Low-temperature organic Rankine cycle engine with isothermal expansion for use in desalination

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ABSTRACT

Groundwater salinity is a widespread problem that contributes to the freshwater deficit of humanity. Consequently, where conventional energy supply is also lacking, organic Rankine cycle (ORC) engines are being considered as a feasible option to harness readily available low-grade heat (<180°C) to drive the desalination of the saline water via reverse osmosis (RO). However, this application is still not very well developed, and has significantly high specific energy consumption (SEC). Hence, this study explores the isothermal expansion of the ORC working fluid to achieve improved efficiency for driving a batch-RO desalination process, “DesaLink”. Here, the working fluid is directly vaporized in the expansion cylinder which is heated externally by heat transfer fluid, thus obviating the need for a separate external boiler and high-pressure piping. Experimental investigations with R245fa have shown cycle efficiency of 8.8%. And it is predicted that the engine could drive DesaLink to produce 256 L of freshwater per 8 h per day, from 4000 ppm saline water, with a thermal and mechanical SEC of 2.5 and 0.36 kWh/m³, respectively, representing a significant improvement on previously reported or predicted SEC values.

Keywords: Energy and water; Low-grade heat; Organic Rankine cycle; Isothermal expansion; Desalination

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