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► To cite this version:

Tien-Cuong Nguyen, Dominique Anne-Archard, Véronique Coma, Xavier Cameleyre, Eric Lombard, et al.. Hydrolysis of high concentration lignocellulose suspensions with a cumulative feeding strategy: rheometry and morpho- granulometry. 10. European Symposium on Biochemical Engineering Sciences (ESBES), Sep 2014, Lille, France. hal-01886482

HAL Id: hal-01886482

<https://hal.science/hal-01886482>

Submitted on 5 Jun 2020

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Hydrolysis of high concentration lignocellulose suspensions with a cumulative feeding strategy: rheometry and morpho-granulometry

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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 (C_{crit}) 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.

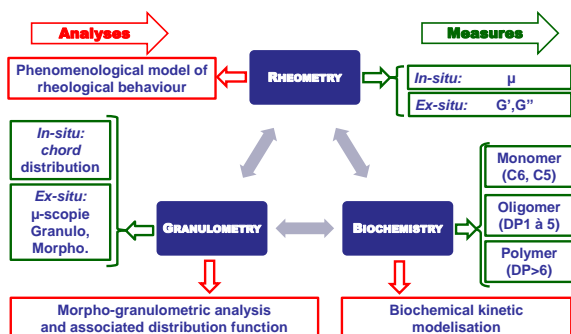


Fig.1: Experimental methodology and strategy

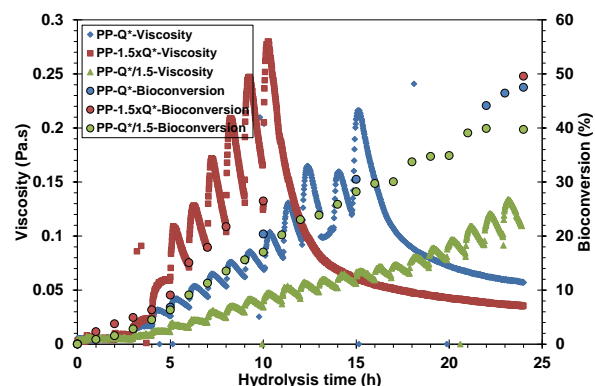


Fig.2: Viscosity and bioconversion rate as a function of hydrolysis time (PP) - Experimental conditions: $1\% \leq [\text{dry matter}] \leq 10\% \text{w/w}$, $T=40^\circ\text{C}$, $\text{pH}=4.8$, Accelerase 1500 (Genencor) 0.5mL/g cellulose -

[1] Nguyen, T.-C., et al., Bioresource Technology, 2013, 133(0), 563-572.

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