



Desalination Research and Innovation pulse

Quarterly Newsletter of DTRI, Q-1, 2023

Introduction

Dear Readers,

Welcome to the first issue of The Desalination Research and Innovation Pulse (DRIP), a quarterly Newsletter of SWCC-DTRI. We are very excited To launch this newsletter which will inform and inspire you on a quarterly basis with both, technical and nontechnical activities and achievements of our organization.

We have given a lot of thought as to whether a newsletter would be of interest to so many of you with whom we have the pleasure and honour of working. While thinking on this issue we realized that we have a unique blend of knowledge and experiences, which could bring more values to our research efforts, if shared with each other. And to achieve this goal,newsletter could be an appropriate initiative.

We are sincerely thankful to our management for their encouragements and supervisions, and all our colleagues who have shared their personal, collective and technical information/achievements, during the compilation of this newsletter

Your valuable opinion, comments and suggestions to make this newsletter better and more meaningful will always be appreciated.

Best Regards,

The DRIP Team Members

VISION

To be the world's leading institute in research and innovation in the water industry and environmental solutions.

MISSION

To Leading innovation in desalination technology for efficient and financially efficient water production and sustainable environmental development for everyone everywhere.

To drive world-class research, technological development and innovation activities to deliver advanced water solutions stemming from innovative water technological industry and business development approaches, to contribute to long-term water security (through advanced water services delivery).

DTRI Statistics

DTRI IN NUMBERS



TROUBLE SHOOTING
PROJECTS

402



PAPERS PRESENTED
IN CONFERENCES

280



APPLIED
RESEARCH

174



PUBLISHED
PAPERS

160



EVALUATION
PROJECTS

110



PATENTS GRANTED
AND FILED

21

Research Achievements

HYBRID PIPES FOR RO WATER TRANSMISSION LINES – AN INNOVATIVE APPROACH

Nausha Asrar, Ali Al-Sahari, Ghulam Mustafa,
Mohammed Al-Hazmi, Fatma AlRadhi,
and Abdulrahman AlAnezi

Objective

Replace expensive Duplex stainless steel pipes with low-cost high corrosion resistant carbon steel pipe internally lined with specially designed polymer material.

Achievements

Pilot plant test, in RO-2 unit of the DTRI pilot plant, is in progress at 70 Bar pressure. A carbon steel elbow has been lined with ETFE 2195. On Jan 17th 2023, this ETFE/CS elbow was installed.



REHABILITATION AND CAPACITY AUGMENTATION OF THE YANBU SWRO DESALINATION PLANT

Ghulam Mustafa, Nausha Asrar
and Eng. Eslam Alwaznani

Objective

Improvement in plant recovery and reliability to operate the plant smoothly for the next 30 years.

Achievements

The RO plant of Yanbu facing considerable corrosion and material degradation problems. Due to issue with the energy recovery devices, the desalination process is consuming high specific energy for permeate water production. Replacement of the old HFF RO membrane with the new spiral wound RO membrane and complete plant rehabilitation will enhance the potablewater production from 80 MLD up to 128 MLD and operating life of the plant for the next 30 years.

SWRO BRINE CONCENTRATION WITH LOW PRESSURE NF MEMBRANES

Sheng LI, Prof. Sangho Lee,
Ghulam Mustafa and Eslam Alwaznani

Objective

For downstream crystallization, raise the SWRO brine concentration from 80,000 ppm (ideally up to 180,000 ppm) with NF membranes working at 40 bars.

Achievements

The combination of of Different NF membrane model could concentrate the SWRO brine from 78 g/L to about 125 g/L at 22 Bars in a 3-stage configuration. Based on our experimental data,the combination of another two NF membranes might further enhance the brine concentration performance. The new NF membrane combination is being evaluated in the developed simulation model (as shown in below picture).



(1)Figure: Research methodology for SWRO brine concentration process using NF.

