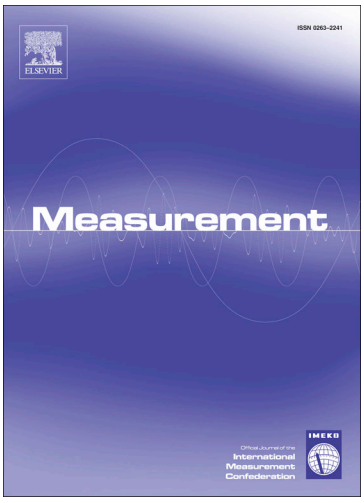

Measurement method and influencing factors of temperature and humidity of condensed flue gas based on in situ flue gas heat tracing

Jianmin Gao, Zhihao Sun, Zhiqiang Wang, Xin Wang, Jian Guan, Guoli Qi, Zhongwei Wang, Qian Du, Yukun Qin

PII: S0263-2241(18)30080-0
DOI: https://doi.org/10.1016/j.measurement.2018.01.067
Reference: MEASUR 5242

To appear in: *Measurement*

Received Date: 13 July 2017
Revised Date: 10 November 2017
Accepted Date: 30 January 2018

Please cite this article as: J. Gao, Z. Sun, Z. Wang, X. Wang, J. Guan, G. Qi, Z. Wang, Q. Du, Y. Qin, Measurement method and influencing factors of temperature and humidity of condensed flue gas based on in situ flue gas heat tracing, *Measurement* (2018), doi: https://doi.org/10.1016/j.measurement.2018.01.067

Measurement method and influencing factors of temperature and humidity of condensed flue gas based on in situ flue gas heat tracing

Jianmin Gao[a,*], Zhihao Sun[a], Zhiqiang Wang[b], Xin Wang[a], Jian Guan[c], Guoli Qi[c], Zhongwei Wang[c], Qian Du[a], Yukun Qin[a]

[a]School of Energy Science and Engineering, Harbin Institute of Technology, Harbin 150001, Heilong Jiang Province, China

[b]China Coal Research Institute, Beijing 100013, China

[c]China Special Equipment Inspection And Research Institute, Beijing 100029, China

Corresponding author: Jianmin Gao (yagjm@hit.edu.cn), School of Energy Science and Engineering, Harbin Institute of Technology, Harbin 150001, Heilong Jiang Province, China

Abstract: Condensing boilers are efficient for the utilization of natural gas. However, condensed droplets in flue gas are supercooled after condensation heat transfer, and direct contact devices cannot accurately measure the temperature of flue gas containing such droplets. Therefore, an in situ heating interlayer pumping device was designed. Experimental results showed that in situ heating interlayer pumping device can effectively filtered out the influence of supercooled droplets, the temperature of flue gas measured by the proposed device was about 3℃ higher than that measured by direct contact temperature measuring device; the device optimum flow rate was 0.35L/min, optimum heat tracing temperature was in the range 100–140°C; the effective reliability of the device was verified experimentally using the positive balance efficiency and the counter balance efficiency of 30-kW gas-fired condensing heat-transfer test platform.

Keywords: condensing boiler; flue gas; condensation; supercooling; thermal test; interlayer pumping

1. Introduction

To limit environmental pollution, natural gas is increasingly valued as a relatively clean and efficient energy source [1-3].When burning natural gas, the efficiency of condensing boilers can be increased by 8%–15% through the installation of waste-heat recovery equipment [4-8]. As condensing boilers represent advanced and environmental friendly heating technology [9], condensing boilers are widely used [10]. Research on condensing boilers is continually evolving. For example, Vignali [11] found that condensing boiler technology has a lower environmental impact than its traditional counterpart for six impact categories considered. Bespalov et al. [12] examined economic issues concerning the design of deep flue gas heat recovery units for natural gas-fired boilers. Lee et al. [13] investigated design factors using a simplified model of a heat exchanger and pilot condensing boiler. Li et al. [14] proposed a novel non-contact total heat recovery system for a gas-fired boiler, and found that the efficiency improved by 103.4%, and that the operation cost of a non-contact heat recovery system is less than that of a boiler with an absorption heat pump system for heat recovery.The boiler efficiency is an important parameter which evaluates the ability of the boiler to convert the fuel energy content into useful heat. Boilers efficiency can be determined using either the positive balance method (Input-Output method) or counter balance method (energy balance method) [15,16]. The counter balance method is generally used in practice to determine boiler efficiency and is conducted by summing the losses and comparing them with the heat input [15-17]. Lee et al. [18] used thermodynamic analysis to calculate the