SuperCritical Water Desalination (SCWD)

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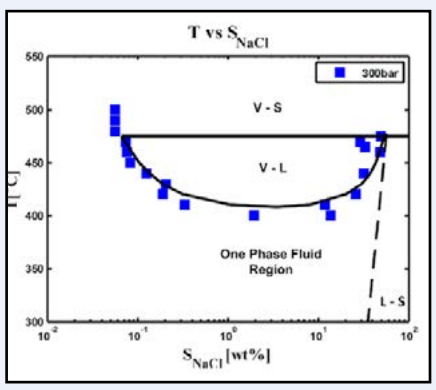
Motivation

The demand for fresh drinking water is increasing due to the growing global population and industrialisation, and the simultaneous decrease of freshwater resources. Conventional technologies are able to produce potable water from saltwater, but concurrently produce waste streams with high saline concentrations. The discard of these waste streams is harmful to the environment and therefore alternative methods of freshwater production should be investigated, which reduces the waste discharge and/or is able to treat the brackish waste streams. When water is at supercritical conditions, P>221bar and T>374°C, it becomes non-polar, thereby decreasing the solubility of inorganic components in water. Consequently, this results in the precipitation of solid salt or the separation of a concentrated brine from supercritical water[1]. Supercritical water desalination (SCWD) is a promising new zero liquid discharge (ZLD) desalination technology that is able to produce a low saline water stream and solid salt. This technology on itself can be energy intensive due to the operating conditions, but could become more efficient when integrated with conventional methods as either a pre– or post treatment step.

Technological challenge

Before this process can be applied industrially or integrated with conventional technologies, it first needs to be optimised in terms of energy costs and recovery. Once the optimum conditions have been established, the influence of different salts and feed concentrations need to be investigated as the separation behaviour of the salts vary depending on type 1 and 2 salts. Afterwards, the incorporation of the SCW process can be examined both experimentally and through modelling and process simulation. From the results, it can then be determined if the integration of this process is economically feasible and also energy efficient.



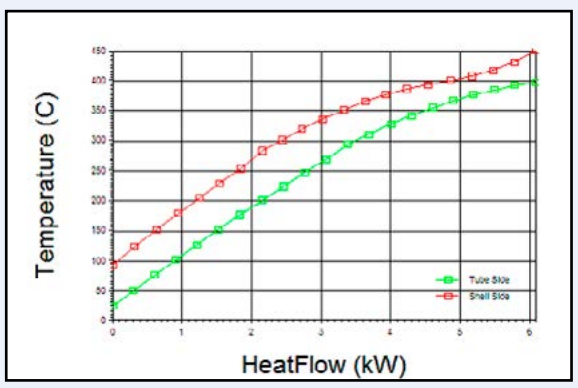


Fig 1. Phase diagram of NaCl-H_2O system at 300 bar (left); Axial temperature profile of heat exchanger at 300 bar (right)

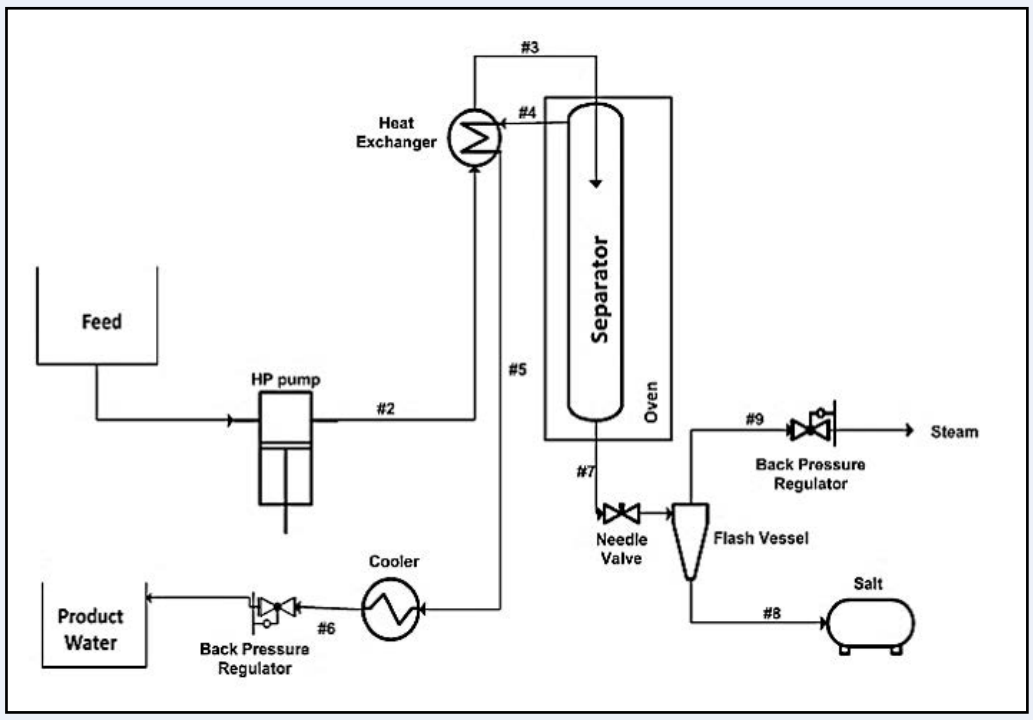


Fig 2. Supercritical water desalination (SCWD) pilot plant

Research goals

- Energy recovery and optimization of SCWD pilot plant (Fig 3a).
- Different operating modes *i.e*. separation temperature and feed concentration.
- Influence of different salts and salt mixtures on operation.
- Modelling and simulation of supercritical phase behaviour and the SCWD process.
- Integration of SCWD with existing water/salt production processes including techno-economic evaluation.
- Visual investigation of phase behaviour and crystallisation.

Fig 3a. SCWD Pilot plant (5 kg/h Brine)

Fig 3b. Solid salt (NaCl)

Fig 3c. Drinking water (< 750 TDS)

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[1] S.O. Odu et al., Industrial & Engineering Chemistry Research 54 (2015) 5527 - 5535.