In addition, the mathematical model for the DD process, developed and validated with experimental data previously obtained for HCl case [3], has been adapted and validated with experimental data obtained in this work.

Membrane behaviors to $H_2SO_4$ diffusion were compared with results obtained for HCl [3]. Opposite to the HCl case, $H_2SO_4$ diffusion permeability tends to decrease when increasing the solution concentration and the presence of copper reduces sulphuric acid recovery.

*Keywords*: Sulphuric acid recovery; Copper electroplating solutions, Diffusion dialysis

### Acknowledgments

This work has been funded by EU within the ReWaCEM project (Resource recovery from industrial waste water by cutting edge membrane technologies) – Horizon 2020 program, Grant Agreement no. 723729.

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## Modelling hybrid systems for seawater desalination: electromembrane processes (RED, ARED and ED) coupled with RO

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The need to reduce energy consumption in seawater reverse osmosis processes has pushed research towards the development of new hybrid systems in which, for example, other membrane processes can be used to pre-treat seawater. Electrodialysis and reverse electrodialysis can act as a dilution step before seawater enters the RO unit, thus leading to an important energy saving in RO. In this work, two coupled models are proposed for the RED-RO and ED-RO system. Each process model was validated before being used for a sensitivity analysis in which the effect of the integration on the cost saving in the overall process was assessed. The analysis was performed by changing (R)ED voltage and RO pressure and considering three different scenarios: a standard scenario, an optimist scenario with a lower membrane cost and a pessimistic scenario with a lower electricity cost and comparing the result with the a standalone RO process. Negative values of "*Cost Saving*" were found when an excessive dilution step was performed before the RO, while competitive scenarios were found by optimizing the dilution extent, especially for the RED-RO case.

*Keywords*: Reverse osmosis, Hybrid systems, Electromembrane processes, Coupled model, Cost saving

**Acknowledgements**

This work has been performed within the REvivED water (Low energy solutions for drinking water production by a REvival of ElectroDialysis systems) project, Horizon 2020 programme, Grant Agreement no. 685579, www.revivedwater.eu.

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# Problems associated with fluctuations in potable water quality — The Cyprus experience during the last 3 decades and the role of reverse osmosis desalination

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The scarcity of potable water in Cyprus has become a matter of national emergency during the past few decades. This has been the result of prolonged draught periods and the absence of a sustainable national policy regarding integrated management of water resources on the island. Traditionally, potable water reserves have been solely dependent on rainwater collected in reservoirs. However, dry climatic conditions, increased demand from the tourism industry, additional requirements imposed by a diverse range of agricultural and industrial activities as well as the ever increasing domestic sector demand, have rendered the available water reserves insufficient, both quantity and quality-wise. The combined pressure to improve on water quality and quantity has led to the adoption of desalination as the only sustainable means of safeguarding adequate water reserves on the island. Nowadays, the island enjoys the benefits of 4 fully operational seawater desalination plants with a total daily production capacity of approximately 220 $Km^3$.

Seawater desalination has been operational since 1997; however, total production is still not adequate to cover increasing demand and the Water Development Department (WDD) of the Ministry of Agriculture, Rural Development and the Environment, is striving to meet demand by combining desalinated water with other surface waters. In this context, the government has already announced restrictions to the allocation of water for irrigation purposes during 2018, in favour of avoiding cuts in potable water supplies.

This mixing of good quality desalinated waster with water from other sources, of seldom questionable quality, has been creating a series of problems associated with potable water quality and other numerous anomalies being observed in the distribution network, the most important of which are the following:

1. Organoleptic problems observed at consumers outlets (e.g. bad odour and unpleasant smells, colouration)
2. Elevated pollutant/micro-pollutant concentrations (e.g. nitrates, heavy metals, pesticides)
3. Excessive scale deposition interchangeable with corrosive tendency
4. Elevated THM's concentrations in potable water supplies.
5. Biofilm formation.