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Abstract

Fluidized bed thermochemical conversion of biomass (combustion, gasification, pyrolysis) displays a long record of successes, spanning from lab- to industrial scales, and stems out as the most viable pathway for the exploitation of biogenic fuels, either alone or in combination with fossil fuels. In spite of its diffusion, there are still open design and operational issues that are largely related to segregation and mixing of solid and gas phases in fluidized beds and effectiveness of multiphase contacting patterns. The common claim of fluidized beds being well stirred/well controlled environments for heterogeneous and gas-phase reactions falls short when applied to processing of biomass fuels.

This study aims at providing a comprehensive framework of fundamental phenomena affecting mixing/segregation of phases during thermochemical processing of biomass and of their interlinks. The basic processes include patterns and kinetics of biomass devolatilization, particle and volatile matter (VM) segregation along and across the reaction chamber, particle attrition/fragmentation and generation of fine particulates, the diversity of gasification patterns and rates, as related to chemical composition and morphology of the parent biogenic fuels. Segregation brings about important consequences in terms of temperature uniformity, of proper control of heterogeneous and gas-phase reaction pathways, of ash behaviour, of pollutant emissions, of plant operability and dependability. Measures to counteract segregation, including pre-processing of biomass and/or appropriate control of bed hydrodynamics, will also be surveyed from the fundamental and applied standpoints.

Keywords: Fluidized bed, mixing, biomass, combustion, pyrolysis, gasification, segregation