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Enrico Drioli, Alessandra Criscuoli and Francesca Macedonio

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An Integrated Approach (MEDINA)

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Introduction

Prof. Enrico Drioli and Dr. Eng. Francesca Macedonio

Membrane-Based Desalination: An Integrated Approach (acronym ***MEDINA***) was a project financed by the European Commission within the scope of its 6th Framework Program.

The project formally started on 15th October 2006 and ended on 14th January 2010.

The main aim of the project was to improve the overall performance of membrane-based water desalination processes by applying an innovative approach based on the integration of different membrane operations in the reverse osmosis (RO) pre-treatment and post-treatment stages accordingly to the philosophy of Process Intensification.

In order to achieve its aim, project Consortium collected 13 research teams of proven and complementary expertise in seawater and brackish water desalination (Table 1): 7 between universities and research centres from 4 Member States; two Australian, one Israeli and a Tunisian research centres; 2 industrial companies. In addition to the core research partners, MEDINA project included the participation of several desalination plants and utilities and, thereby, the research project team benefited from direct contact with full-scale plant experience. This real-world field of experience allowed the researchers to test, fine-tune and try to transfer directly their findings and applications directly to the practitioners.

Objective of MEDINA project was to address the technological issues and vacant questions that are not, or only partly, answered to date, in sight of improving and optimising membrane desalination as well as the integration of its technology into existing infrastructures and water management practices. The implementation of an integrated approach to the design of advanced membrane desalination systems represents an attractive opportunity because of the synergic effects that can be reached, the simplicity of these units, and the possibility of advanced levels of automation and remote control. In the pre-treatment steps, the integration of different tools (such as water quality characterisation, membrane cleaning strategies, selection of the most appropriate pre-treatment processes) leads to the minimisation of membrane replacement needs thereby reducing the operating costs. In the RO post-treatment stages, the presence of Membrane Contactors (MC) and/or Membrane Distillation (MD) and/or Membrane Crystallizer (MCr) and/or Wind Intensified Enhanced Evaporation (WAIV) working on the brine streams, offers the possibility to produce more fresh water thus increasing water recovery factor of current desalination plants, reducing brine disposal problem and approaching the concept of "*zero-liquid-discharge*", "*total raw materials utilization*" and "*low energy consumption*".

The performed research activities covered all the aspects related to membrane desalination: from the characterization of water sources to the development of appropriate pre-treatment methods; from the investigation of alternative designs and engineering approaches able to decrease the environmental impacts to the adoption of renewable energy sources for driving some unit operations; from the development of innovative post-treatment strategies to the optimization and integration of the different units.

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**CO = Coordinator; CR = Contractor.*

The project was subdivided in the following nine distinct work packages (WP), consisting of closely related activities:
WP1 – Water Quality Assessment Tools
WP2 – Evaluation and Comparison of Seawater and Brackish Water Pretreatment Processes
WP3 – Development of Tools for RO Fouling Characterization and Understanding
WP4 – Development of Cleaning Strategies for RO Membranes
WP5 – Process strategies for mitigation of impact of concentrates on the environment
WP6 – Innovative Technologies to Reduce Energy Consumption in Seawater Desalination Facilities
WP7 – Optimization and Modelling of Seawater and Brackish Water Reverse Osmosis Desalination Processes
WP8 – Integrated system configuration
WP9 – Environmental Impact Assessment and Life Cycle Analysis (LCA) of Membrane-Based Desalination Plants.
The most relevant results achieved in the thirty-nine months of the project will be described in the following chapters.

Chapter 1

Water quality assessment tools

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In this chapter, the most interesting results carried out in Work Package 1 of MEDINA project are summarized. The WP1 leader has been Prof. Gary L. Amy. The contributors of this WP have been as follows:

- UNESCO-IHE (Sergio G. Salinas Rodriguez, Maria D. Kennedy, Jan C. Schippers and Gary L. Amy);
- AR-VW (Sophie Rapenne, Pierre-Jean Remize, Caroline Barbe);
- LOB (C-L de O. Manes, N. J. West, P. Lebaron);
- KWR (Dick van der Kooij, Harm Veenendaal);
- IWW (Gabriela Schaule, Kathrin Petrowski, Stefan Huber);
- UNSW (Lee Nuang Sim, Yun Ye, Vicki Chen, Anthony G. Fane).

WP1 was structured into the following complementary Work Tasks:

- WT 1.1 Water Quality Characterisation Tools;
- WT 1.2 Development of Particulate/Colloidal Fouling Indicators;
- WT 1.3 Development of scaling indicators

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