A global model for small scale wood combustion


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Heat and mass transfer processes in a stove

Approach in this work

- consider only thermally thin wood layers burning off in successive time steps to obtain a one dimensional approximation
- use average heat transfer coefficients and average surface areas
- use validated one step mechanisms with stoichiometric equations for pyrolysis, carbon burnoff and gas phase reactions

Properties of Global Models

- Rate constants fitted to global reactions are subject to the assumed mechanism, hence they are not exchangeable between different models, in contrast to elementary reactions.
  Independent validation required.
- To date no reliable standards are available for wood pyrolysis which initializes combustion.
  New model was developed and validated.

New five step pyrolysis model

\[
C_{6}H_{10}O_{5} \text{ cellulose} \rightarrow \text{ gas} + 2.5 \text{ C} \\
C_{6}H_{10}O_{5} \text{ tar} \rightarrow 0.75 \text{ tar} + \text{ gas} + 0.625 \text{ C} \\
C_{5}H_{8}O_{4} \text{ hemicellulose} \rightarrow \text{ gas} + 2 \text{ C} \\
C_{10}H_{10}O_{4} \text{ lignin} \rightarrow \text{ gas} + 4.3 \text{ C}
\]

model validation: comparison with results from thermogravimetry and flash pyrolysis

Validation of Global Model by Comparison with Fixed Bed Combustion Experiment

calculated burn-down of fixed bed filled with beech wood spheres 10 mm i.d.

Pyrolysis Model Validation by Tar (Oil) Formation under Non-Isothermal Conditions

calculated product formation of beech wood pyrolysis

KLEAA code


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