Energy and exergy analysis of a cruise ship

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The shipping sector is today facing numerous challenges. Fuel prices are expected to increase in the medium - long term, and a sharp turn in environmental regulations will require several companies to switch to more expensive distillate fuels. In this context, passenger ships represent a small but increasing share of the industry. The complexity of the energy system of a ship where the energy required by propulsion is no longer the trivial main contributor to the whole energy use thus makes this kind of ship of particular interest for the analysis of how energy is converted from its original form to its final use on board. To illustrate this, we perform an analysis of the energy and exergy flow rates of a cruise ship sailing in the Baltic Sea based on a combination of available measurements from ship operations and of mechanistic knowledge of the system. The energy analysis allows identifying propulsion as the main energy user (41% of the total) followed by heat (34%) and electric power (25%) generation; the exergy analysis allows instead identifying the main inefficiencies of the system: exergy is primarily destroyed in all processes involving combustion (88% of the exergy destruction is generated in the Diesel engines and in the oil-fired boilers) and in the sea water cooler (5.4%); the main exergy losses happen instead in the exhaust gas, mostly from the main engines (67% of total losses) and particularly from those not equipped with heat recovery devices. The improved understanding which derives from the results of the energy and exergy analysis can be used as a guidance to identify where improvements of the systems should be directed.

General information
State: Published
Organisations: Department of Mechanical Engineering, Thermal Energy, Chalmers University of Technology, Linnaeus University
Contributors: Baldi, F., Ahlgren, F., Nguyen, T., Gabrielli, C., Andersson, K.
Number of pages: 17
Publication date: 2015

Host publication information
Title of host publication: Proceedings of ECOS 2015 : 28th International Conference on Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems
Keywords: Energy analysis, Exergy analysis, Low carbon shipping
Electronic versions:
BALDI_ECOS2015_AR.pdf
Source: PublicationPreSubmission
Source-ID: 110826862
Research output: Research - peer-review › Article in proceedings – Annual report year: 2015