

Dynamic behaviour of a single biomass particle in bubbling fluidised bed reactors: experimental investigation and model development

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Abstract

Fluidised bed reactors have a long record of success in the field of thermochemical conversions due to their favourable mixing features, near-constant temperature and the good operating flexibility. These features make fluidised beds particularly suitable for the application with heterogeneous feedstock, including biomass and waste. Nevertheless, there are still issues related to the mixing and separation of heterogeneous phases in fluidised beds. Solid feedstock is usually less dense than the bed material used for thermochemical applications, and therefore it experiences axial segregation and tends to stratify on the bed surface causing complications in the hydrodynamics of the bed. In addition, at high temperatures the volatile content is released in form of bubbles which generally exert a “lift” effect on the particle itself, by dragging it up to the bed surface. Such phenomenon leads to high release of volatile matter into the freeboard and limited mass and heat transfer with catalyst particles in the bed inventory. This issue is particularly relevant during thermochemical conversions of material with high content of volatile matter, such as biomass, plastics and RDF (Refused Derived Fuel).

The aim of this work is to investigate the dynamic behaviour of a single reacting beech wood sphere in a hot fluidised bed reactor by means of advanced X-Ray imaging techniques. The analysis will be undertaken at different fluidisation regimes and temperatures, to closely mirror the operating conditions of Waste-to-Energy processes. Small lead tracers will be inserted into the beech wood particles to make them visible upon the x-ray irradiation and to vary the sample density. Experimental results of different biomass particle densities will be used to validate a comprehensive segregation model developed by means of the MATLAB software. The modelling work will be carried out taking into account both the pyrolysis and char burnout stages, with the overall purpose of better understanding the mixing of solid fuels during thermochemical conversions in fluidised bed reactors and predict their dynamic and thermal behaviour. This information is of prime importance for the design of industrial scale reactors operating on either biomass or waste.