Effect of cold source conditions on the design and control of organic rankine cycles for waste heat recovery from industrial processes

Abstract:
Organic Rankine Cycle systems are able to convert efficiently middle/low-grade heat sources into mechanical, electrical or combined heat and power, and are a valuable alternative to increase the energy efficiency of industrial processes. The investment costs of ORCs are a major limit for the integration of the technology in industrial sites, mainly because of the short payback time that industries request. For these reason, this work investigates measures to reduce the investment costs and avoid a case-by-case tailored design of ORCs. As benchmark, a case of waste heat recovery from billet reheat furnace is taken. The design and off-design of an air-cooled recuperated ORC is optimized for two different climate locations by using an integral optimization code developed in MATLAB®. A dynamic model is developed in Dymola to compare the control strategies as well. The results show that optimal economic performance can be achieved in the two locations by a similar design. This also results in similar parameter settings for the controllers, leading to small penalties when using the ORC system in climate conditions other than the design one, compared to a tailored design.
The results provide important information for academia, industry and decision-makers to achieve a cost-effective design and operation of Organic Rankine Cycle units in different climate regions in view of a possible modularization and cost reduction.

Stichworte: Environmental conditions; Low grade waste heat recovery; Optimization; Organic Rankine cycle (ORC); Thermo-economic


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