power effect of ultrasonically vibrated spacers in air gap membrane distillation: Theoretical and experimental investigations
Al-juboori, R. A., Naji, O., Bowtell, L., Alpatova, A., Soukane, S. & Ghaffour, N., Jan 18 2021, In: Separation and Purification Technology. 262, p. 118319

Hole-Type Spacers for More Stable Shale Gas-Produced Water Treatment by Forward Osmosis
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Controlling Harmful Algal Blooms (HABs) by Coagulation-Flocculation-Sedimentation using liquid ferrate and clay
Alshahri, A., Fortunato, L., Ghaffour, N. & Leiknes, T., Jan 2021, In: Chemosphere. p. 129676

Seawater electrolysis for hydrogen production: a solution looking for a problem?
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Scaling sets the limits of large scale membrane distillation modules for the treatment of high salinity feeds
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In situ ultrathin silica layer formation on polyamide thin-film composite membrane surface for enhanced forward osmosis performances
Akther, N., Lin, Y., Wang, S., Phuntsho, S., Fu, Q., Ghaffour, N., Matsuyama, H. & Shon, H. K., Nov 9 2020, In: Journal of Membrane Science. p. 118876

Dead-end membrane distillation with localized interfacial heating for sustainable and energy-efficient desalination
Mustakeem, M., Qamar, A., Alpatova, A. & Ghaffour, N., Oct 30 2020, In: Water Research. p. 116584

Impact of osmotic and thermal isolation barrier on concentration and temperature polarization and energy efficiency in a novel FO-MD integrated module
Son, H. S., Kim, Y., Nawaz, M. S., Al-Hajji, M. A., Abu-Ghdaib, M., Soukane, S. & Ghaffour, N., Oct 18 2020, In: Journal of Membrane Science. p. 118811

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Kerdi, S., Qamar, A., Vrouwenvelder, J. S. & Ghaffour, N., Oct 7 2020, In: Water Research. p. 116502

Solar-heated submerged vacuum membrane distillation system with agitation techniques for desalination
Bamasag, A., Alqahtani, T., Sinha, S., Ghaffour, N. & Phelan, P., Oct 7 2020, In: Separation and Purification Technology. p. 117855

Role of dissolved air flotation (DAF) and liquid ferrate on mitigation of algal organic matter (AOM) during algal bloom events in RO desalination

Alshahri, A., Fortunato, L., Zaouri, N. A., Ghaffour, N. & Leiknes, T., Sep 28 2020, In: Separation and Purification Technology. 256, p. 117795

Conceptual design of a dynamic turbospacer for efficient low pressure membrane filtration

Ali, S. M., Qamar, A., Phuntsho, S., Ghaffour, N., Vrouwenvelder, J. S. & Shon, H. K., Sep 3 2020, In: Desalination. 496, p. 114712

Showerhead feed distribution for optimized performance of large scale membrane distillation modules

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Effective membrane backwash with carbon dioxide under severe fouling and operation conditions

Alpatova, A., Qamar, A., Al Ghamdi, M., Lee, J. G. & Ghaffour, N., Jun 7 2020, In: Journal of Membrane Science. 611, p. 118290

Minimum Net Driving Temperature Concept for Membrane Distillation

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Experimental investigation of a solar-heated direct contact membrane distillation system using evacuated tube collectors

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Membrane filtration performance enhancement and biofouling mitigation using symmetric spacers with helical filaments

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Influence of graphene oxide lateral size on the properties and performances of forward osmosis membrane

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Membrane fouling quantification by specific cake resistance and flux enhancement using helical cleaners

Ghaffour, N. & Qamar, A., Jan 19 2020, In: Separation and Purification Technology. 239, p. 116587

A Data-Driven Soft Sensor to Forecast Energy Consumption in Wastewater Treatment Plants: A Case Study

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Integration of Multi Effect Evaporation and Membrane Distillation Desalination Processes for Enhanced Performance and Recovery Ratios

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Data on Environmental Impact Discussed by Researchers at King Abdullah University of Science and Technology (KAUST) (Advanced Coagulation With Liquid Ferrate As Swro Desalination Pretreatment During Severe Algal Bloom. Process Performance, ...)

Mohammed Awad, Luca Fortunato & NorEddine Ghaffour

12/30/22

1 item of Media coverage

Data on Membrane Research Reported by Researchers at King Abdullah University of Science and Technology (KAUST) (A Fouling Comparison Study of Algal, Bacterial and Humic Organic Matters in Seawater Desalination Pretreatment Using Ceramic UF ...)

