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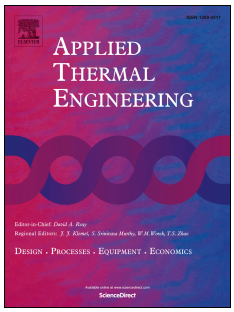

Numerical investigation of the nonlinear flow characteristics in an ultra-supercritical utility boiler furnace

M. Yang, Y.Y. Shen, H.T. Xu, M. Zhao, S.W. Shen, K. Huang

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Numerical investigation of the nonlinear flow characteristics in an ultra-supercritical utility boiler furnace

M. Yang*, Y.Y. Shen, H.T. Xu, M. Zhao, S.W. Shen, K. Huang

School of Energy and Power Engineering, University of Shanghai for Science and Technology, Shanghai, 200093, P.R. China

*Corresponding Author. Tel.& Fax: 86-55272320. E-mail address: yangm@usst.edu.cn (M. Yang)

Abstract

The temperature deviation is an inherent issue in large-scale tangentially fired pulverized-coal boilers. This article investigates numerically the forming mechanism of gas velocity and temperature deviations from the perspective of nonlinear flow characteristics in an ultra-supercritical utility boiler. Firstly, the cold state simulations of two-dimensional and three-dimensional models of furnace are performed. With the increase of Reynolds number from burner nozzles, the temperature and velocity distributions in furnace show the trend of symmetrical, slightly asymmetrical, and completely asymmetrical. The generated tangential radius of flow becomes larger and declining. It is concluded that the nonlinear flow characteristics is the key issue for the velocity and temperature deviations in the tangentially fired pulverized-coal boiler furnace. Secondly, the full combustion simulation is carried out under BMCR (Boiler Maximum Continuous Rating) conditions and validated by experimental measurement. It is also found that the centre of tangent circle becomes larger along the height of the boiler furnace and deflects though the burner structure and boundary conditions are absolutely symmetrical. The temperature and velocity distributions are asymmetrical under BMCR conditions. Due to the nonlinear flow, it inevitably brings the residual swirling flow at the upper furnace zone which is one origin of temperature deviation of the gas after the furnace exit.

Keyword: Numerical investigation, Nonlinear flow, Boiler furnace, Temperature deviation

1. Introduction

Tangentially fired pulverized-coal boilers are widely used in industrial and power plant due to its well flame fulfilled degree in furnace volume, good flame stability, good adaptability of coal ranks and loads, low NOx emission and easy operation [1-7].

Among the main issues related to the tangentially fired pulverized-coal boilers, temperature deviation is an inherent one. It was investigated that approximately 60% boiler outages results from boiler tube failure and the temperature deviation ranks in the first place among all the operational