A Model for Nitrogen Chemistry in Oxy-Fuel Combustion of Pulverized Coal

In this work, a model for the nitrogen chemistry in the oxy-fuel combustion of pulverized coal has been developed. The model is a chemical reaction engineering type of model with a detailed reaction mechanism for the gas-phase chemistry, together with a simplified description of the mixing of flows, heating and devolatilization of particles, and gas–solid reactions. The model is validated by comparison with entrained flow reactor results from the present work and from the literature on pulverized coal combustion in O2/CO2 and air, covering the effects of fuel, mixing conditions, temperature, stoichiometry, and inlet NO level. In general, the model provides a satisfactory description of NO formation in air and oxy-fuel combustion of coal, but under some conditions, it underestimates the impact on NO of replacing N2 with CO2. According to the model, differences in the NO yield between the oxy-fuel combustion and the conventional combustion of pulverized coal can mostly be attributed to the recycling of NO (reburning effect) and to changes in the mixing patterns between fuel and oxygen. For pulverized-fuel combustion at high temperatures, we think that NO is mainly reduced by heterogeneous reactions involving both char and soot. Here, the tar yield of the volatiles is mainly converted to soot and H2, limiting the concentration of hydrocarbons and thereby the importance of gas-phase removal of NO. Our work emphasizes the need for accurate descriptions of mixing, volatile composition (fate of tar), and heterogeneous reactions. Furthermore, more work is desirable on the reduction of NO by CO on char at higher temperatures.

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