Thermodynamic and Economic Simulation of Organic Rankine Cycle Coupled with Natural Gas Stationary Engines

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Abstract

Waste heat energy sources, such as stationary engines exhaust gases, are suitable for the energy generation via organic Rankine cycle (ORC). This document combines a thermodynamic simulation and an economic analysis of the performance of a Cummins stationary engine with an ORC as a bottoming cycle, by using different organic fluids. The maximum output power is less than 165 KW while the temperature of the heat source varies between 200 and 250°C. The studied working fluids, namely R245fa, R1233zd (E) and R1234ze (Z), are selected based on environmental, safety and thermal performance criteria. The Levelized Cost of Energy (LCOE) and the Specific Investment Cost (SIC) for the maximum output power are presented. Results showed that R1233zd(E) achieves the highest net power output. R1233zde(E) increases net power production up to 9.3% and 165 kW, when it is compared to the stationary engine power output. Results also showed that R245fa is the fluid with the lowest net power production. R245fa increases net power production up to 8.3% and 148 kW, when it is compared to the stationary engine power output. Finally, results showed that thermal oil temperature of 200°C reduce the LCOE of ORC. R1233zd (E) is the most cost-effective fluid, with a LCOE value of 5.3 cents USD/kWh and an SIC value of 429 USD/kW.

Keywords: *ORC, Waste heat, natural gas, organic Rankine cycle, exhaust gases.*