EDS Webinar, April 29. 2021
16:00 – 18:00 CET / 15:00 – 17:00 GMT / 10:00 – 12:00 EST

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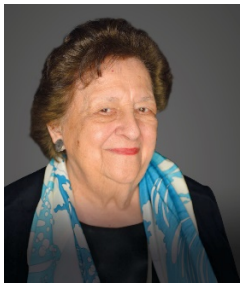
Brines: From Waste to Value
EU Horizon 2020 & European Commission Projects

Abstracts / Program → Detailed abstracts see page 2-4

Speakers & Panelists	Topic
Ursula Annunziata EDS	EDS President Welcome Message to Speakers and Attendees
Miriam Balaban	Webinar introduction Call for brine samples Introduce speakers
Prof. Heike Glade University of Bremen	Leads Q&A between speakers and attendees
Sandra Casas Project Manager of Sea4Value Eurecat	Introduction Sea4Value Horizon 2020 EU Project
Q&A	
Prof. Enrico Drioli, University of Calabria	New Mining: The Sea
Dr. Corrado Sommariva SWPC	New Technologies for Brine Concentration and Energy Efficiency in SWRO
Q&A	
Dr. Ahmed Al Amoudi, Vice President, DTRI Saudi Arabia	Introduce Saudi Arabian brine mining project
Dr. Christopher Michael Fellows Senior Water Expert, DTRI	SWCC Initiatives in Brine Mining
Andrea Cipollina, Victor Monsalvo, Dimitris Xevgenos	SEArcularMINE – Horizon 2020 EU Project REWAISE – Horizon 2020 EU Project WATER MINING - European Commission & TU Delft
Q&A	
Miriam Balaban	Call for brines and wrap up



Miriam Balaban

Webinar introduction - Call for brine samples - Introducing speakers

Miriam, a graduate in chemistry from the University of Pennsylvania, pursued a career in science editing and was President of the International Federation of Science Editors and has been Dean and Professor of a School for Scientific Communication at the Mario Negri Institute in Italy. She is presently based at the University Campus Bio-Medico of Rome and is a Research Associate in the Department of Mechanical Engineering at MIT.

She founded the journal "Desalination" and was Editor in Chief from 1966 to 2009. She then
founded the journal "Desalination and Water Treatment" in 2009 and continues as Editor in Chief today. She founded the Desalination Directory in 1980 which is reference to over 30,000 individuals and organizations and lists events and other information. She has been Secretary-General of the European Desalination Society since its founding in 1993 and has received awards from the President of Italy and several organizations: the International Desalination Association (IDA), the European Desalination Society (EDS), the European Membrane Society, the International Water Association (IWA), and the Desalination Associations of China and Korea.

Emeritus Professor at the School of Engineering of the University of Calabria. Founding Director of the Institute on Membrane Technology, CNR, Italy. Since 2018 Distinguished Visiting Professor at Nanjing Tech University, College of Chemical Engineering. Since 2018 Guest Professor of School of Marine Science and Technology of Harbin Institute of Technology, Weihai, P.R.China. Since 2012 Distinguished Adjunct Professor, CEDT King Abdulaziz University, Jeddah Saudi Arabia; 2010-2020 WCU Distinguish Visiting Professor, at the Hanyang University, Seoul Korea

Prof. Enrico Drioli

A new mining: the Sea

Institute on membrane Technology, National Research Council of Italy, CNR-ITM, via P. Bucci cubo 17/C, 87036, Rende (CS) Italy – University of Calabria, Department of Environmental and Chemical Engineering, Via Pietro Bucci cubo 44A, 87036 Rende, CS, Italy – State Key Laboratory of Materials-Oriented Chemical Engineering, College of Chemical Engineering, Nanjing Tech University, Nanjing 210009, China – Center of Excellence in Desalination Technology, King Abdulaziz University, Jeddah, Saudi Arabia

Intelligent integrations of membrane operations in desalination can increase water recovery factors from around 50 %, today realized with reverse osmosis (RO), to above 90 % by utilizing membrane desalination systems with membrane distillation (MD) and/or membrane crystallization (MCr) units for the exploitation of the RO brine. Integrated membrane-based desalination processes will not only increase water production but also give the possibility to recover high quantities and qualities of minerals from RO brine, thus reducing brine disposal problems and minimize the costs associated to desalination. Due to the numerous ions contained in ocean and sea-waters, several studies are in progress to analyse the possibility to recover valuable components.

In the presentation, the possibility to utilize seawater and brackish waters not only as a source of fresh water but also for the production of metals of interest will be illustrated. An analysis on the amount and quality of possible recoverable ions from the current seawater desalination plants will been carried out.

The large amount of brine produced all round the world by large scale RO operations might be an interesting resource of minerals, in some cases alternative to the traditional mines. Moreover, the high quality of the crystals obtained through MCr and the possibility to produce specific polymorphs might create a competitive new production system for various metals present in the desalination brines.

