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Electricity generation from a heat source at temperature of 160 – 200°C

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Abstract. The ORC (Organic Rankine cycle) power plant is believed to be one of the most promising technologies for waste heat recovery. A method of thermodynamic optimization was conducted to design a subcritical ORC, supercritical ORC, and trilateral Rankine cycle (TLC) power plant in this study. The heat source inlet temperatures of 160°C, 180°C, and 200°C and the heat sink temperature of 30°C were investigated. Various working fluids were examined to determine the one that provides a maximum net power output. The number of working fluids studied in the simulations for the subcritical power plant, supercritical power plant, and TLC are 14, 12, and 14, respectively. The results show that the subcritical ORC power plant with isopentane as the working fluid provides the maximum net power of 62.6 kW when the heat source temperature is 200°C. It was found that the appropriate working fluids, that provide the maximum net power output, have their critical temperature 10°C - 20°C colder than the heat source temperature tested for the subcritical ORC power plant. Furthermore, the supercritical ORC plant with R236ea as the working fluid provides the maximum net power of 74.3 kW when the heat source temperature is 200°C. Moreover, the TLC plant with R113 as the working fluid provides the maximum net power of 79.66 kW when the heat source temperature is 200°C. Additionally, the off-design performances of those plants were investigated and found that the net power output can be maintained by a proper adjustment of the evaporation and condensation pressures of the working fluids.

Keywords: Waste heat recovery, subcritical ORC, supercritical ORC, trilateral Rankine cycle, off-design.