Effect of Initial Mixing on Enzymatic Hydrolysis of Ball Milled Wood

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Introduction
Dry Milling process is a very promising method to reduce the recalcitrance of biomass for biofuel production. The sugar yield can be as high as 89.4% (10 FPU/g rice straw, 5% solid). However, energy consumption could be 108 MJ/kg rice straw (Hideno et al., 2009).

Find a way reducing the severity of milling while maintain the high sugar yield and maintain a non-chemical process will be very favorable to reduce the cost of producing biofuels and will minimize the environmental consequences.

Effective initial mixing to promote good enzyme distribution and will finally have a improved sugar yield(Roche et al., 2009). The role of the mechanical action is to increase the amount of amorphous cellulose, which is more susceptible to enzyme attack than crystalline cellulose(Lenting and Warmoeskerken, 2001).

Torque rheometer is a candidate mixing unit because it has a very good mixing ability. Roller rotor was found to be most effective and efficient(Ahmed Salahudeen et al., 2011).

In this poster, torque rheometer is used as the prime mixing unit. Ball milled wood and enzymes were mixed inside torque rheometer before going into hydrolysis.

Objectives
A initial mixing process was added between ball milling and enzymatic hydrolysis process in order to improve initial dispersion of enzymes and increase sugar yield.

**• Mixing action occur inside torque rheometer. The mixing torque can reveal the extent of fiber damage occur in this mixing environment. The mixing torque during mixing at different variables ( Mixing time, Rotation speed) will be demonstrated.

**• Effective initial mixing to promote good enzyme distribution and will finally have an improved sugar yield. The sugar yield at different mixing conditions will be compared.**

Flow Chart

**Course Milling** → **Ball Milling** → **Initial Mixing** → **Further Incubation**

**Ball Mill Conditions**
- Milling time: 60/80 mins
- Temperature: 25°C
- Jar Volume: 500 ml
- Ball Diameter 6mm: 181.5g
- Ball Diameter 20mm: 31.5g
- Ball weight/Pulp weight: 15:1/1

**Reference**

Results

**Fig. 1 Energy Consumption of Course Milling (Wiley Mill)**

**Fig. 2 Energy Consumption of Ball Milling**

**Fig. 3 Mixing Torque of Ball Milled Wood at Difference Rotation Speed.**

**Fig. 4 a) Effect of mixing time on enzymatic hydrolysis of ball milled wood (40% solid); b) Effect of mixing time on enzymatic hydrolysis of ball milled wood (30% solid); c) Effect of rotation speed on enzymatic hydrolysis**

Conclusion
In this poster, the effect of initial mixing of ball milled wood and enzymes on sugar yield were mainly presented:

- From mixing torque curve under different rotation speed, we can see a shearing thickening behavior of ball milled wood and enzyme slurry.
- The resistance of mixing dropped close to 1/3 of the initial resistance after 10 minutes torque rheometer mixing. The decrease of processing resistance will greatly save the energy consumption when mixing and transporting wood slurries in real world production.
- Enzyme activities might be under damage at higher rotation speed and long processing time.
- With higher solid loading, the detrimental effect was more obvious comparing with lower concentration. Friction between dry particles might be the reason of damaging enzymes.
- In order to improve effectiveness of enzymatic hydrolysis, the mixing process is recommended to be controlled at lower rotation speed, shorter time and comparatively lower concentration.