Relevant bibliography
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Corrado Sommariva is a consultant of International reputation in the field of desalination, power generation waste water and sustainability. He has over 35 years of international experience and has covered several executive positions in Consultancy firms for the last 20 years. Corrado Sommariva has served the President of International Desalination Association (2011-2013), President of the European Desalination Society (2004-2006), Chairman of WHO committee for safe water use from desalination. Dr Sommariva has published more than 100 leading edge papers and four books on desalination and sustainability. Dr Sommariva has a honorary doctorate from Heriot Watt University for his contribution to the development of desalination. In 2015 he was honored by the President of Italy with the title of Master of work .

Dr. Corrado Sommariva [1],

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New technology for brine concentration and energy efficiency in SWRO

The higher the concentration of the brine the closer the same is to the saturation point and to mineral stage. The increase in the salinity of the brine is generally achieved in concentrators against a substantial increase in energy whereas in the present paper a remarkable increase in brine concentration compared to the state of the art is achieved as part of the Reverse

Osmosis process and by saving electricity which paves the way to the further stage of crystallization.

The concentration of discharge brine from reverse osmosis facilitates the further stage of crystallization and the associated production of metals of interest so giving with brines a potential value for sustainable mining.

The Reverse Osmosis process consists of two passes: a first pass with a typical seawater recovery that is not less than 40%, and a second pass with a recovery that is typically around 90%- 95%. In the majority of the RO plants, the permeate of the first pass has a TDS (total Dissolved solids) level lower than 500 mg/l, therefore it is fed to a second pass of RO to reduce the TDS level below 20 mg/l.

The objective of the second pass therefore is to achieve the desired salinity values in the final RO product. Generally, the second pass is in turn consisting of a two-stage membrane system. The reject of the second stage membrane has a residual pressure ranging between 8 to 10 bars and the conductivity ranging between 8,000 and 10,000 ppm.

In state of the art SWRO process, the reject of the second pass is conveyed to the feed of the first pass and dilute it decreasing the osmotic pressure. While on one hand this dilution is beneficial, this mixing presents some significant energy dissipation related to both residual pressure, and gradient salinity waste.

The objective of this paper is to investigate and quantify the energy savings that can be achieved by recovering the energy potential related to the residual pressure of the second pass reject and of the salinity gradient offered by this stream and the other streams in the RO process.

Aandra Casas --
Project Manager of Sea4Value (Eurecat)

Chemical Engineer (UPC, 2006) and PhD Chemical Engineer (Environmental Engineering) (UPC, 2011). Since 2018, she collaborates with the Fundació EURECAT in the area of Environmental Sustainability. Her topics of interest cover water treatment technologies using both conventional and advanced systems, especially those involving membranes or electrochemical processes. She has experience in the optimization of tertiary systems for reclamation and reuse of water as well as in zero liquid discharge systems (ZLD). She has participated in more than 30 R&D projects both publicly and privately funded, she has conducted more than 10 Scientific-Technical publications and has contributed to several international conference.

Dr Fellows - DTRI/SWCC

Received his PhD in physical chemistry in 1999 and worked at the University of Sydney and the University of New England (Australia) before joining the DTRI in 2019. His chief interests are in scale control, polymerization mechanisms, and the very broad topic of fundamental thermodynamics and kinetics of chemical processes of relevance to industry. Within the DTRI, his work encompasses the development and testing of novel antiscalants based on the 'edge-activity' mechanism, development of novel processes for remineralization, development of evaporation-control systems, and modelling processes for extracting valuable components from desalination brine – 'brine mining'. Dr Fellows has authored over 100 peer-reviewed journal articles and book chapters. He is currently an adjunct associate professor at the University of New England, Australia, a member of the IUPAC Polymer Division, and chair of the IUPAC Subcommittee on Polymer Education.

Saline Water Conversion Corporation (SWCC) Initiatives in Brine Mining

The Saline Water Conversion Corporation (SWCC) in the Kingdom of Saudi Arabia is the world's largest desalination organization, producing upwards of 5 million m^3 of desalinated water daily from a network of 30 desalination plants. The same energy inputs that separate fresh water concentrate the remaining dissolved solids, taking the brine produced a significant energetic distance along the ancient path of producing salt from seawater. At present no use is made of this 'value-added' seawater. However, a project in development will see 2 million tons per annum of sodium chloride and thousands of tons of bromine produced in the first phase, with the aim to produce other commercial products from SWCC brine in later phases. SWCC initiatives are mindful of the commercial and physicochemical limitations of brine mining and are directed towards our primary goal: reducing the cost of water to users.

The presentation will discuss SWCC initiatives in brine mining both in the short-term and looking ahead to the longer-term. Crucial to the SWCC initiatives is the use of Nanofiltration (NF). By reducing the concentration of divalent ions in the brine, NF removes scale-forming ions to allow operation of low-energy membrane brine concentrators to a high solids content. The reduced concentration of these ions also reduces the cost and complexity of processes required to produce high-purity salt suitable for the chlor-alkali industry. The bitterns remaining after sodium chloride crystallization is a rich source of bromine. Potentially, these bitterns will also serve as a source of potassium fertilizer and more exotic salts of monovalent cations in the future. The NF reject stream is also of great interest for future phases of brine mining: historically, magnesium has been produced by treatment of seawater, and this reject stream has a vastly higher concentration of magnesium than seawater.