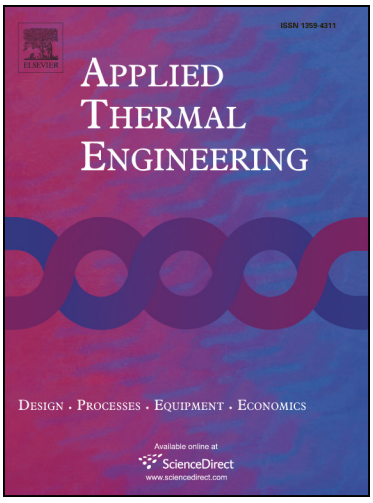

Energy-Exergy analysis and energy efficiency improvement of coal-fired industrial boilers based on thermal test data

Qi Zhang, Henan Yi, Zaihai Yu, Jintong Gao, Xiaozhuang Wang, Heyong Lin, Bo Shen

PII: S1359-4311(18)31019-6
DOI: https://doi.org/10.1016/j.applthermaleng.2018.08.069
Reference: ATE 12572

To appear in: *Applied Thermal Engineering*

Received Date: 18 February 2018
Revised Date: 23 July 2018
Accepted Date: 19 August 2018

Please cite this article as: Q. Zhang, H. Yi, Z. Yu, J. Gao, X. Wang, H. Lin, B. Shen, Energy-Exergy analysis and energy efficiency improvement of coal-fired industrial boilers based on thermal test data, *Applied Thermal Engineering* (2018), doi: https://doi.org/10.1016/j.applthermaleng.2018.08.069

Energy-Exergy analysis and energy efficiency improvement of coal-fired industrial boilers based on thermal test data

Qi Zhang[a,*], Henan Yi[a], Zaihai Yu[b], Jintong Gao[a], Xiaozhuang Wang[a], Heyong Lin[c], Bo Shen[d]

[a]State Environmental Protection Key Laboratory of Eco-Industry, Northeastern University, Shenyang 110819, Liaoning, PR China
[b]Energy Saving Center of Boilers, Liaoning Academy of Safety Science, Shenyang 110004, Liaoning, PR China
[c]Ying kou Institute of Boiler and Pressure Vessel Inspection, Yingkou 115000, Liaoning, P R China
[d]Energy Analysis and Environmental Impacts Division, Lawrence Berkey National Laboratory, Berkeley, CA 94720, USA

Abstract:

Energy conservation and emission reduction in coal-fired boilers are significant to mitigate climate change and alleviate environmental pollution. In this study, the potential for efficiency promotion is assessed by understanding the factors affecting boiler performance. The results are based on thermal tests of 141 coal-fired industrial boilers in Liaoning province, China. Additionally, an exergy analysis model suitable for coal-fired industrial boilers is proposed under the framework of the first and second laws of thermodynamics to improve the operation of boilers. The energy and exergy efficiencies as well as CO_2 emissions have been discussed as well. The results indicate that the heat loss of flue gas and unburnt carbon represent the main heat losses. Exergy loss is dominated by destruction due to irreversibility in coal combustion and heat transfer. Average energy efficiency and CO_2 emission of 141 boilers were estimated to be 76.08% and 147.13 kg-CO_2/GJ, respectively. Exergy efficiencies of typical samples were estimated at about 12.88% for hot water boiler and 27.97% for steam boiler. Raising the efficiencies of 141 boilers to the target level proposed in the standard will lead to a decrease of coal consumption by 155 kt, emission reduction of 341 kt for CO_2, 3.72 kt for SO_2, and 3.48 kt for NO_x per year.

Keywords: energy analysis; exergy analysis; carbon emission; industrial boilers.

Highlights:

1) Detailed energy and exergy analysis of tested industrial boilers are performed.
2) Influence factors of energy efficiency of coal-fired boilers are discussed.
3) Carbon dioxide emissions of industrial coal-fired boilers are calculated.
4) Improvement potential for energy conservation and pollution reducing is revealed.