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ABSTRACTS

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ELECTRODIALYSIS WATER TREATMENT METHOD FOR THE REMOVAL OF INORGANIC POLLUTANTS FROM GROUNDWATER

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Abstract: Enhancing water availability through reuse and desalination is becoming popular with the water stress due to the rapid population growth and scarcity of freshwater resources in the dry climatic areas of the world. Among pressure-driven treatment technologies, reverse osmosis is the prominent technology for water desalination. Creating distilled water, process removes most of the beneficial constituents present in water therefore not suitable for long-term consumption. Day by day, the application of electrochemical treatment technologies has attracted great attention, for their environmental acceptance, higher pollutant removal efficiency, and cost-effectiveness. The entire process is considered as “green” because of the high electron yield and the treatment without the addition of chemicals. Optimization of electrodialysis reversal (EDR) operating parameters is necessary to enhance its efficiency. Due to the complicating and conflicting nature of electrochemical phenomena, the process optimization is carried out with the help of statistical experimental design methodologies rather than using varying one variable at a time (OVAT). Therefore, in this study, EDR treatment process operating parameters; current density, and flow rate were optimized by central composite design - a statistical approach. For a given location (01; 8◦ 21′ 11.3″ N, 80◦ 30′ 07.9″ E; 470 mg/L TDS, 183 mg/L $CaCO_3$, 0.45 mg/L fluorides and pH 6.60) with 87% water recovery and 91% percent removal of constituents, the optimal removal efficiencies of hardness (75%) and fluoride (83%) were achieved at 19.23 kW h.m^{-3}. The developed model successfully validates the experimental data at another location (02; 8◦19′53.9" N, 80◦36′04.1" E; 380 mg/L TDS, 291 mg/L $CaCO_3$, 0.48 mg/L fluorides and pH 7.10). When water is checked at a different location in the same climatic zone and removes 93% hardness and 85% fluoride with 13.20 kW h m^{-3} energy consumption. Results of thirteen sample locations hardness and fluoride removal efficiency data with optimized conditions of 1.58 mA cm^{-2} current density and 20 mL min^{-1} flow rate, further imply the applicability of EDR as a decentralized water treatment facility. EDR can regulate water salinity by tuning the total dissolved solids in treated water. When the process is powered by renewable energy from solar or wind sources, EDR is more attractive to dry climatic zone in Sri Lanka.

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Keywords: Electrodialysis reversal; Fluoride; Hardness; Response surface methodology