NO Reduction over Biomass and Coal Char during Simultaneous Combustion

This paper reports an experimental study of NO reduction over chars of straw, bark, bituminous coal, and lignite. The experiments were performed in a fixed bed reactor in the temperature range 850–1150 °C. The chars were generated by in situ pyrolysis at the reaction temperature to minimize further thermal deactivation. The rates of NO reduction over char were studied by char combustion experiments and O2-free experiments respectively. Two simple models were applied to interpret the data from the char combustion experiments. One model assumed that combustion and NO release take place uniformly in the bed, while the other model assumes that combustion and NO release take place in a reaction front at the top of the bed. The reaction rates of NO reduction on char from O2-free experiments were lower by almost an order of magnitude than those from char combustion experiments interpreted by the uniform NO release model. The main reasons for this difference were thermal deactivation, increasing surface area during char combustion, producing reactive surface intermediates, and presence of gases such as CO, which can promote the NO reduction. Lignite char showed the highest reactivity among the 4 chars. The straw and bark chars showed higher reactivity, about a factor of 4–5, than bituminous char at 850 °C. The difference in reactivity between biomass char and bituminous char decreased with increasing reaction temperature. The reaction rate expressions for NO reduction during simultaneous combustion interpreted by the uniform NO release model are the following: 

\[ r_{\text{NO}} = -2.80 \times 10^5 \times \exp(-9.68 \times 10^3/T) \times C_{\text{NO}} \text{ mol·(kg C)}^{-1} \cdot \text{s}^{-1} \] for bark char,

\[ r_{\text{NO}} = -1.20 \times 10^{10} \times \exp(-2.49 \times 10^4/T) \times C_{\text{NO}} \text{ mol·(kg C)}^{-1} \cdot \text{s}^{-1} \] for straw char,

\[ r_{\text{NO}} = -9.04 \times 10^8 \times \exp(-2.13 \times 10^4/T) \times C_{\text{NO}} \text{ mol·(kg C)}^{-1} \cdot \text{s}^{-1} \] for bituminous char,

\[ r_{\text{NO}} = -1.37 \times 10^7 \times \exp(-1.39 \times 10^4/T) \times C_{\text{NO}} \text{ mol·(kg C)}^{-1} \cdot \text{s}^{-1} \] for lignite char.

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