International Specialty Conference on
Ocean Brine Mining

March 21-23, 2022
Le Meridien Hotel, Al Khobar
Saudi Arabia

Final Program

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International Specialty Conference on Ocean Brine Mining

Held under the patronage H.E. Eng. Abdulrahman Abdulmohsen A. AlFadley, Minister of the Environment, Water and Agriculture of the Kingdom of Saudi Arabia, this conference has been organized by the International Desalination Association (IDA) and the Desalination Technologies Research Institute (DTRI) of the Saline Water Conversion Corporation (SWCC) and with the leadership of H.E. Eng. Abdullah Ibrahim Al-Abdulkarim, Governor, Saline Water Conversion Corporation.

The Value of Brine from Desalination Plants
Brine from desalination plants contains valuable minerals. Desalination brine mining can surpass earth mining as a source of rare-earth metals such as lithium, strontium, cesium, rubidium, barium, and others, and brings a new era of exploration of the vast water resources of the planet. This conference opens a venue for presenting and discussing the latest advanced technologies for extracting minerals and rare metals from desalination brine.

Conference Focus
A forum for expert scientists, applied researchers, practitioners, and innovators in the field of desalination brine mining to share their latest technologies and experience of mineral and metal extraction.

Emphasis has been given to membrane-based ocean brine concentration and advanced extraction methods and technologies which combine low energy use and competitive production of rare metals and minerals.

The presentations focus on technologies and systems that advance to the point of proof-of-concept and beyond, that can yield minerals and rare metals at a cost lower than that of earth mining and conventional production methods. Case studies for demonstration or full-scale implementation of brine concentration and mineral extraction technologies will also be presented.
It is my great pleasure and privilege to welcome you to the first of its kind International Specialty Conference on “Ocean Brine Mining” jointly organized by the International Desalination Association (IDA) and the Saline Water Conversion Corporation (SWCC) under the patronage of the Ministry of the Environment, Water and Power of Saudi Arabia (MEWA). This conference is a unique international event dedicated to opening a new page in the history of desalination – a pathway for turning brine from a waste byproduct of seawater desalination into a valuable source of industrial commodities and rare metals. We look forward to hosting you in the beautiful city of Al Khobar on the Gulf coast of Saudi Arabia between March 21 and 23, 2022, and your valuable contribution to the success of the conference.

As a co-organizer of the Ocean Brine Mining Conference with the International Desalination Association, I would like to thank you for your interest and attendance at this premier industry event and to wish you a successful and beneficial experience at the conference. We aim to amalgamate the creative essence and entrepreneurial spirit of the desalination industry to chart a path toward the beneficial reuse of brine by harvesting the sea's mineral richness. This path will help us reach environmentally sustainable desalination and zero liquid discharge. The development and deployment of clean energy technologies and sustainable products, processes and manufacturing industries of the 21st century will require large amounts of critical metals and valuable elements, including platinum group metals, lithium, copper, cobalt, silver, and gold. Desalination brine mining opens the opportunity to tap into the ocean for such valuable commodities. SWCC’s vision is to harness the value contained in seawater brine and use it to subsidize desalinated water production. This achievement will lower the water cost down to zero and transform desalination into the lowest-cost technology for freshwater output in the world.

I wish you an enjoyable stay in the Kingdom of Saudi Arabia.
Message from DTRI

Dear fellow conference participants,

Welcome to the first of its kind international event exclusively focused on the beneficial use of brine generated by desalination plants. Brine mining is trailblazing a new desalination industry path of Zero Discharge & Zero Cost Desalination.

This specialty conference aims to provide a unique forum for expert scientists, applied researchers, practitioners, and innovators to share their latest technologies and experience of brine concentration and extracting valuable minerals from brine. This high-quality content-rich conference focuses on leading-edge technologies that convert cost-effectively brine into mineral products and extract rare metals of strategic importance for advanced future industries such as lithium, cesium, rubidium, and barium. The 3-day conference includes a pre conference workshop on advanced technology for the extraction of high purity sodium chloride and bromine from ocean brine followed by 1.5 days of technical presentations and a half-day of site visits of advanced brine concentration demonstration facility in the city of Jubail and one of the largest desalination plants in the world – the 1 million m$^3$/day Ras Al Khair desalination facility.

