Modeling a CFB biomass gasifier. Part III: Kinetic equations involved, unknowns, and problems in solving the set

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[Part I and II have already been presented. They appear in the Proceedings of the Biomass Conferences held in Sevilla (Spain), June 2000, and in Tyrol (Austria), September 2000]

The first part of this communication is mainly focussed to present the set of twenty chemical reactions (and of their kinetics) taking part in a CFB biomass gasifier (CFBBG) which have some but clear influence in the gas composition, gas yield and gas quality (tar content) at the exit of the CFBBG. This reacting network needs in turn about 20 kinetic equations with around 30 unknowns. Half of the unknowns are stoichiometric coefficients because the partitioning of some key reactants as O_2 and H_2O among the lot of competitive reactants (H_2, CO, CH_4, C_2H_n, tars, char, …) is not known.

Once stablished a scientifically based set of kinetic equations and mass balances for all species (which are complex and not linear differential equations) it is demonstrated how it can not be solved with rigour. So, assumptions or simplifications must be introduced. Depending on the assumptions, several and different empiric models can be generated. In fact, the few existing models for CFBBGs can be generated from a global and complex model using different simplifications. These simplifications, the error introduced with each one, are discussed in this communication.

The authors select, develop and use two of such empiric (or simplified) models. They are solved, and the effects of the equivalence ratio, temperatures, biomass composition and moisture on the gas composition, yield and quality are shown.

A model without checking is nothing and there are very few commercial CFBBG worldwide available for checking these models. A world survey has been made to get some key design details and results for model validation. Although results from such survey have been scarce, they are used to check the models and to find their intervals of usefulness.

The lot of papers or data in the open literature obtained under conditions far from real CFBBGs (and not useful thus) is made clear in this work. This work gives insight in important and realistic parameters which are not known nowadays and that someone should find out in the future.