Overcoming Factors Limiting High Solids Fermentation of Lignocellulosic Biomass

Background

- Simultaneous saccharification and fermentation (SSF) can reduce cost of lignocellulosic ethanol production by consolidating process steps and reducing end-product inhibition of enzymes compared to separate hydrolysis and fermentation (SHF).
- A long-standing limitation of SSF has been too low ethanol yields at the high solids loading of biomass needed during fermentation to realize sufficiently high titers favorable for more economical recovery

Approach

- This study illustrates how competing factors that limit ethanol yields at high solids fermentations are overcome by integrating newly developed Co-solvent Enhanced Lignocellulosic Fractionation (CELF) pretreatment with SSF. These factors include typical pretreatment inhibitor, mass transfer, carbon limitations, nonoptimal temperatures and high enzyme loadings.

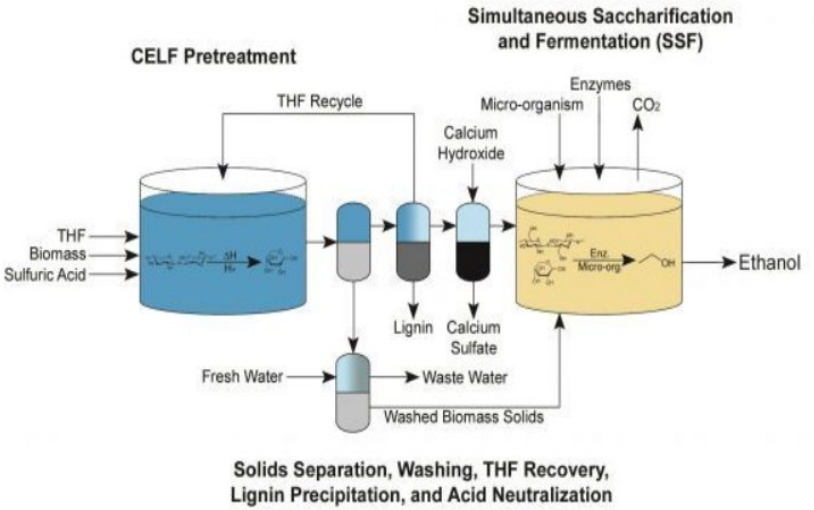

Diagram of a biomass conversion process that integrates CELF pretreatment with simultaneous saccharification fermentation (SSF) to produce ethanol.

Outcome

- Optimizing SSF of CELF-pretreated corn stover achieved unprecedented ethanol titers of 79.2, 81.3, and 85.6 g L^{-1} in batch shake flasks, corresponding to ethanol yields of 90.5%, 86.1%, and 80.8% at solids loadings of 20.0, 21.5, and 23.0 wt%, respectively.
- Ethanol yields remained over 90% at an enzyme loading of only 10 mg-protein/g-glucan (~6.5 FPU), revealing that primary factors limiting ethanol production were due to reduced cell viability and glucose uptake by *S. cerevisiae* D5A and not loss of enzyme activity or mixing issues.

Significance

- For the first time, a strategy is demonstrated whereby high solids fermentation of biomass to ethanol is now limited by the microbe rather than by process engineering.

Nguyen, Cai, Kumar and Wyman, "Overcoming factors limiting high-solids fermentation of lignocellulosic biomass to ethanol." *PNAS* (2017) doi: 10.1073/pnas.1704652114

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