Best wishes for fruitful and beneficial participation at the conference, and enjoy your stay in our beautiful city of Al Khobar. We welcome you and thank you for your valuable participation in making this conference a success.

Dr. Ahmed Al Amoudi
Director General, DTRI of SWCC

Eng. Nikolay Voutchkov
Senior Expert, DTRI

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Dr. Ahmed Al Amoudi
Director General, DTRI of SWCC

Eng. Nikolay Voutchkov
Senior Expert, DTRI
Message from IDA

Dear Distinguished Delegates,

On behalf of the Board of Directors of IDA, it’s our sincere pleasure to welcome you to the First Specialty Conference on Ocean Brine Mining held under the patronage of H.E. Minister Al-Fadley, the Minister of Environment, Water, and Agriculture of the Kingdom of Saudi Arabia, and hosted by H.E. Eng. Abdullah Ibrahim Al-Abdulkarim, Governor, Saline Water Conversion Corporation.

It has been our pleasure to jointly organize this conference with the dynamic technical team at the Desalination Technology Research Institute (DTRI) of SWCC, under the leadership of our colleague Dr. Ahmed Al Amoudi, Executive Director of the DTRI and the DTRI - IDA Technical Program Committee led by Mr. Nikolay Voutchkov.

This innovative conference provides a unique forum to share knowledge and experience on leading-edge technologies that cost-effectively convert brine into mineral products and extract rare metals of strategic importance for advanced industries, including lithium, cesium, rubidium, barium.

Over three decades, desalination technology evolution has broken barriers in flux, energy consumption, scale, and flexibility to adapt to new contract and financial models. IDA commends these important changes and transformations and will continue supporting development. Mineral recovery from Brine discharge is a key innovation topic. The partnership with SWCC and DTRI is part of our mission to expand IDA activities and stakeholders to support technical evolution for a better world.

A tremendous amount of diligent work has been conducted to bring this pioneering conference to life. We thank all involved for their volunteer contributions of time and expertise.

We greatly appreciate the sponsors of this conference, who have enabled the IDA and our partners to create this valuable knowledge-sharing event. Our special thanks go to WETICO, our Silver Sponsor, Suez, AJMC, FEDCO, and FTSH20, Bronze Sponsors.

Welcome to the Kingdom of Saudi Arabia and welcome to Ocean Brine Mining!

Mr. Carlos Cosin
IDA President

Ms. Shannon K. McCarthy
Secretary General of IDA
DAY 1 Monday, March 21st

Technical Workshop – Ocean Brine Mining for Sodium Chloride and Bromine

Transport from Le Meridien to DTRI (90mins) 7:30 am pickup

09:30-09:45 Introductions
Dr. Ahmed Al Amoudi, Director General, DTRI of SWCC, KSA

09:45-10:30 Overview of DTRI System for Brine Mining of NaCl and Br
Program Moderator and Speaker: Eng. Nikolay Voutchkov, SWCC, KSA

10:30-11:00 Coffee Break

11:00-12:00 Scope of Work of 2 Million Tons/Year NaCl and Br Project
Speakers: Dr. Seungwon Ihm, & Dr. Christopher Fellows, SWCC, KSA

12:00-13:00 Lunch Break

13:00-13:30 Hydranautics NF, SWRO & UHPRO Systems w/ Turbocharger
Speakers: Dr. Craig Bartels, Hydranautics, USA & Mr. Rory Weaver, FEDCO, USA

13:30-14:00 SUEZ NF System
Speaker: Dr. Neil Moe, SUEZ, France

14:00-14:30 FTS Membrane Brine Concentration System
Speaker: Mr. John Tracy, Fluid Technology Solutions (FTS), USA

14:30-15:00 Coffee Break

15:00-15:30 Toyobo Membrane Brine Concentration System
Speaker: Mr. Takahito Nakao, Toyobo, Japan

15:30-16:00 Suez Brine Crystallization System
Speaker: Mr. Karel Vratny, SUEZ, France

16:00 – 16:30 Project Questions & Answers Session
16:30-17:00  Visit to SWCC Brine Concentration System

17:00  Workshop Adjourned and Transport to the Le Meridien Hotel - arrival estimated 19:00.

