Sustainable Recovery of Potable Water from Saline Waters

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PROBLEM AND RESEARCH OBJECTIVES

Due to increasing energy costs and declining energy sources, interest in the use of low grade heat sources and recovery of waste heat is growing. The goal of this study is to evaluate the feasibility of utilizing low grade heat to run a new desalination process. Traditional desalination processes such as reverse osmosis, electrodialysis, mechanical vapor compression, and multi-effect flash distillation require electrical energy derived from nonrenewable sources the cost of which has increased by 10 times over past 20 years. Recently, a new desalination process has been proposed by Al-Kharabsheh & Goswami (2004), which has the potential to run solely on low grade heat at around 50^{o}C. We propose a modification to that process, whereby it can be run round the clock using a thermal energy storage (TES) system. The TES system can be maintained at the desired temperature using waste heat from any available source. In this study, we evaluated the feasibility of utilizing the heat rejected by a solar-powered absorption refrigeration system (ARS) to provide the energy for the TES.

METHODOLOGY

An integrated process model has been developed using Extend® and EES® software to simulate the desalination- Absorption refrigeration system (ARS) process. Process parameters have been established to evaluate process performance and economical feasibility of the combined desalination/air conditioning system. Operating parameters have been identified. Design values of solar panels and TES volumes have been calculated for different desalination/air-conditioning rates.

PRINCIPAL FINDINGS

A variety of near-full scale experiments have been completed with different process configurations with (1) direct solar collector and (2) direct solar energy + photovoltaic (PV) panels. Using direct solar collectors, 4.9 L/day of desalinated water was produced using a collector area of 1 m^2. Using direct solar energy during daylight hours and photovoltaic energy during non-sunlight hours (with a 6 m^2 PV module) the production was 12 L/d. The specific energy requirements in the two cases were 4,157 kJ/kg 2,926 kJ/kg of desalinated water, respectively. The system was evaluated at various evaporation temperatures and brine withdrawal rates to calibrate and validate the process model developed during the first year. In addition, the feasibility of reclaiming potable quality water from the effluent of the Las Cruces Wastewater Treatment plant by the system was evaluated. The results of these studies showed that the quality of the product water exceeded the US Drinking Water Standards.