MEMBRANE BIOFOULING CONTROL WITH ANTI-MICROBIAL PEPTIDES

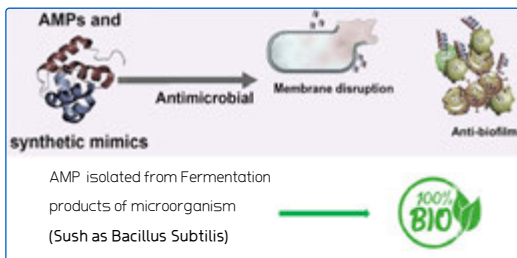
Sheng LI, Mohammed Al Namazi
and Layan Al Kharboush

Objective

Evaluation of effectiveness of naturally produced anti-microbial peptide (AMP) on control of membrane biofouling.

Achievements

Experiments conducted on both, low pressure Forward Osmosis (FO) and high pressure Nanofiltration (NF) system have indicated that AMP could reduce more than 50% flux decline in FO caused by the biofilm formation of spiked marine yeast (Fungus) and around 20% flux decline in NF caused by the biofilm formation of spiked marine yeast (Fungus).



(1)Figure: Mechanism of AMP on biofouling control.

CAPTURED CO₂ UTILIZATION VIA MICRO-ALGAE CULTIVATION

Troy Green, Sheng LI, Youngwok Yoo
and Layan Al Kharboush

Objective

Cultivate microalgae in SWRO brine for CO₂ utilization and explore the downstream product possibilities.

Achievements

One microalgae specie, *D. Salina*, has been identified for cultivation. The *D. Salina* has been successfully grow in an extremely high salinity (236 mS/cm), and producing β -carotene (Below picture left) By reducing the cultivation salinity to similar as SWRO brine (130 mS/cm), the *D. Salina* also grow well and produce more lipid content, which can be potentially utilized for food supplemental.



D. Salina producing OMEGA 3, DHA and EPA, pharmaceutical, cosmetic and biofuel production (Below picture middle and right).

PILOT UNIT OF VACUUM CRYSTALLIZATION TO PRODUCE HIGH PURITY NaCl

Ammar Alnumani, Seungwon Ihm
and Christopher Michael Fellows

Objective

Investigation of reliability and effectiveness of thermal crystallizer in producing high purity (99.6%) NaCl salt and study the remaining bittern as a source of Br and Li and few more elements.

Achievements

A Pilot Plant is delivered and installed in DTRI, Jubail. After commissioning in March, various operational modes of the pilot Crystallizer will be conducted to study the quality of NaCl crystal salt. The Mg content will be one of key parameters in the study. The performances of NF ion rejection, OARO concentration, and clarifier will be carefully studied in connection to the final NaCl salt quality.



CARBON CAPTURE SYSTEM AND UTILIZATION OF CAPTURED CO₂ IN SWRO POST-TREATMENT SYSTEM

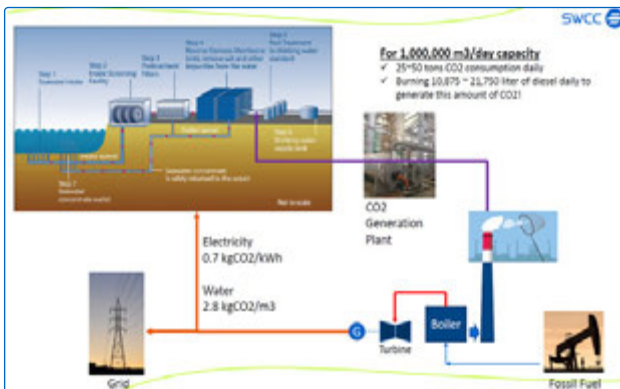
Youngwook Yoo, Christopher Michael Fellows,
Troy Green, Sheng Li, Ahmed Al Ghamdi and Amro Mahmoud

Objective

Capturing CO₂ from Ras Al Khair Plant with high efficiency and lower energy consumption carbon capture technology and the utilize captured CO₂ in SWRO post-treatment system.

Achievements

On 20th Feb, 2023, MoU has been signed with CARBONCO. DTRI is intending to install carbon capture system in one of the power plant of Ras Al Khair. This will be a high efficiency, Low energy footprint, amine absorbent system which has the potential to be commercialized in near future.



CORROSION AND CRACKING OF SUPER DUPLEX STAINLESS STEEL PIPELINES AT ALKHOBAR PLANT

Nausha Asrar, Ali AlSahari,
Abdulrahman AlAnezi and Fatma AlRadhi

Objective

Investigation of cause of corrosion of the super duplex stainless steel (SDSS) pipes and cracking of the weld joint. Recommendations on remedial measures.