16:00 - 20:00  Conference Registration Open at the Le Meridien Hotel, Al Khobar

19:30 - 21:00  Welcome Reception —Le Meridien Hotel, Al Khobar

**Day 2 Tuesday, March 22**

**Morning Session**

08:30-09:00  Welcome Remarks

*Master of Ceremony Dr. Al-Amoudi, Director General, DTRI of SWCC, Conference Chairman*

◇ H.E. Eng. Abdullah Ibrahim Al-Abdulkarim, Governor, SWCC
◇ Ms. Shannon McCarthy, Secretary General of IDA

**Theme 2.1: Innovation in Desalination Brine Concentration and Mining**

*Session 2.1.1 – Advanced Technologies for Membrane Brine Concentration*

- **Chairman:** Prof. Mohammed Albeirutty, King Abdulaziz University
- **Co-Chairman:** Eng. Nikolay Voutchkov, DTRI/SWCC

09:00-09:30  Challenges and Advancements for Ultra High Brine Recovery

*Author and Presenter: Dr. Craig Bartels, Hydranautics, USA*

09:30-10:00  High Performance RO Membranes and Membrane System for High Concentration Seawater Desalination

*Author and Presenter: Mr. Hussein Almughrabi, Toray Membrane Middle East, KSA*

10:00-10:30  Dual Pretreatment-Concentration Hybrid Process of Salty Water Feed of Desalination Plants

*Author and Presenter: Dr. Aiman Al-Rawajfeh, Tafila Technical University, Jordan*

10:30-11:00  Coffee Break
Session 2.1.2 – Brine Concentration and Treatment - Challenges and Solutions

- **Chairman:** Mr. Hussein Almughrabi, Toray Membrane Middle East
- **Co-Chair:** Prof. Sangho Lee, Kookmin University

11:00-11:30  Carbon Footprint of Various Brine Concentrators In Zero Liquid Discharge Process  
**Author and Presenter:** Eng. Youngwook Yoo, SWCC, KSA

11:30-12:00  High Recovery Reverse Osmosis Water Systems  
**Author and Presenter:** Mr. Rory Weaver, FEDCO, USA

12:00-13:00  Lunch Break

Afternoon Session

**Theme 2.2: Innovation in Brine Concentration and Mining**

Session 2.2.1 – Integrated Brine Concentration and Mining

- **Chairman:** Prof. Enrico Drioli, ITM-CNR
- **Co-Chair:** Dr. Seungwon Ihm, Saline Water Conversion Corporation

13:00-13:30  Brine Utilization from Seawater Desalination: An Integrated Concept for the Recovery of Valuable Minerals From Seawater  
**Author and Presenter:** Mr. Sherif Elsayed, K-UTEC AG Salt Technologies, Germany

13:30-14:00  On the Gaps and Needs to Achieve Ultra-High Pressure Reverse Osmosis Desalination  
**Author and Presenter:** Dr. Arian Edalat, Pacifica Water Solutions, USA

14:00-14:30  Coffee Break

14:30-15:00  Workhorse Membrane Technologies For Ocean Brine Mining  
**Author and Presenter:** Dr. Neil Moe, SUEZ, France

15:00-15:30  SEArcularMINE: Feasibility study of the Integration of a Desalination Plant Upstream of Saltworks  
**Authors:** Eng. Daniel Baaklini, A. Hannachi, D. Pastorelli, F. Vicari, R. Cucchiarra, SUEZ, France  
**Presenter:** Eng. Daniel Baaklini, SUEZ, France
Session 2.2.2 – Case Studies for Membrane Brine Concentration

15:30-16:00  Long-Term Operating Results of an Osmotically Assisted Reverse Osmosis Brine Concentration System Integrated with a Seawater Reverse Osmosis Desalination Plant
   Author and Presenter: Mr. John Tracy, Fluid Technology Solutions (FTS), USA

