Hydrolysis of concentrated lignocellulose suspensions with a cumulative feeding strategy based on a critical concentration: From laboratory to pilot scale

Tien-Cuong Nguyen, Dominique Anne-Archard, Véronique Coma, Frédérique Pichavant, Xavier Cameleyre, Eric Lombard, Kim Anh To, Luc Fillaudeau

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HYDROLYSIS OF CONCENTRATED LIGNOCELLULOSE SUSPENSIONS WITH A CUMULATIVE FEEDING STRATEGY BASED ON A CRITICAL CONCENTRATION: FROM LABORATORY TO PILOT SCALE

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Presenting author: Tien Cuong Nguyen
Authors and affiliations : Tien Cuong Nguyen:Université de Toulouse,Lab. Ingénierie des Systèmes Biologiques et des Procédés,Toulouse,France;CNRS,Fédération de Recherche FERMAT,Toulouse,France|Dominique Anne-Archard:Université de Toulouse ,Institut de Mécanique des Fluides de Toulouse,Toulouse,France;CNRS,Fédération de Recherche FERMAT,Toulouse,France|Véronique Coma:Université Bordeaux 1,Laboratoire de Chimie des Polymères Organiques ,Bordeaux,France|Frédérique Pichavant:Université Bordeaux 1,Laboratoire de Chimie des Polymères Organiques,Bordeaux,France|Xavier Cameleyre:Université de Toulouse,Lab. Ingénierie des Systèmes Biologiques et des Procédés,Toulouse,France;CNRS,Fédération de Recherche FERMAT,Toulouse,France|Eric Lombard:Université de Toulouse,Lab. Ingénierie des Systèmes Biologiques et des Procédés,Toulouse,France;CNRS,Fédération de Recherche FERMAT,Toulouse,France|Kim Anh To:School of Biotechnology and Food Technology,Hanoi University of Science and Technology,Hanoi,Vietnam|Luc Fillaudeau:Université de Toulouse,Lab. Ingénierie des Systèmes Biologiques et des Procédés,Toulouse,France;CNRS,Fédération de Recherche FERMAT ,Toulouse,France

Abstract:
In the context of biofuels and chemical production of petroleum substitutes from renewable carbon, bioconversion of lignocellulose biomasses is currently a major challenge. The limited knowledge of liquefaction and saccharification mechanisms stands as the main factor which penalizes bio-refinery progress. The objective of the present work was to increase the substrate concentration during hydrolysis in controlling transfer limitations by a specific strategy of substrate feeding. This concept was studied at laboratory scale and transposed into pilot scale. In-situ and ex-situ rheometry, morpho-granulometry and biochemical measurements were used to investigate transfer limitations. In a preliminary step (lab scale), rheological behaviour was modelled and a critical concentration (Ccrit) inducing a sharp increase of viscosity was identified for Whatman paper (WP, 35 gdm.L-1) and paper pulp (PP, 31 gdm.L-1) [1]. Analysing hydrolysis experiments leads to assume an optimal feed rate Q* linked to this critical concentration. In a first step, cumulative feeding strategies (up to 10%w/w) were conducted for WP and PP in 2L reactor with different ratios Q/Q*. A cumulative feeding substrate strategy allows to considerably reduce the transfer limitations linked to high concentrations and to control the glucose production kinetics [2]. In the second step, the enzymatic hydrolysis (up to 20%w/w) was investigated in a 20L reactor coupled with an extruder (substrate feeding). This transposition will be discussed regarding the biochemical kinetics and physical limitations.

Reference 1: 1. Nguyen, t.C., et al., in situ rheometry of concentrated cellulose fibre suspensions and relationships with enzymatic hydrolysis. Bioresource technology, 2013. 133(0): p. 563-572.
Reference 2 : 2. Nguyen, T.C., In-situ and ex-situ multi-scale physical metrologies to investigate the destructuration mechanism of lignocellulosic matrices and release kinetics of fermentable cellulosic carbon, in Institut National des Sciences Appliquées de Toulouse 2014, Université de Toulouse. p. 190.
Reference 3 :
Reference 4 :

Highlight 1: Increase the substrate concentration during hydrolysis in controlling transfer limitations
Highlight 2: Studie at laboratory scale and transpose into pilot scale
Highlight 3: A cumulative feeding substrate strategy allows to control the glucose production kinetics