Hydrolysis and Fermentation of Lime-pretreated Biomass

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Alkaline pretreatment of lignocellulosic biomass has regained interest because of perceived advantages for ethanol production, including low formation of fermentation inhibitors. We investigated mild-temperature, lime ($Ca(OH)_2$) pretreatment of lignocellulosic biomass for enzymatic hydrolysis purposes.

Methods

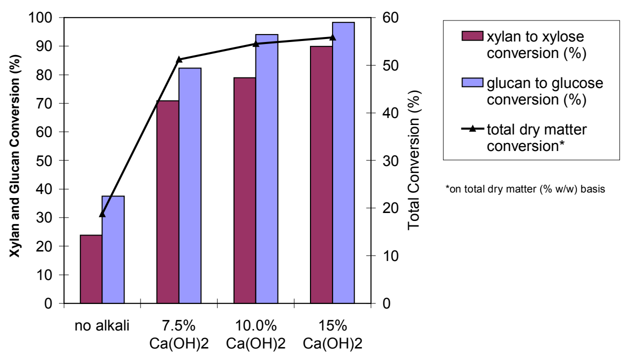
- Feedstock: Wheat straw (32% glucan, 20% xylan)
- Pretreatment: 1.8 L working volume; 85°C, 16h
- Enzymatic hydrolysis: 24h-72h; 50°C
- Ethanol fermentation: *Saccharomyces cerevisae*, 32°C

Results

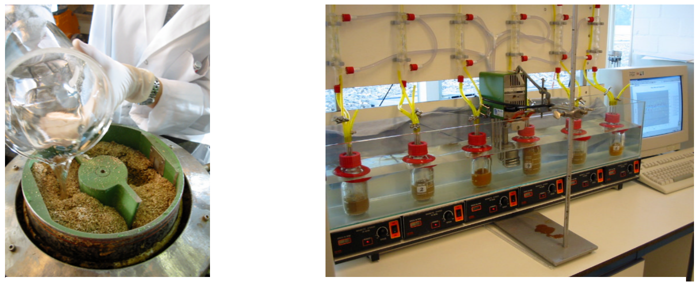
- Contrary to many other pretreatment methods, lime pretreatment at atmospheric conditions does not lead to significant dissolving of xylan or lignin.

		Composition [%]					
	mass [%]	Ara	Xyl	Man	Gal	Glc	Lignin
Wheat straw, untreated	100.0	2.1	20.3	0.5	0.7	32.0	24.0
Lime-pretreated wheat straw	99.3	2.0	19.0	0.0	0.0	33.0	23.5

- High enzyme loading rates show considerable glucan-to-glucose and xylan-to-xylose conversion.



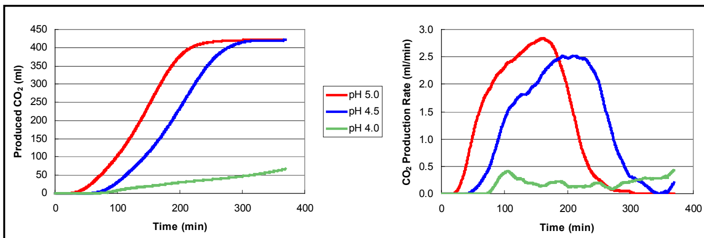
Enzymatic hydrolysis yields (24h; pH = 5.0; 118 FPU/g dm) at varying lime loading rates; Enzyme used: Genencor GC220



Apparatus: pulp reactor used for pretreatment (left); Fermentation test bench for ethanol fermentation (right)

- Lower enzyme dosage (2 - 15 FPU/g dm) results in 16-53% glucan conversion, indicating high enzyme inhibition and/or inactivation.

- Fermentation of unwashed substrates show no (pH=5.0), moderate (pH=4.5) to severe (pH=4.0) inhibition of *S. cerevisae* due to acetic acid.



CO_2 production and -production rate during fermentation of lime-pretreated biomass

- Applying simple washing techniques to recover alkali and remove inhibiting compounds leads to major improvements in fermentability of substrates.

Conclusions

Lime pretreatment leads to high enzymatic degradability and fermentability of lignocellulose, without significant de-lignification or xylan degradation. On-going work is focused on evaluating alkali recovery techniques, simultaneous saccharification and fermentation, upscaling, and economic evaluation.

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