An optimal design approach of gas hydrate and reverse osmosis hybrid system for seawater desalination

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\textbf{ABSTRACT}

Gas hydrate (GH) desalination process is based on a liquid (salty water) to solid (GH) phase change coupled with a physical process to separate the GHs from the remaining salty water. However, GH process exhibits less than 90\% of salt rejection, so reverse osmosis (RO) process is needed to finally meet the desalinated product water quality. In order to increase the total recovery of the GH and RO hybrid system, the concentrate of the RO process should return to the feed stream of the GH process. In this work, RO simulation was carried out to find an optimal RO recovery with which the energy consumption of RO was minimized. The optimal RO recovery values for GH processes with salt rejection of 78, 84, and 90\% were 0.6, 0.8, and 0.8, respectively. The minimal total energy consumption appears at higher RO recovery rates than the optimal values to minimize the RO energy consumption because the portion of the GH energy consumption is inversely proportional to the RO recovery. The simulation also reveals that the maximum allowable energy consumption of GH process is 1.4 kWh/m\textsuperscript{3} (with GH salt rejection of 78\%) to overcome seawater RO process with energy recovery device, and it can be increased up to 1.9 kWh/m\textsuperscript{3} when GH salt rejection increases up to 90\%.

\textbf{Keywords:} Gas hydrate; Reverse osmosis; Seawater desalination; Energy consumption

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