Achievements

Tee piping system of Al-Khobar Plant , AK-4, R0-I cracked and SDSS pipelines started pitting corrosion in less than two years. SWCC-DTRI identified defective weld material, welding procedure and use of poor quality of the super duplex stainless steel (SDSS) as the cause of this major failure. DTRI suggested AK-4 plant management to conduct Risk Based Investigation (RBI) of all the pipes and weld joints to asses their expected life and take necessary actions to improve the weld quality and protect the external surface of the SDSS pipes from pitting problem.



(1) Cracking of the Tee-joint weld
(2) Pitting of entire external surfaces of SDSS pipes

FAILURE ANALYSIS OF ECONOMIZER TUBES OF HEAT RECOVERY STEAM GENERATOR (HRSG)-51 IN RAS ALKHAIR PLANT

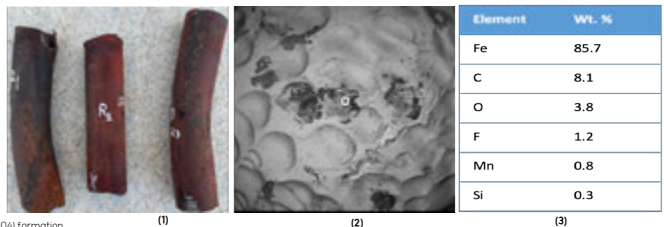
Nausha Asrar, Ali AlSahari, Fatma AlRadhi
and Abdulrahman AlAnezi

Objective

Investigation of cause of thinning and cracking of the economizer tubes and suggest remedial measures.

Achievements

This failure investigation of economizer tubes of heat recovery steam generator HRSG -51 is further to earlier two comprehensive failure investigations (Ref.: Technical reports on HRSG 52, CPCi-3814-22-05 & CPCi-3814-22-06). Investigation of third failure determined that Flow Accelerated Corrosion (FAC) occurred at the internal surfaces of the economizer tubes. A comprehensive recommendations to achieve effective chemical treatment has been suggested to RAK plant through an official letter No. 10507 from DTRI.



(1) Economizer tubes cracked due to thinning of the wall.

(2) Pitting on the internal wall of the tubes due to FAC.

(3) Chemical analysis confirms absence of magnetite (Fe₃O₄) formation.

Intellectual Property



INTELLECTUAL PROPERTY

Method and system for extraction of minerals based on monovalent cations from brine

System for water sample extraction

Bromate level control in desalinated water

Salt gradient harvesting energy using multi stage switching pressure retard osmosis system and method

Systems and methods for simulation of desalination brine concentration processes

Method for removing air from sponge balls before loading into system for heat exchanger cleaning

Knowledge sharing

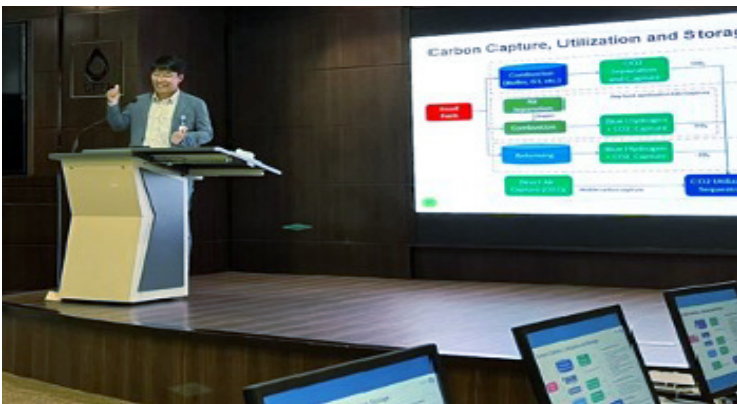
NET-CARBON ZERO TARGET OF KSA -PROJECTION AND THE WAY FORWARD

● Speaker: Eng.Youngwook Yoo

Abstract

SWCC-DTRI is considering CO2 capture from one of our thermal power plant and for the production of high purity vaterite calcium carbonate.

