Organic Rankine cycle unit for waste heat recovery on ships (PilotORC) - DTU Orbit (31/12/2018)

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The project PilotORC was aimed at evaluating the technical and economic feasibility of the use of organic Rankine cycle (ORC) units to recover low-temperature waste heat sources (i.e. exhaust gases, scavenge air, engine cooling system, and lubricant oil system) on container vessels. The project included numerical simulations and experimental tests on a 125 kW demonstration ORC unit that utilizes the waste heat of the main engine cooling system on board one of Maersk's container vessels.

During the design of the demonstration ORC unit, different alternatives for the condenser were analyzed in order to minimize the size of the heat exchanger area. Later on the ORC unit was successfully installed on board, and it has been working uninterruptedly since, demonstrating the maturity of the ORC technology for maritime applications. During the onboard testing, additional measuring devices were installed on the unit and experimental data at design and off-design conditions were collected.

Several simulation models were developed in order to evaluate alternative integrations of the ORC units with different sources and configurations. The developed models allowed for the study of different ORC configurations at design and off-design conditions, the simulation of radial-inflow turbines, and the prediction of thermophysical properties of alternative working fluids. The models for the ORC unit were validated with the collected experimental data. The validated models were used to evaluate the retro-fitting potential of using ORC units for maritime applications, and the relevance of this technology for new-building projects. Firstly, an evaluation of the waste heat resources available on board Maersk containers fleet, and an estimation of the potential energy recovery by means of the ORC technology was performed. The estimations showed that significant fuel savings can be achieved. It was found that integrating ORC units with the jacket cooling water within the service steam circuit could enable payback periods of approximately 5 years and high fuel savings. Conversely, if the heat from the exhaust gases was recovered, the total power production of the ORC unit could cover 10% of the main engine power. Larger energy savings, 10 - 15%, could be expected if advanced design methods are employed.

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