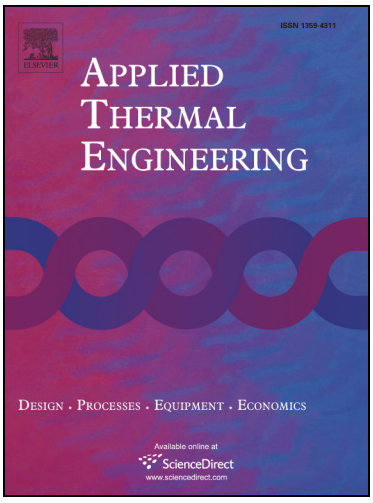

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Energy and Exergy Analyses of a Mass-fired Boiler for a Proposed Waste-to-Energy Power Plant in Tehran

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Abstract

Thermodynamic analysis of a municipal solid waste-to-energy boiler was thoroughly conducted. For this purpose, mass, energy, and exergy balance equations were formed over the entire boiler and its components. This study aimed to report the first and second law efficiencies to identify the main sources of irreversibility within the boiler. Three districts of Tehran mega city were selected, and the fictive molecule $C_{26.75}H_{3.58}O_{15.79}N_{1.08}S_{0.11}$ was obtained from the average chemical composition of the aggregated waste. Moreover, the zonal method was applied to design the furnace, following by a simpler approach to design heat recovery steam generator. The energy and exergy analysis was then performed for all components and the entire boiler, followed by a sensitivity analysis on the blow-down water ratio effects. Results indicated that the irreversibility in furnace, with 52,617.3 $kJ\,s^{-1}$, was the main source of the exergy destruction. In addition, the overall energetic and exergetic efficiency of the studied boiler were reported as 78.7 and 16.0 %, respectively.

It appears that as a consequence of relatively small lower heating value of the utilized waste and considering the heat loss due to the bottom ash and blow-down water, a considerable reduction in the boiler efficiency occurred.

Keywords:
Blow-down Water, Energy and Exergy Analysis, Mass-fired Boiler, Municipal Solid Waste, Zonal Method.

Nomenclature

Acronym

HRSG	Heat Recovery Steam Generator
LHV	Lower Heating Value, $kJ\,kg^{-1}$
MSW	Municipal Solid Waste
WtE	Waste-to-Energy

Greek Symbol

$\triangle$	used for a change in any parameter
η_I	energy efficiency,%
η_{II}	exergy efficiency,%
σ	Stefan Boltzmann constant, $W\,m^{-2}K^{-4}$

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