● For more information, scan the QR below:



SIGNIFICANT FIGURES AND ERROR CALCULATIONS

● Speaker: Dr.Christopher Fellows

Abstract

Speaker discussed the levels of precision and accuracy are physically realistic with the parameters we commonly measure in the desalination industry, and how we should reflect this when we report those numbers. Explained about how to estimate error in a measurement, and how to propagate errors through a calculation.

● For more information, scan the QR below:



SWEET, SOUR AND OXYGEN CORROSION IN INDUSTRIES

● Speaker: Dr. Nausha Asrar

Abstract

Speaker presented the basic concepts, field-base cases of corrosion related failures, key parameters of sweet (CO_2), sour (wet H_2S) and oxygen corrosion and behavior of few corrosion resistant alloys (CRAs). This may help engineers and researchers in appropriate selection of the materials and finding remedial measures.

● For more information, scan the QR below:

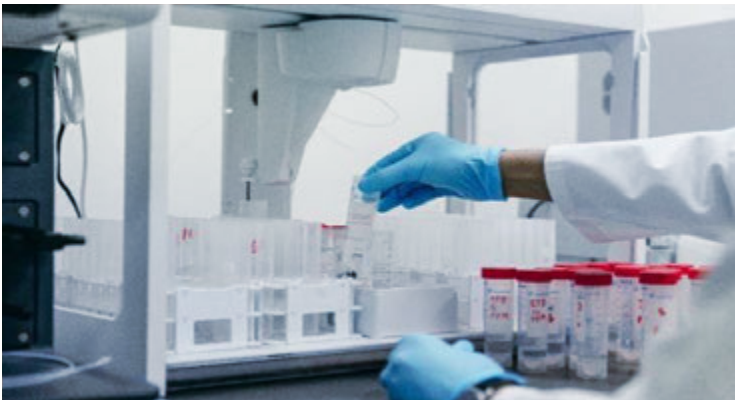
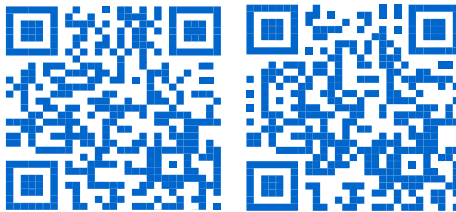


Published Papers

Water Treatment and Reuse

Two papers have been published in the journal "Membranes" on water treatment and reuse. One paper compares different techniques for removing hydroxide from water treated with semiconductor materials. The other paper explores improving ion removal for water reuse in power and water dual-purpose plants using chemical washing.

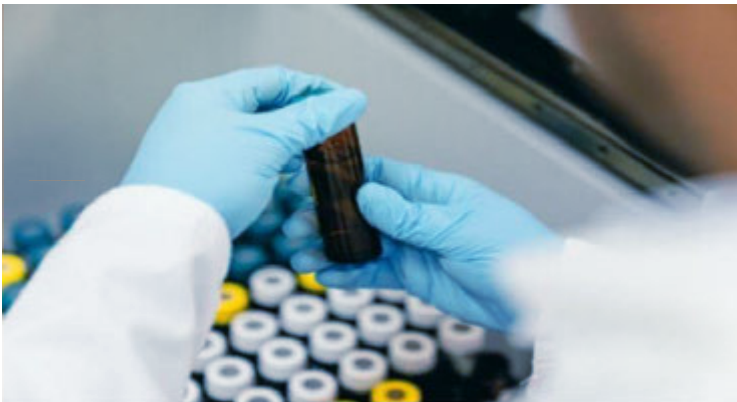
● For more information, scan the QR below:



Biofouling in Seawater Desalination

Comparative study on bacterial and algal biofouling in the primary treatment stage of seawater desalination and the impact of using ultrafiltration (UF) membranes for its removal has been published in the scientific journal "Membranes". .

● For more information, scan the QR below:



Adding Magnesium in Drinking Water

A study conducted by SWCC in collaboration with Imam Abdulrahman Bin Faisal University has revealed that the addition of Magnesium to drinking water can help the diabolic patients to achieve better blood glucose level control.