NorEddine Ghaffour

03/14/23

1 item of Media coverage

Dubai hosts 15th International Conference on Challenges in Environmental Science & Engineering

NorEddine Ghaffour

12/24/22

3 items of Media coverage

Dubai hosts the 15th International Conference on Challenges in Environmental Science and Engineering 2022 for the first time in the Middle East

NorEddine Ghaffour

12/26/22

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12/24/22

1 item of Media coverage

Findings on Networks Reported by Investigators at King Abdullah University of Science and Technology (KAUST) (A Deep Neural Networks Framework for In-situ Biofilm Thickness Detection and Hydrodynamics Tracing for Filtration Systems)

Johannes Vrouwenvelder, NorEddine Ghaffour, Xiangliang Zhang, Najat Amin, Sarah Kerdi & Adnan Abedalqader Qamar

11/18/22

1 item of Media coverage

Investigators from King Abdullah University of Science and Technology (KAUST) Have Reported New Data on Machine Learning (Machine Learning and Computational Approaches for Designing Membrane Distillation Modules)

NorEddine Ghaffour, Sarah Kerdi & Adnan Abedalqader Qamar

11/17/23

1 item of Media coverage

King Abdullah University of Science and Technology (KAUST) Researchers Have Provided New Data on Water Supply (Selected physical and chemical cleanings remove biofilm in seawater membrane distillation without causing pore wetting)

NorEddine Ghaffour, Johannes Vrouwenvelder, Graciela Gonzalez Gil, Alla Alpatova, Nadia Farhat, Bastiaan Blankert, Harun Elcik & Najat Amin

09/22/23

1 item of Media coverage

Making more water from the sea, but at what cost?

NorEddine Ghaffour

10/27/19

1 item of Media coverage

More water can be produced in the world from seawater, but at what cost?

NorEddine Ghaffour & Muhammad Shahzad

10/24/19

1 item of Media coverage

New Findings on Renewable Energy from King Abdullah University of Science and Technology (KAUST) Summarized (Renewable Energy-driven Membrane Distillation In the Context of Life Cycle Assessment)

NorEddine Ghaffour & Sofiane Soukane
03/4/24
1 item of Media coverage

Red Sea Development selects leading desalination proposals

NorEddine Ghaffour
11/15/19
2 items of Media coverage

Saudi Arabia Offers Lessons on Hurdles to Fresh Water

NorEddine Ghaffour & Muhammad Shahzad
10/23/19
1 item of Media coverage

Take salt out of the water

NorEddine Ghaffour
11/9/19
1 item of Media coverage

The world can make more water from the sea

NorEddine Ghaffour & Muhammad Shahzad
10/23/19
1 item of Media coverage

The world can make more water from the sea - but at what cost?

NorEddine Ghaffour & Muhammad Shahzad
10/22/19
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The world can make more water from the sea, but at what cost?

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NorEddine Ghaffour & Muhammad Shahzad

10/22/19

1 item of Media coverage

TRSDC and KAUST announce Brains for Brine winners

NorEddine Ghaffour

11/27/19

1 item of Media coverage

TRSDC and Kaust pick winners of Brains for Brine Challenge

NorEddine Ghaffour

11/14/19

1 item of Media coverage

TRSDC and Kaust pick winners of Brains for Brine Challenge

NorEddine Ghaffour

11/14/19

2 items of Media coverage

United Arab Emirates : Dubai hosts the 15th International Conference on Challenges in Environmental Science and Engineering 2022 for the first time in the Middle East

NorEddine Ghaffour

12/24/22 → 12/26/22

3 items of Media coverage

US Patent Issued to KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY on Aug. 10 for "Compact high-throughput device for water treatment" (Saudi Arabia Inventors)

NorEddine Ghaffour

08/11/21

1 item of Media coverage

US Patent Issued to KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY on Jan. 25 for "Method for hybridized desalination system using membrane distillation and adsorption desalination cycles" (Saudi Arabia, Pakistani Inventors)

Kim NG, NorEddine Ghaffour & Muhammad Shahzad

01/26/22

1 item of Media coverage

US Patent Issued to KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY on March 1 for "Periodic mesoporous organosilica-doped nanocomposite membranes and systems including same" (Saudi Arabia Inventors)

Niveen M. Khashab & NorEddine Ghaffour

03/2/22

1 item of Media coverage

US Patent Issued to KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY on May 10 for "Fouling resistant membrane spacers" (Saudi Arabia Inventors)

NorEddine Ghaffour & Adnan Abedalqader Qamar

05/11/22

1 item of Media coverage

US Patent Issued to KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY on Oct. 11 for "Multi-stage flash (MSF) reversal system and method" (Saudi Arabia Inventors)

NorEddine Ghaffour

10/12/22

1 item of Media coverage

Courses

EnSE 225 Water Desalinization

08/28/10 → ...

EnSE 325 Water Desalination

09/3/11 → ...