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Combustion Technology

Pyrolysis Model for Biomass

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Background

Against the background of changing legal conditions, due to the Renewable Energy Act, in addition to wood alternative fuels are used in decentralised grate firings with thermal outputs < 20 MW increasingly.
To describe the combustion behaviour of these fuels, beside empirical studies numerical models can offer a support.
After drying, pyrolysis is the second process step within the combustion. Therefore a detailed pyrolysis model is critical for the simulation of combustion processes.

Pyrolysis Model for Biomass

Using the pyrolysis model, it is assumed that biomass is build of the pseudo-components cellulose $(C_6H_{10}O_5)_n$, hemicellulose $(C_5H_8O_4)_n$ und Lignin $(C_{10}H_{10}O_4)_n$.
In the equation for the thermal degradation, only monomers and pseudo-components will be considered.
Each of this monomers is degraded during two parallel running chemical reactions, which differ in their final products gaseous tar and metaplastic tar.

Pseudo-components

$$a_1\,Tar_{(g)} + b_1\,CO_2 + c_1\,CO + d_1\,H_2 + e_1\,H_2O + f_1\,CH_4 + g_1\,Char_{(s)} \quad (1)$$

$$a_2\,Tar_{(l,\,s)} + b_2\,CO_2 + c_2\,CO + d_2\,H_2 + e_2\,H_2O + f_2\,CH_4 + g_2\,CHar_{(s)} \quad (2)$$

The assumption of a metaplastic as an intermediate product is well known from other models.
In the present model, the nature of metaplastics is not given exactly. A high boiling liquid, a solid material or a mixture of both is possible. The metaplastic itself is degraded according to equation (1)
For this set of reaction equations, the velocity constants are varied till the calculated total mass loss matches with the DTG curves.

As the mass loss of the solid material mirrors itself in an adequate development of the gas phase, the stoichiometric coefficients a to g have to be varied till a complete mass balance is achieved.
This adjustment is performed by the model automatically. This is represented by a high flexibility of the assumed product distribution: A variation of the gross equations for $tar_{(g)}$, $tar_{(l,\,s)}$ and/ or $char_{(s)}$ results in a change of the calculated gas composition.The automated calculation of the product distribution makes the iterative refinement of the model results easier. In case of the beech wood pyrolysis, the model has been tested successfully.

For further information go to:
https://www.itc.kit.edu/

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