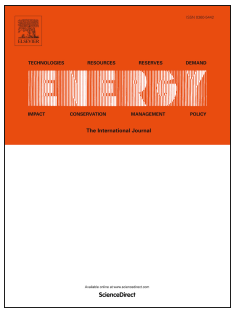
Accepted Manuscript



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PII: S0360-5442(18)30439-0

DOI: 10.1016/j.energy.2018.03.037

Reference: EGY 12495

To appear in: *Energy*

Received Date: 20 August 2017

Revised Date: 1 March 2018

Accepted Date: 6 March 2018

Please cite this article as: Xue J, Goldfarb JL, Enhanced devolatilization during torrefaction of blended biomass streams results in additive heating values and synergistic oxidation behavior of solid fuels, *Energy* (2018), doi: 10.1016/j.energy.2018.03.037.

Enhanced Devolatilization During Torrefaction of Blended Biomass Streams Results in Additive Heating Values and Synergistic Oxidation Behavior of Solid Fuels

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Abstract

Torrefaction improves energy density, grindability, and hydrophobicity of raw biomass for gasification and combustion. While literature focuses on single biomass torrefaction, industrial production is likely to be from biomass mixtures. To address this knowledge gap, we torrefied three raw biomasses (pistachio nutshells, feed corn stover, cherry pits) at 250°C, as "pure" biomasses and in multiple component mixtures to understand if synergistic interactions during torrefaction impact oxidation behavior of resulting solid fuels. The combustion enthalpies of blended biomasses were well predicted by an additive function, whereby a blend's property was the mass-weighted average of each biomass' torrefied property. However, synergistic effects that enhanced devolatilization when biomasses were comingled during torrefaction led to systemically lower volatile matter contents and higher surface areas of resulting solid fuels. This synergistic behavior continues in terms of activation energy of oxidation of the torrefied samples. Co-torrefaction of biomass may lead to a solid fuel with predictable heat content, but synergistic effects lead to oxidation of blended streams at different rates and activation energies, with blends often having lower reactivities and higher activation energies than an "additive" prediction of pure fuel components. This is attributed to enhanced devolatilization among biomasses, leading to more condensed carbonaceous solids.

Keywords

Torrefied biomass; oxidation kinetics; biomass blend; oxidation; volatile compounds; reaction synergy

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