

Unlocking the desalination processes future roadmap

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Received 28 February 2022; Accepted 12 November 2022

ABSTRACT

Energy-water-environment nexus is very important to attain COP21 goal, maintaining environment temperature increase below 2°C, but unfortunately two third share of CO₂ emission has already been used and the remaining will be exhausted by 2050. A number of technological developments in power and desalination sectors improved their efficiencies to save energy and carbon emission but still they are operating far from their thermodynamic limits. The theoretical thermodynamics limit for seawater desalination at normal conditions is about 0.78 kWh/m³ depending on the initial salt contents. However, practical plants are operated at several folds higher than this limit due mainly to inherent losses in the processes that were incurred in removing dissolved salts. Technological advancement in thermally driven processes hybridization have set the new bench mark for lowest energy consumption that has boosted the water production trend of desalination industry. In this paper, we presented multi-effect desalination (MED) hybridization with pressure swing adsorption (PSAD) cycle to overcome lower brine temperature limitations to boost overall performance of the system. The synergetic effect from hybridization of MED-PSAD permits a higher overall operational range and inter-stage temperature differences, leading to a boost in water production up to 2–3 folds. We showed that the proposed hybrid cycle can achieve highest performance SUPR = 20% of thermodynamic limit: one of the highest performance reported in the literature up till now. These figures can be translated to less than US\$ 0.47/m³ – a lowest specific cost ever reported in the literature. The proposed cycle is not only tested at pilot scale, but also successfully commercialized into industry and received many international awards as one of the most efficient and sustainable desalination technology.

Keywords: Hybrid desalination; Energy efficiency; Desalination sustainability; Thermodynamic limit

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Presented at the 14th Gulf Water Conference: Water in the GCC... Towards Economic Efficiency and Financial Sustainability 13–15 February 2022, Riyadh, Saudi Arabia

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