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Fluid selection and optimal operating conditions of an ORC, and trilateral Rankine cycle power plant for a heat source temperature of 210°C - 250°C

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Abstract. A selection of an appropriate working fluid for electricity production using a heat source of 210°C - 250°C was conducted. Three types of power plants were examined. They are a subcritical ORC (organic Rankine cycle), supercritical ORC, and trilateral Rankine cycle (TLC) power plants. An optimal operating condition for each working fluid and each power plant type was searched by using the golden section search method. A MATLAB code was developed and used in this simulation. The thermodynamic properties of the working fluids were calculated by using NIST REFPROP program. The justification of the code was validated with a result taken from the literature. The maximum net output was obtained when using the supercritical ORC plant with R141b as its working fluid and the heat source temperature is at 250°C. That plant produces a power of 141.72 kW and the cycle efficiency is 16.25%. The maximum net power output of 133.40 kW and cycle efficiency of 15.70% are obtained from the subcritical plant with pentane as its working fluid and is used as the working fluid and the heat source temperature is also at 250°C. Moreover, the net power outputs of 133.82 kW and cycle efficiency of 14.90% are obtained when using R141b as the working fluid in the TLC power plant. According to the off-design simulations, an appropriate adjustment of the working fluid flow rate can regulate the net power output.

Keywords: subcritical ORC, supercritical ORC, trilateral Rankine cycle, thermodynamic optimization, working fluid selection