Experimental thermal performance and modelling of a waste heat recovery unit in an energy cogeneration system

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Abstract

In this paper, the performance of a gas/oil heat recovery unit is assessed experimentally and by the development of an Aspen model and artificial neural networks. The heat recovery unit is a cross-flow heat exchanger used to recover the residual heat of the exhaust gases coming from a microturbine to drive an absorption chiller. The test facility consists mainly of a microturbine, a heat recovery unit, and an air-cooled absorption chiller. The experiments were conducted at partial power loads and different thermal oil mass flows. Regarding the models, the Aspen model depends on inlet conditions, the mechanical description of the heat recovery unit, and the fluids thermophysical properties, whereas the ANN model consists of 3 trained artificial neurons, 4 inputs (inlet flows and temperatures), and 2 outputs (thermal load and overall heat transfer coefficient). The experimental tests show that the recovery unit recovers from 18.8 kW to 8.1 kW when the microturbine power output is varied from 23 kWe to 4 kWe. Results also show that the overall heat transfer coefficient ranges between 243 $W.m^{-2}.K^{-1}$ and 89 $W.m^{-2}.K^{-1}$, while they evidence that the overall heat transfer resistance is controlled by the exhaust gases heat transfer resistance. Furthermore, simulation results show that the Aspen model predicts the heat recovery unit thermal load and overall heat transfer coefficient with average relative differences of 0.93% and 11.27%, respectively, to the experiments. The ANN model evidences average relative differences of 0.51% and 3.48% for the thermal load and overall heat transfer coefficient, respectively.

keywords

Cooling and power; Energy cogeneration; Exhaust gasesHeat exchanger; Heat recovery; Thermal oil