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Thermal behavior of an engineered fuel and its constituents for a large range of heating rates with emphasis on heat transfer limitations

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Highlights

- Devolatilization of a waste derived fuel and its constituents was studied via TGA.
- Heating rate (HR) ranged from 5 to 400°C/min.
- At HR greater than100°C/min, we observed a bias in TGA results.
- The bias at high HR appeared to be due to heat transfer limitation.
- We developed a heat transfer model to correct such limitations in TGA samples

Abstract

Engineered fuels (EF) manufactured from waste can be an advantageous substitute for coal or other fossil fuel in (co-)combustion, gasification or pyrolysis processes. Unfortunately, because of their heterogeneity, the thermal behavior of such fuels can often be complex, limiting their application. In the present study, the pyrolysis of a heterogeneous commercial EF composed of fibers and plastics was investigated using a TGA apparatus over a large range of heating rates (from 5 to 400°C/min). At a heating rate of 5°C/min, the EF devolatilization curve was simply a proportional sum of the devolatilization curves of its individual components. When the heating rate was increased up to 100°C/min, however, a shift in the devolatilization TG curve of the fibers, plastics and EF to higher temperatures was observed as a consequence of heat transfer limitations within samples. Furthermore, differences between the proportional sum of the devolatilization curves of the individual components of the EF and its experimental curve were observed, and increased with increasing heating rates up to 400°C/min. A model was developed to correct for heat transfer limitations by considering thermal phenomena such as heat transfer limitations between the TGA and the sample, change in sample heat capacity and effect of endothermic reactions on sample temperature. This model predicted the shift of EF devolatilization towards higher temperature with increasing heating rates, which suggests that no significant chemical effects occurred between the EF components.

Key words: Engineered fuel; Refuse derived fuel; wastes; TGA; devolatilization; heat transfer