● For more information, scan the QR below:



DTRI Activities

INNOVATIVE PROJECTS FOR SUSTAINABLE WATER SUPPLY

His Excellency Engineer Abdullah Al-Abdulkareem, The Governor of the Saline Water Conversion Corporation, visited in the Desalination Technologies Research & Innovation Institute to see the innovative projects and initiatives during his visit to the Eastern Province. The institute aims to enhance water supply security, preserve the environment, and utilize brine for minerals extraction in line with Saudi Arabia's 2030 vision. The experts of DTRI presented experiments on low-pressure nanomembranes and solar energy in desalination processes, seeking sustainable and environmentally friendly water solutions with high efficiency.



THE WATER RESEARCH COMMUNITY MEETING AT AL-KHOBAR



The Desalination Technologies Research Institute (DTRI) successfully organized the first Water Research Community Meeting at Al-Khobar. More than 200 researchers and experts from different universities and research institutes attended the meeting. The focus of the meeting was to discuss and understand the current research trends related to the water and desalination industry. More than 60 research proposals were presented during the event in addition to 5 different panel discussions.

DTRI – SWCC AND KAUST SINED THREE NEW COLLABORATION AGREEMENTS



The Desalination Technologies Research Institute (DTRI), the Saline Water Conversion Corporation (SWCC) research arm, has signed three new research agreements with King Abdullah University of Science and Technology (KAUST) focusing on: developing advanced porous materials for desalination applications; developing new nanofiltration membranes for the separation of Magnesium and Sodium from seawater brine; in addition to developing novel membrane processes for brine mining.



DTRI - SWCC SIGNED A COOPERATION AGREEMENT WITH THE SOUTH KOREAN GOVERNMENT-SUPPORTED TAEKYUNG GROUB

The Desalination Technologies Research Institute (DTRI) has signed a cooperation agreement with the South Korean government-supported Taekyung Group, to assess the production of vaterite calcium carbonate using brine from desalination plants. This project is expected to reduce the cost of desalination through generating additional value and will help achieve the organization goal of reaching zero liquid discharge.



MEMORANDUM OF UNDERSTANDING WITH GLOBAL INDUSTRY LEADERS

EVOLVE 2023 Forum was organized to explore collaboration in the areas of manufacturing, desalination and water services. During this event Engineer Tariq Alghaffari, The Executive Director of DTRI, signed Memorandum of Understanding with the following companies:



(H2O)
CEO, MR. Ammar Al-Ali



(EVOLVE)
CEO, Dr. Chris Wyres



(CARBONCO)
CEO, MR. Jay Hyung Yoo

DTRI SIGNS DIFFERENT MEMORANDUM OF UNDERSTANDING AND RESEARCH AGREEMENTS WITH SAUDI UNIVERSITIES

The Executive Director of DTRI, Eng. Tariq Alghaffari, signed MOU and research agreements during the EVOLVE 2023 Forum with Umm Al-Qura and Tabuk University. The MOU and the research agreements aims to collaborate in providing technical, research, and consulting services, as well as sharing knowledge and expertise between the Institute and the University in the field of desalination.



DELEGATES FROM THE INDIAN RSPL VISITED DTRI



13



High level delegates from the Indian chemicals company RSPL visited the Desalination Technologies Research Institute (DTRI), the Saline Water Conversion Corporation (SWCC) research arm, to discuss possible future collaboration in the areas of brine mining. The research team of DTRI explained to the delegates about the advancement in brine mining technologies achieved by DTRI.

DTRI – SWCC DELEGATES VISITED KING ABDULAZIZ UNIVERSITY (KAU)

Delegates from SWCC including the Desalination Technologies Research Institute (DTRI) director, visited King Abdulaziz University (KAU) to discuss the possible research and development collaborations in the area of desalination technologies. The DTRI director explained during the visit that the institute, which is the research arm of the SWCC, is always open for collaborations with universities and research institutes.



DTRI PLANTED 120 MANGROVE TRESS

A team from DTRI has planted 120 Mangrove trees at Ras Alkhair desalination plant as part of the Saudi's Green Initiative and to support the SWCC efforts to enhance the biodiversity and reduce carbon dioxide emissions.



