Thermoeconomic optimization of a Kalina cycle for a central receiver concentrating solar power plant - DTU Orbit (08/11/2017)

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Concentrating solar power plants use a number of reflecting mirrors to focus and convert the incident solar energy to heat, and a power cycle to convert this heat into electricity. This paper evaluates the use of a high temperature Kalina cycle for a central receiver concentrating solar power plant with direct vapour generation and without storage. The use of the ammonia-water mixture as the power cycle working fluid with non-isothermal evaporation and condensation presents the potential to improve the overall performance of the plant. This however comes at a price of requiring larger heat exchangers because of lower thermal pinch and heat transfer degradation for mixtures as compared with using a pure fluid in a conventional steam Rankine cycle, and the necessity to use a complex cycle arrangement. Most of the previous studies on the Kalina cycle focused solely on the thermodynamic aspects of the cycle, thereby comparing cycles which require different investment costs. In this study, the economic aspect and the part-load performance are also considered for a thorough evaluation of the Kalina cycle. A thermoeconomic optimization was performed by minimizing the levelized cost of electricity. The different Kalina cycle simulations resulted in the levelized costs of electricity between 212.2 \$ MWh^{-1} and 218.9 \$ MWh^{-1}. For a plant of same rated capacity, the state-of-the-art steam Rankine cycle has a levelized cost of electricity of 181.0 \$ MWh^{-1}. Therefore, when considering both the thermodynamic and the economic perspectives, the results suggest that it is not beneficial to use the Kalina cycle for high temperature concentrating solar power plants.

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