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CFD modelling of a large-scale MILD-OXY combustion boiler for CO_2 reduction

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In this paper a previously developed CFD model of a pulverized coal fired concept boiler [1] was used and improved to study the effects of selected sub-models on various operational parameters and predicted flow fields in the combustion chamber. The examined concept boiler was designed to obtain high CO2 concentration at the outlet, increased thermal efficiency and fuel flexibility. This was achieved by reduction of the external flue gas recirculation. Emission of pollutant NO was also obtained. The boiler was operated under MILD and OXY combustion conditions, thus the injection of fuel and oxidizer as well as the geometry of the combustion chamber were designed to obtain strong internal recirculation of the flue gas. Our previous study [1] showed that combination of the MILD and the OXY combustion techniques allows reducing the external flue gas recirculation of standard OXY combustion and improve the efficiency of the power plant. The model of that study was based on several assumptions, whose influence on the final results was not examined. In this study the model was improved and the effect of applying other sub-models was verified. In particular, the Eddy Dissipation Concept turbulence-chemistry interaction model, with a global reaction mechanism, and the Chemical Percolation devolatilization model were used in this study, whereas Eddy Dissipation Model, which is valid for high Damköhler numbers, and a standard constant rate devolatilization model was used in the previous. The results confirmed that there is a relatively large influence of the selected modeling approach on the obtained maximum and outlet flue gas temperatures, however little influence on total heat transfer to the combustion chamber walls, carbon conversion and thermal efficiency of the furnace was observed. The predicted relatively low CO and NOx emissions in the improved model showed that the boiler can be efficiently and environmentally friendly operated at the proposed conditions.

References

[1] Adamczyk WP, Bialecki RA, Ditaranto M, Gladysz P, Haugen NEL, Katelbach-Wozniak A, Klimanek A, Sladek S, Szlek A, Wecel G, CFD modeling and thermodynamic analysis of a concept of a MILD-OXY combustion large scale pulverized coal boiler, Energy, 140, 1, 2017, p. 1305-1315, http://dx.doi.org/10.1016/j.energy.2017.03.130