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Mixing effects on the kinetics and the dynamics of two-phase enzymatic hydrolysis of hemicellulose for biofuel production

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ABSTRACT

This work uses a coupled experimental and modeling approach to explore the effects of macro- and micro-mixing on the kinetics and the dynamics of two-phase enzymatic hydrolysis of hemicellulose. Reactor mixing does not alter the non-competitive nature of product inhibition in hemicellulose hydrolysis by endoxylanase, but produces stronger inhibition that reduces the soluble sugar yield by 8-14.5%, as the mixing speed increases from 0 to 200 rpm. The kinetic constants (K_m, V_{max}, K_x) assume mass-transfer disguised values at 0-200 rpm. An optimal mixing strategy, comprising of 55-70 min of initial rapid convective macromixing followed by diffusive micromixing (without any macromixing) for the rest of the hydrolysis, increases xylose and reducing sugar yields by 6.3-8% and 13-20%, respectively, over continuous mixing at 200 rpm, for 1-5 mg/ml substrate loading at an optimum enzyme to substrate ratio of 1:20, with an energy saving of 94-96% over 24 h.

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