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Using in-situ viscosimetry and morphogranulometry to explore hydrolysis mechanisms of filter paper and pretreated sugarcane bagasse under semi-dilute suspensions

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Abstract

The relationship between in-situ viscosimetry, in- and ex-situ morphogranulometry, and biochemistry has been investigated during enzymatic hydrolysis of pretreated sugarcane bagasse (SCB, 3% w/v) and filter paper (FP, 1.5% w/v) at various enzyme dosages (0.3 to 25 FPU/g cellulose). Semi-dilute conditions (1.5 to 2 times higher than critical concentrations) were considered in order to generate non-Newtonian rheological behaviors and to avoid neglecting particle-particle interactions in opposition to dilute conditions. Observed phenomena as well as hydrolysis mechanisms including solvation, separation, fragmentation, and solubilization appeared to depend strongly on initial substrate properties. For both FP and SCB, suspension viscosities were correlated with particle size distributions and volume fractions during hydrolysis, but they exhibited strongly different trends. With SCB, a viscosity overshoot was clearly observed at enzyme loading ≤ 10 FPU/g cellulose. This phenomenon is explained by the separation of agglomerates into individual fragments, leading to an increase in the total number of particles and a morphological shift of particles from sphere-like into fiber-like. With FP, the viscosity collapsed at the initial stage in relation to the volume reduction of coarse particles and the number increase of fine particles. Suspension viscosity was strongly dependent on the fraction of coarse population and nearly independent from the glucose conversion yield.

Keywords

in-situ viscosity; particle size distribution; filter paper; sugar cane bagasse; enzyme; hydrolysis.