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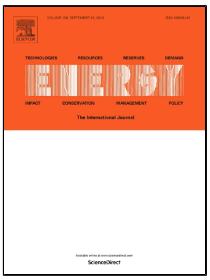

Conventional and Advanced Exergy Analyses of a Marine Steam Power Plant

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Abstract:

Stricter rules and regulations about emissions for marine vessels and escalating fuel prices have motivated researchers and engineers to study further on improving fuel efficiency. Thus, it has become crucial to estimate the improvement potential and the sources of irreversibilities within energy systems. In this paper conventional and advanced exergy analyses are applied to a marine steam power plant to reveal insights which may help designers to make decisions on component renewal issues. The results of the study showed that the highest exergy destruction is within the boiler due to chemical reactions. Moreover, it has the highest avoidable exergy destruction. Pumps in the system contribute to the destruction in small percentages. Turbines have more importance compared to the heat exchangers. The findings for avoidable endogenous exergy destructions indicated that the improvement efforts should be focused essentially on boiler, turbines, condenser and pump equipment respectively, and that feed water heaters could be improved externally by improving other components. It is also concluded that the overall system has a 10% improvement potential of the exergy efficiency, of which almost three out of four is due to two components namely, boiler (6%), and low pressure turbine (1.3%), other components have smaller room for improvement.

Keywords: Steam power plant, marine energy systems, advanced exergy analysis, Energy Efficiency Design Index

Highlights:

- A marine steam power plant is simplified for advanced exergy analysis and its accuracy is validated with the real data from literature.
- Overall system has a 10% exergy efficiency improvement potential.
- Improvements in boiler, and 3rd stage of low pressure turbine could recover 73% of overall efficiency improvement potential.

Nomenclature

Abbreviations

CDP: condensed feed water pump

CO2: Carbon dioxide

COGAS: Combined Gas and Steam

COND: Condenser

EI: Efficiency Improvement (%)

EEDI: Energy Efficiency Design Index

EEOI: Energy Efficiency Operational Indicator

FWMP: feed water main pump