Motivation:
Lignocellulose represents a readily available renewable feedstock which may be used in the production of a variety of chemicals and fuels. An integrated bio-refinery could extract hemicellulose while preserving cellulose for pulp production. Fermenting the hemicellulose derived five carbon sugars is more difficult than fermenting cellulose derived glucose. Increasing the yield through use of hemicellulose is essential to making the bio-refinery economical.

Composition of wood on dry, extractive free basis:
Cellulose is a polymeric chain of glucose units only
Hemicellulose is a heterogeneous polymeric chain with branching substituents

Structure of Hemicellulose (Arabinoglucuronoxylan) – Xylose backbone with branching Arabinose and glucuronic acid substituents. Other types of hemicellulose contain Glucose, Galactose, and Mannose

Fermentation Control:
- pH: 6.5 by 2M NaOH
- Temperature: 37°C by heat jacket / cooling coil
- Aeration: 1LPM by thermal mass flow control
- Agitation: 100RPM

Monitoring Cell Growth:
- Optical Density at 600nm

Hydrolysis to Monosugars
Before fermentation it is necessary to break the bonds linking the hemicellulose sugar units. This is done with dilute acid at 121°C. Longer reaction time, higher temperature and more acid correspond to more severe hydrolysis, which decreases monosugar recovery except for increased glucose due to cellulose degradation. Degradation products such as acetic acid, furfural, and hydroxymethyl furfural also increase. These compounds are known to inhibit the micro-organisms used in fermenting.

Effect of Temperature on Fermentation
Xylose fermentation at 37°C showed much faster sugar consumption and ethanol production rates that the same conditions run at 30°C.

Fermentation of Five Sugar Mix Mixtures of the five pure sugars were prepared in ratios corresponding to recovery data of hemicellulose extracts prepared in our lab. Air flow was slightly lower for the 60min case at 0.4LPM.

In both trials glucose was consumed within the first 10 hours. Xylose remains nearly constant until this time, then ferments at a much faster rate. Galactose is entirely consumed within 60 hours. Mannose determination was not possible. Arabinose showed very little decrease in the 80 hours monitored. 30g/L ethanol was produced in the 99min trial, compared to only 17g/L in the 60min trial.

Conclusions: Ethanol was produced from simulated hemicellulose extracts at 85% of theoretical yield. This data provides a baseline of comparison for future work.

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