CCD Series No-15: simple design batch SWRO-CCD units of high recovery and low energy without ERD for wide range flux operation of high cost-effectiveness

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ABSTRACT

Closed-circuit desalination (CCD) is a batch process of low energy without need for an energy recovery device (ERD), high recovery irrespective of the number of elements per module, and wide range flux independent of cross-flow and/or recovery, which can be made continuous by the engagement of a side conduit for brine replacement with fresh feed. Batch units for seawater desalination (SWRO-CCD) of the general NMe\(n\) design, where \(N\) stands for the number of modules and \(n\) for the number of elements per module, are low-cost systems since avoid the need for ERD and the valves means for the making such a process continuous. Such SWRO-CCD batch units, which pose for recharge between desalination steps, can supply 10 → 1,200 m\(^3\)/d low-cost seawater permeates sufficient for communities of 100 → 12,000 resident on the basis of 100 L/d/person and for much larger communities if supplied permeates used primarily for drinking and cooking applications. Batch SWRO-CCD units are ideal for small seashore communities with access to shallow beach wells in light of their low-energy consumption and great operational flexibility such as of low flux energy saving mode during night time of low demand with increased production as function of demand at higher flux and greater energy expense during daytime. The wide range flux performance capability of the referred batch units make them ideal for integration with renewable energy sources through solar panels and/or small wind turbines. The energy consumption and permeates quality (parenthesis) as function of flux for the referred units with ME3 (E = SWC6-MAX) modules’ designs for ocean seawater (35,000 ppm) operation of 50% recovery using pressurizing means of 85% efficiency are as follows: 1.79 kWh/m\(^3\) (595 ppm) at 13 Lmh; 1.97 kWh/m\(^3\) (388 ppm) at 20 Lmh; 2.12 kWh/m\(^3\) (309 ppm) at 25 Lmh; and 2.25 kWh/m\(^3\) (259 ppm) at 30 Lmh. The experimentally confirmed cited energy figures, even at high flux, manifest high-energy conversion efficiency unattainable by conventional SWRO techniques.

Keywords: CCD; SWRO; Batch SWRO desalination; Seawater desalination; High recovery; Low energy; High flux