

Abstract

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Utilizing the scavenge air in improving the performance of Diesel engine waste heat recovery systems

This thesis aims to improve the power generation efficiency of diesel engine waste heat recovery systems by introducing the scavenge air as a primary heating fluid. The scavenge air is a promising source of waste heat as it reaches temperatures as high as the exhaust gas with a nearly similar mass flow rate. However there are problems incorporated with using the scavenge air as a heating fluid related to the change in its temperature with the engine load. A comparative study will be presented for different operating models of waste heat recovery systems performing on a Rankine cycle relying on the scavenge air and exhaust gas as heating fluids. The integration between the scavenge air and exhaust gas is thought to overcome the problems associated with using the scavenge air as a heating fluid. Moreover, a thermodynamic analysis was performed for the proposed systems to identify the optimum operating parameters for achieving proper operation with an improvement in the overall efficiency. The analysis was developed on an in-house MATLAB program to solve the characteristic equations. In addition, a performance analysis was conducted to assess the applicability and power output of each system with varying engine load. An assessment of the economic and environmental aspects of the suggested designs was presented as well. Consequently, the results show that the recommended cycle involves the use of the exhaust gas and scavenge air as heating fluids in a single pressure cycle which achieves an improvement in the overall efficiency of 5.1%, with an additional output power of 1210 kW. Furthermore, the waste heat recovery system achieves a reduction in fuel consumption of 9.7% and a reduction in carbon dioxide emission of 4790 x 10³ kg/year. In conclusion, the systems presented established the role of the scavenge air in improving the power generation efficiency of diesel engine waste heat recovery systems.