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Minimum Liquid Discharge desalination: a pilot study in Lampedusa island

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During the last decades, a rising interest has been focused on the recovery of valuable products from non-conventional sources, such as waste brine or seawater. Seawater can be exploited in order to recover fresh water and many other valuable products such as Mg and Ca compounds, sodium chloride, etc.

In the framework of the Horizon 2020 European project WATER MINING, a novel integrated demo plant has been designed, installed and operated, aiming at the production of fresh water, magnesium and chemicals, such as sodium hydroxide and hydrochloric acid. The demo plant integrates several units, namely: (i) NanoFiltration (NF), (ii) Multiple Feed Plug Flow Reactor (MF-PFR), (iii) Multi-Effect Distillation (MED), (iv) ElectroDialysis with Bipolar Membrane (EDBM) and (v) evaporative ponds. In the integrated process scheme, seawater is fed to the NF, producing a concentrated stream enriched in bivalent ions and a permeate stream containing monovalent ones, such as sodium and chlorides. The concentrate stream is fed to the MF-PFR crystallizer, selectively recovering magnesium, as magnesium hydroxide, and then calcium, in the form of hydroxide. The precipitation of both hydroxides occurs by adding an alkaline solution at 1M. The produced slurry is directed to a thickener in order to separate the solids from the liquid. After magnesium and calcium removal, the clarified solution is used to feed the EDBM unit, producing a de-salty solution, an alkaline solution and a hydrochloric acid solution exploiting electrical energy and special ion exchange membranes. The NF permeate, conversely, is fed into a MED unit producing almost distilled water and a highly concentrated sodium chloride brine, which is finally fed into the evaporative ponds to produce food-grade sodium chloride. Demonstrated key performance indicators of pilot scale installation, range from: a bivalent ions rejection of the NF higher than 90%; a purity of produced magnesium hydroxide up to 97-98%; alkaline and acidic solution produced at 1M; high-quality grade freshwater (conductivity below 20 $\mu\text{S}/\text{cm}$); and sodium chloride with a purity higher than 97%.

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