Waste Heat Recovering Using Organic Rankine Cycle with Mixed Working Fluid for the Marine Diesel Engine

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Abstract:

The aim of this study is to investigate the performances of the waste heat recovery system for a large marine four stroke diesel engine-WARTSILA 16V46F. Two waste heat sources, which are exhaust gas and cylinder cooling water of the marine diesel engine, are integrated and applied to drive the organic Rankine cycle (ORC). The net power output and payback period of investment costs are used to evaluated the thermodynamic and economic performances of the systems, respectively. The environmentally friendly working fluids, R1233ZDE, R1234ZEZ, R1336MZZZ are selected due to without ozone depletion potential, and very lower global warming potential. Furthermore, the performances of the pure and mixed working fluids are analyzed and compared.

The results show that with comparison of the thermodynamic performance of the three pure working fluids, the net power output of R1336MZZZ is the largest, and R1233ZDE is most excellent in the economic performance analysis. In performance comparison of the mixed working fluid, the power output of R1234ZEZ/R1336MZZZ is the largest, which is 7.86%, 7.72% and 6.98% higher than that of the pure working fluids R1233ZDE, R1234ZEZ and R1336MZZZ respectively. In the economic analysis of the investment cost payback period, R1234ZEZ/R1336MZZZ behaves the highest economic performance with mass mixed ratio 0.3/0.7, and its minimum investment payback period is shortened by 3.28%, 3.73% and 4.47% compared with the pure working fluids R1233ZDE, R1234ZEZ and R1336MZZZ respectively. In addition, further analysis of the fuel oil saving, and CO_2 emission reduction with waste heat recovery system are conducted to optimize the operation of the large marine four stroke diesel engine.

Keywords:

Waste heat recovery (WHR), organic Rankine cycle (ORC), payback period, mixed working fluid, mass mixed ratio.