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Hydrolysis of high concentration lignocellulose suspensions with a cumulative feeding strategy: rheometry and morphogranulometry

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Abstract

Bioconversion of lignocelluloses is currently a major challenge if biorefining operations are to become commonplace. The objectives of the present work were to understand and describe the evolution of physical properties of lignocellulose suspensions during enzyme-based hydrolysis reaction. Experimental set-up and methodology were developed in order to carry out a multiscale study of the lignocellulosic materials under high dry content. In-situ and ex-situ rheometry and morpho-granulometry measurements were used to investigate transfer limitations (Fig. 1). Rheological behaviour was modelled and critical concentrations (Ccr) inducing a sharp increase of viscosity were identified with Whatman paper (WP, 35 gdm/L) and paper pulp (PP, 31 gdm/L) [1]. In a first step, hydrolysis experiments demonstrate that single dimensionless viscosity-time curves, \( \mu = f(t) \), could be established for each substrates. Analysing hydrolysis experiments lead to assume an optimal feed rate \( Q^* \) linked to the critical concentration. In a second step, cumulative feeding strategies (up to 10%w/w) were conducted for WP and PP with different ratios \( Q/Q^* \). Results report the evolution of viscosity, hydrolysis rate (Fig. 2) and mean particle size. Mixing power during suspension and hydrolysis steps are discussed as a function of hydrolysis rates.

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**Fig. 1: Experimental methodology and strategy**

**Fig. 2: Viscosity and bioconversion rate as a function of hydrolysis time (PP) - Experimental conditions:** 1%\( \leq \) [dry matter] \( \leq \) 10%w/w, \( T=40^\circ \text{C}, \) \( pH=4.8, \) Accelerase 1500 (Genencor) 0.5mL/g cellulose -


**Key-words:** hydrolysis, lignocellulose, viscosity, particle size, bioconversion.