DTRI DELEGATES VISITED DIFFERENT UNIVERSITIES AND INSTITUTES IN THE UK

Delegates from the Desalination Technologies Research Institute (DTRI) Visited the following universities and research institutes: The National Graphene Laboratory at the University of Manchester, The Henry Royce Institute (the UK's national institute for advanced materials research and innovation), The University of Oxford, The University of Nottingham, The University of Warwick. The aim of the visit was to explore possibilities of research collaboration with above organizations. An NDA was signed with Water Cycle (a company specialized in minerals extraction).



HIGH LEVEL DELEGATES FROM THE SAUDI MINISTRY OF DEFENSE VISITED THE DTRI

High-level delegates from the Saudi's Ministry of Defense visited The Desalination Technologies Research Institute (DTRI) to see Ongoing research project and visited the pilot facilities at the institute.



SWCC-DTRI PRESENTATIONS IN (AMPP) ANNUAL CONFERENCE AND EXHIBITION, DENVER, USA

I. Partisipation in Roundtable Meeting

Expert and Researchers from the Desalination Technologies Research Institute (DTRI) attended the AMPP Annual Conference and participated in the roundtable meeting of Global Society. Dr. Nausha Asrar and Engr. Ali AlSahari presented activities of SWCC in general and research activities of DTRI in particular.

Representatives of 22 companies and corrosion related organizations of 15 different countries of the world joined this meeting. Due to SWCC participation in this meeting, AMPP displayed a national flag of Saudi Arabia in the meeting room.



II. Technical paper presentation

Three papers based on research work of DTRI were presented. The conference was attended by more than 6000 experts and professionals from 60 different countries and it is considered one of the largest conferences specialized in the



area of corrosion. Eng. Ali Alsahary, the Research & Technical Consulting Section Manager at the DTRI, mentioned that the attendance and presentations at AMPP conference were part of the SWCC efforts to establish new global partnerships in the area of R&D.

III. Meeting with AMPP senior officials

Meeting was held with Elain Bowman, past president of NACE and Stuart Bond, European area manager, to implement the audit and corrosion management program (per the SWCC –NACE MOU) in one of the SWCC plant. Also, options were discussed to do work jointly on determination of corrosion cost of SWCC plants.



DTRI TEAM VISITED KING ABDULAZIZ UNIVERSITY

A research team of the Desalination Technologies Research Institute (DTRI) visited the Marine science college and Engineering college at King Abdulaziz University to discuss the new developments in the area of harmful algal bloom Modelling, and investigation.



ONGOING COLLABORATIVE PROJEECTS OF DTRI WITH KACST

A team of DTRI visited King Abdulaziz City for Science and Technology (KACST) to discuss the progress of a number of ongoing collaborative research projects including their pilot plant project at Rabigh. The pilot plant at Rabigh is the first hybrid plant that runs on renewable energy with a zero carbon emission.



KACST
مدينة الملك عبدالعزيز
للعلوم والتقنية

DTRI TEAM VISITED THE EGYPTIAN SALTS & MINERALS COMPANY (EMISAL)



Continuing the efforts in Brine Mining subject, Eng. Ammar has visited the Egyptian Salts & Minerals Company (EMISAL) to explore the industrial processes of salts extraction from Quaroun lake. The company has experience for 33 years in salts industry and Magnesium Sulfate, Sodium Chloride, and Sodium Sulfates are the main products of the company.

TOWARDS BUILDING A HYBRID RENEWABLE SOLAR ENERGY PLANT

Teams from DTRI and King Abdullah City for Atomic and Renewable Energy (KACARE) met to discuss the research proposal and plan to built a novel hybrid renewable concentrated solar energy plant. This project is considered part of the a number of collaborative research projects that aims to improve the operational efficiency, reduce the cost, and reduce the carbon footprint of the desalination processes.



DTRI TEAM'S VISIT TO THE SUBSEA WORKSHOP

The objective of the meeting was to showcase the FSubsea pumps, assess their performance, and engage in discussions about the subsea R0 pilot unit and BirdsEye system. The meeting encompassed a range of significant topics crucial for FSubsea and SWCC in attaining their respective objectives, such as installation operations, system control, and optimization.



DTRI RECEIVED ISO/IEC 17025 : 2017

DTRI received ISO/IEC 17025:2017 certification as a result of passing the inspection and meeting all the standard requirements. The certification is an acknowledgement of the high efficiency of the quality management system in the institute.



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