16:00-16:30  Development of Membrane for Concentrating Brines – Innovative Solution for Valuable Mineral Recovery
   Author and Presenter: Mr. Takahito Nakao, Toyobo, Japan

16:30-17:00  Energy and Exergy Analysis of the NF-RO-BC System
   Author and Presenter: Dr. Seungwon Ihm, SWCC, KSA

17:00-17:30  Strategy to Resolve Operational Challenges of Nanofiltration Plants in Seawater Brine Valorization
   Author: Mr. Pablo Cañada Garcia, Dr. Neil Moe, Mr. Manel Soria Tendillo, SUEZ WTS, Italy
   Presenter: Mr. Pablo Cañada Garcia, SUEZ WTS, Italy

19:30-22:00  Gala Dinner and Awards Ceremony – Le Meridian Hotel, Al Khobar

Day 3 Wednesday, March 23rd

Morning Session

Theme 3.1: Brine Mining for Minerals and Metals

Session 3.1.1 – Advanced Technologies for Mining of Brine for Rare Metals

- Chairman: Mr. Miguel Sanz, Director of Strategic Development, Suez, France
- Co-Chair: Mr. Fayyaz Mubeen, President, PakDA, Pakistan

08:00-08:30  Characterization, Thermal Properties, Removal of Metal Cations and Metal Electrodeposition
   Author: Prof Abir Abdel-Naby and Dr. Jwaher Al-Ghamdi, Imam Abdulrahman Bin Faisal University, KSA
   Presenter: Prof Abir Abdel-Naby, Imam Abdulrahman Bin Faisal University, KSA
08:30-9:00  Commissioning and start-up of the Shoaiba NF Desalination Plant for Product Water Quality Enhancement with Magnesium  
Authors: Mr. Juan Ramon Ruiz, Mr. Roberto Leon, Mr. Jose Manuel Sánchez, Mr. Javier López, WETICO, KSA  
Presenter: Mr. Javier López, Engineering Director, WETICO, KSA

09:00-9:30  Oceans as Open Sky Mines for Minerals and Water Extraction via Advanced Integrated Membrane Systems  
Author and Presenter: Prof. Enrico Drioli, ITM-CNR, Italy

9:30-10:00  Future Mining of Valuable Metals and Minerals from Brine for Microelectronics, Pharmaceutical and Chemical Industries  
Author and Presenter: Mr. Shahram Shafie, EFD Corporation, USA

10:00-10:30  Coffee Break

Session 3.1.2 – Mining of Brine for Mineral Salts

10:30 -11:00  Economics of Brine Mining for Sodium Chloride  
Author and Presenter: Dr. Basel Abusharkh, SWCC, KSA

11:00-11:30  Challenges and Opportunities for Brine Recovery in Seawater Desalination Plants  
Author and Presenter: Dr. Naiara Hernandez Ibanez, Aqualia, Spain

11:30–13:00  Lunch Break

Afternoon Session

Theme 3.2. – The Future of Brine Mining

- **Chairman:** Dr. Ahmed Al Amoudi, Director General, DTRI of SWCC  
- **Co-Chair:** Mr. Devesh Sharma, IDA First Vice President, Managing Director of Aquatech International

13:00-13:30  Full Recovery Desalination for Sustainable Materials Production: Water and Minerals for the Future  
Author and Presenter: Mr. Paul Wallace, Enviro Water Minerals, USA
13:30-14:00  Valorization of Seawater Concentrate  
Author and Presenter: Dr. Christopher Fellows, SWCC, KSA

14:30-15:00  Research and Development of Brine Mining in Pakistan  
Author and Presenter: Mr. Fayyaz Mubeen, President, PakDA, Pakistan

15:00-15:30  Closing Ceremony

15:30 - 19:30  Visit to Brine Concentration Pilot Plant in Jubail (transport time approx. 1 hour and 30 minutes each way)

**Day 4 Thursday, March 24th**

08:00  Visit to Ras Al Khair SWRO Plant (transport time approx. 2 hours and 30 minutes each way)
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