The paper presents a model framework that describes the reactions kinetics of entrained flow gasification. The model consists of different submodels for fuel devolatilisation, intrinsic char gasification, surface area evolution, char thermal annealing, pore diffusion, boundary layer diffusion, and particle size and density variation. These submodels are partly derived from measurements in previous publications and are partly based on theoretical derivations. The model framework is validated using fuel devolatilisation data and char gasification kinetics of a lignite that are measured in two entrained flow reactors at temperatures up to 1600 degrees C and pressures up to 1.0 MPa. A good correlation of model and experimental data is found for various operating conditions. The objective of the model development is the prediction of gasification behaviour in larger scale entrained flow gasifiers. To show its capabilities the model is applied to a one-dimensional plug flow reactor that represents a simple approach for a larger scale entrained flow reactor. Gas and temperature profiles within a 500 MW gasifier are predicted and cold gas efficiency and fuel conversion for different gasifier geometries and operating conditions are shown. Based on the model predictions the reaction regime of char conversion in entrained flow gasifiers is analysed. At very high temperature in the burner zone, char gasification approaches Regime III.
conditions and a concentration gradient develops in the gas boundary layer around the char particles. The observed activation energy is 62 kJ/mol. In the medium stages of char conversion the reaction occurs under Regime II conditions and then approaches Regime I conditions at high conversion and at lower temperature. This is indicated by the high observed activation energy of 239 kJ/mol in the final stages of conversion. As all three reaction regimes are relevant, fuel properties that have an impact on diffusion (e.g. particle size and pore structure) as well as on the intrinsic char reaction (e.g. intrinsic reactivity and thermal annealing) have to be considered to determine entrained flow gasification kinetics.

Stichworte:

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