Optimal design of compact organic Rankine cycle units for domestic solar applications - DTU Orbit (12/08/2019)

**Optimal design of compact organic Rankine cycle units for domestic solar applications**

Organic Rankine cycle turbogenerators are a promising technology to transform the solar radiation harvested by solar collectors into electric power. The present work aims at sizing a small-scale organic Rankine cycle unit by tailoring its design for domestic solar applications. Stringent design criteria, i.e., compactness, high performance and safe operation, are targeted by adopting a multi-objective optimization approach modeled with the genetic algorithm. Design-point thermodynamic variables, e.g., evaporating pressure, the working fluid, minimum allowable temperature differences, and the equipment geometry, are the decision variables. Flat plate heat exchangers with herringbone corrugations are selected as heat transfer equipment for the preheater, the evaporator and the condenser. The results unveil the hyperbolic trend binding the net power output to the heat exchanger compactness. Findings also suggest that the evaporator and condenser minimum allowable temperature differences have the largest impact on the system volume and on the cycle performances. Among the fluids considered, the results indicate that R1234yf and R1234ze are the best working fluid candidates. Using flat plate solar collectors (hot water temperature equal to 75 degrees C), R1234yf is the optimal solution. The heat exchanger volume ranges between 6.0 and 23.0 dm(3), whereas the thermal efficiency is around 4.5%. R1234ze is the best working fluid employing parabolic solar collectors (hot water temperature equal to 120 degrees C). In such case the thermal efficiency is around 6.9%, and the heat exchanger volume varies from 6.0 to 18.0 dm(3).

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