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Investigation of Rheological Behavior of Untreated and Microwave-Assisted Alkaline Pretreated Sugarcane Straw for Biofuel Production

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Abstract

Purpose

Biomass slurries, such as those subjected to microwave-assisted alkaline (MAA) pretreatment, will become common substrates for the production of biofuels in the future. While the rheology of acid and ionic liquid pretreated biomass is known, the rheology of alkaline pretreated biomass is not yet reported; hence, the goal of this study was to establish the rheological characteristics of untreated and MAA pretreated sugarcane straw (SC).

Methods

Using rotational rheometry and rheological models, the rheology of SC slurries was assessed as a function of particle size and insoluble solids concentration.

Results

In the range of 5–17% insoluble solids concentration, the slurries were consistently pseudo-plastic ($n = 0.33 \pm 0.02$), possessed yield stress with their flow accurately described by the Casson rheological model ($R2 = 0.98–0.99$). The apparent viscosity and yield stress increased by two orders of magnitude with an increase in insoluble solids concentration. Essentially, MAA pretreated slurries exhibited significantly higher values of apparent viscosity and yield stress than the untreated ones, in the range of 55–80% and 21–63% for particle sizes of < 63 µm (P63) and 90–180 µm (P90), respectively. Pretreated P63 samples exhibited higher apparent viscosity and yield stress than the P90. On the other hand, for untreated samples, P63 samples had a reduced apparent viscosity than P90 samples.

Conclusion

The results of this study definitively reveal that MAA significantly increases the shear rate dependent shear viscosity values along with the yield stress of biomass slurries. This will, therefore, serve as a benchmark for characterizing other MAA pretreated biomass slurries to guide the design of industrial-scale production equipment.

Keywords

Biomass; Biofuels; Sugarcane straw; Rheology; Microwave-assisted alkaline pretreatment