EPT-M-2014-121

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# Analysis of the Trilateral Flash Cycle for power production from low temperature heat sources

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In this study the Trilateral Flash Cycle (TFC) and the Partially Evaporating Cycle (PEC) have been analyzed and compared to the Organic Rankine Cycle (ORC) for power production from low temperature heat sources.
The ORC is a well-known technology that is in use in several plants today. The TFC and PEC on the other hand are still in a state of technical development. The biggest challenge for the TFC and PEC is the two-phase expansion. Lately, two-phase expanders with high efficiencies have been developed, which makes the TFC and PEC economically interesting.
The TFCs main difference from the ORC is that the heating process ends at the boiling point of the working fluid, i.e. there is no evaporation and superheating. This leads to a better temperature match between the working fluid and the heat source, such that more heat can be transferred to the working fluid. Power is produced in a two-phase expander after the heating process. The cost pr. kW for TFC systems have been estimated to be lower than for ORC systems due to the elimination of the evaporator, separator drum, gear box, lube oil system and the fact that simpler heat exchangers can be used.
In the PEC the working fluid is allowed to be partially evaporated during the heating process. This is done in an attempt to combine the advantages of the TFC and the ORC.
The ORC, TFC and PEC have been simulated for three cases with different heat source temperatures. Air with a mass flow of 10 kg/s and temperatures of 100, 150 and 200 °C are used for Case I, Case II and Case III respectively. Water at 20 °C is used as the heat sink. The simulations include detailed heat exchanger models to calculate heat transfer coefficients and pressure losses, and two-phase expander efficiency models for the TFC and PEC. The three cases are simulated with eight different working fluids, R123, R134a, R245fa, R1234ze(E), butane, pentane, isopentane and propane.
The results show that the TFC has the lowest power production for all cases, and the largest estimated system size. Both the total heat exchanger area and expander outlet volume flow are generally higher for the TFC systems, especially for the lower heat source temperature cases. For the 100 °C and 150 °C cases the power production for the TFC and ORC is in the same range. Since TFC systems are estimated to have a lower cost than ORC systems they can be suitable for systems with heat sources in this range when system size is not a critical factor. The PEC doesn't show any advantage over the ORC for the cases analyzed here. This study shows less promising results for the TFC than my project thesis and other published studies. This is mainly due to the variable two-phase expander efficiency used here, and that none of the other studies considers pressure losses in the system or calculation of heat transfer coefficients for each working fluid.