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Waste heat recovery power plant for a heat source temperature of 130 - 150°C

Wachiraporn Raksa-in, and Atit Koonsrisuk*

School of Mechanical Engineering, Institute of Engineering, Suranaree University of Technology, Muang District, Nakhon Ratchasima 30000, Thailand

* Corresponding Author: atit@sut.ac.th

Abstract. Organic Rankine cycle (ORC) is a promising technology for power generation that uses low-temperature heat from various sources including renewable energy and waste heat. The objective of this study is to design thermodynamically a subcritical ORC, supercritical ORC, and trilateral Rankine cycle (TLC) power plants that can provide the highest net power output when the heat source temperature is 130 - 150°C. A numerical model was developed using MATLAB. The thermophysical properties of the working fluids studied are calculated by NIST REFPROP program. The simulations show that the subcritical plant with RC318 as its working fluid provides the highest net power when the heat source temperatures are at 130°C and 140°C. The corresponding net powers are 15.6 kW and 23.08 kW, respectively. While one with perfluoropentane as it working fluid provides the highest net power when the heat source temperatures is at 150°C and the net power is 26.3 kW. The supercritical plant with R1216 as its working fluid provides the highest net power of 17.1 kW when the heat source temperatures is at 130°C. Meanwhile the plant with RC318 as its working fluid provides the highest net power of 24.2 and 31.5 kW when the heat source temperatures are at 140°C and 150°C, respectively. On the other hand, the TLC power plant with perfluoropentane as its working fluid provides the highest power output over the whole range of the heat source temperature studied. Its corresponding power output are 21 kW, 27.2 kW, and 34.5 kW, respectively. Additionally, the off-design simulations when the heat source temperatures were varied in the range of 125 - 155°C were conducted and it was found that a proper adaptation of the operating conditions (evaporation and condensation pressures, working fluid flow rate) can maintain a constant power output.

Keywords: subcritical ORC, supercritical ORC, trilateral Rankine cycle, waste heat