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Simulations of the PC boiler equipped with complex swirling burners. (English)
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Summary: Purpose

- The purpose of this paper is to show possible approaches which can be used for modeling complex flow phenomena caused by swirl burners combined with simulating coal combustion process using air- and oxy-combustion technologies. Additionally, the response of exist boiler working parameter on changing the oxidizer composition from air to a mixture of the oxygen and recirculated flue gases is investigated. Moreover, the heat transfer in the superheaters section of the boiler was taken into account by modeling of the heat exchange process between continuum phase and three stages of the steam superheaters.

Design/methodology/approach

- An accurate solution of the flow field is required in order to predict combustion phenomena correctly for numerical simulations of the industrial pulverized coal (PC) boilers. Nevertheless, it is a very demanding task due to the complicated swirl burner construction and complex character of the flow. The presented simulations were performed using the discrete phase model for tracking particles and combustion phenomena in a dispersed phase, whereas the Eulerian approach was applied for the volatile combustion process modeling in a gaseous phase.

Findings

- Applying the air- to oxy-combustion technology the temperature in the combustion chamber, decreased for investigated oxidizer compositions. This was caused by the higher heat capacity of flue gases which also influences on the level of the heat flux at the boiler walls. Simulations shows that increasing the O_2 concentration to 30 percent of volume base in the oxidizer mixture provided the similar combustion conditions as those for the conventional air firing. Moreover, the evaluated results give a good overview of differences between approaches used for complex swirl burners simulations.

Practical implications

- Nowadays, the numerical techniques such as computational fluid dynamic (CFD) can be seen as an useful engineering tool for design and processes optimization purposes. The application of the CFD gives a possibility to predict the combustion phenomena in a large industrial PC boiler and investigate the impact of changing the combustion technology from a conventional air firing to oxy-fuel combustion.

Originality/value

- This paper gives good overview on existing technique, approaches used for modeling PC boiler equipped with complex swirl burners. Additionally, the novelty of this work is application of the heat exchanger model for predicting heat loses in convective section of the boiler. This usually is not taken into account during simulations. The reader can also find basic concept of oxy-combustion technology, and their impact on boiler working conditions.

MSC:

80M10 Finite element, Galerkin and related methods applied to problems in thermodynamics and heat transfer
80A25 Combustion

Cited in **1** Document

Keywords:

CFD; heat exchanger; oxy-combustion; PC boiler; swirl burner

Software:

FLUENT

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