Modeling Biomass Behavior during Combustion: A Thermochemical Approach to predict slagging. Effect of the S/Cl molar ratio.

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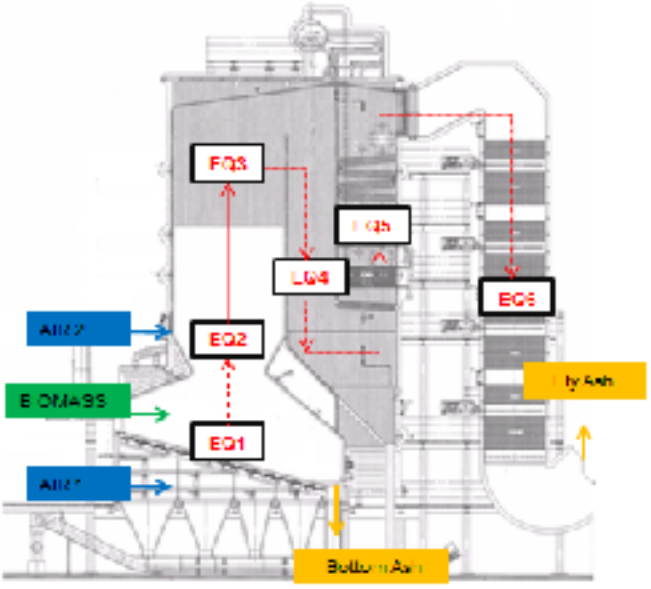
Abstract (300 word limit)

Thermochemical modeling seems a promising tool in the biomass combustion field to avoid ash-related problems during combustion: slagging, fouling and corrosion [1–4]. Several authors have used thermochemical software packages to understand and validate their experimental results in different biomass combustion studies [5–7], focusing directly on ash composition or ash streams composition. Besides, most of these studies are focused on operational issues, especially on those concerning de-fluidization phenomena, in pilot scale combustion plants. In this work, a thermochemical model was developed to predict inorganic elements' release during combustion and the melting behavior and composition of the fly ash in the downstream, allowing to evaluate the effect of biofuel composition on the ash composition and behavior. With the aid of experimental data obtained by common techniques, previously used in other studies, such as chemical fractionation [8,9], and chemical analysis to understand elements distribution during combustion, the model could be validated by comparison with real data.

The results obtained with the model presented in this work, reveal the importance of the S/Cl molar ratio to reduce ash deposition problems during gas cooling in the combustion of wheat straw using large scale vibrating grate technologies.

Image



Recent Publications (minimum 5)

[1] Li QH, Zhang YG, Meng AH, Li L, Li GX. Study on ash fusion temperature using original and simulated biomass ashes. Fuel Process Technol 2013;107:107–12. doi:10.1016/j.fuproc.2012.08.012.

[2] Lehmusto J, Yrjas P, Skrifvars B-J, Hupa M. High temperature corrosion of superheater steels by KCl and K2CO3 under dry and wet conditions. Fuel Process Technol 2012;104:253–64. doi:10.1016/j.fuproc.2012.05.020.

[3] Sengeløv LW, Hansen TB, Bartolomé C, Wu H, Pedersen KH, Frandsen FJ, et al. Sulfation of Condensed Potassium Chloride by SO2. Energy & Fuels 2013;27:3283–9. doi:10.1021/ef400405z.

[4] Wang X, Liu Y, Tan H, Ma L, Xu T. Mechanism Research on the Development of Ash Deposits on the Heating Surface of Biomass Furnaces. Ind Eng Chem Res 2012;51:12984–92. doi:10.1021/ie302009m.

[5] Sommersacher P, Brunner T, Obernberger I, Kienzl N, Kanzian W. Application of Novel and Advanced Fuel Characterization Tools for the Combustion Related Characterization of Different Wood/Kaolin and Straw/Kaolin Mixtures. Energy & Fuels 2013;27:5192–206. doi:10.1021/ef400400n.

[6] Moradian F, Pettersson A, Richards T. Thermodynamic Equilibrium Model Applied To Predict the Fouling Tendency in a Commercial Fluidized-Bed Boiler, Combusting Solid Waste. Energy & Fuels 2015;29:3483–94. doi:10.1021/acs.energyfuels.5b00346.

[7] Nordgren D, Hedman H, Padban N, Boström D, Öhman M. Ash transformations in pulverised fuel co-combustion of straw and woody biomass. Fuel Process Technol 2013;105:52–8. doi:10.1016/j.fuproc.2011.05.027.

[8] Teixeira P, Gulyurtlu I, Lapa N, Lopes H. Use of chemical fractionation to understand partitioning of biomass ash constituents during co-firing in fluidized bed combustion. Fuel 2011. doi:10.1016.

[9] Pöykiö R, Nurmesniemi H, Dahl O, Mäkelä M. Chemical fractionation method for characterization of biomass-based bottom and fly ash fractions from large-sized power plant of an integrated pulp and paper mill complex. Trans Nonferrous Met Soc China 2014;24:588–96. doi:10.1016/S1003-6326(14)63099-5.

Notes/Comments:

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