

Modelling of coal combustion with SimuSage within the VerSi Project

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Combustion models for coal combustion are widely used in industry. Also, there are many scientific models which differ in precision, input data (variables) and calculation time. Typically, no model can satisfy all of these needs. CFD-models for example, attain very high precision, but do have a lack either in input data or they need high calculation time. Within the frame of project "VerSi", a mainly thermochemical model has been developed to calculate certain areas in a pulverized coal-fired boiler. It matches above-mentioned low calculation time and furthermore, uses experimental values as input data. In addition, a complete thermochemical database verified by experimental data and developed by IEK-2 and GTT was used in this model. Its flowsheet represents the particle path from the burner level, to superheater tubes and colder regions like the economiser. The model is programmed with "SimuSage", an object oriented set of components using "ChemApp" via the integrated development environment "Larzarus". As input data, parts of the proximate and ultimate analysis of maximum three different coals can be used. Moreover, the corresponding elemental analyses in oxide form are necessary for the thermochemical calculation. Additionally, particle analysis and former CFD calculations are suitable but not mandatory to set several parameters inside the model. To match hard coal combustion and lignite combustion, input air and coal preheating have been considered. The former can be set in one, two or three steps, including a value for λ . Coal preheating for lignites is implemented within an iterator, to consider the connection between the combustion chamber and the coal mill. Equilibrium calculations are performed at 19 different temperatures, ranging for example from 1400 to 500°C in 50°C steps. Ten of them calculate airborne reactions and nine represent wall reactions. They mainly differ in the way the output is used. Every airborne reactor will partly transfer its output to the next wall and airborne reactor, but the wall reactors will only transfer non-sticking and gaseous material to the next airborne reactor. In order to do that, amount splitters and phase splitters have been used. To face kinetic restrictions during combustion an additional stream path has been implemented. It separates big, non-reactive particles, mainly consisting of pure quartz, from the main stream. This leads to a different composition and therefore to another chemical equilibrium, mostly resulting in higher slag values. The sticking probability at the wall reactors will be calculated on the basis of slag amount and viscosity. To evaluate the results, experimental data from laboratory and boiler ashes will be analysed. First comparisons showed good agreement between the calculations and the experimental data, although the great number of model parameters gives ample scope to interpretation.