Impact of Recycling Stillage on Conversion of Dilute Sulfuric Acid Pretreated Corn Stover to Ethanol
Ali Mohagheghi and Daniel J. Schell
National Renewable Energy Laboratory, Golden, CO 80401

Objective
Assess impact of process water recycle on process performance
Goal: Achieve 25% process water recycle with no negative impact on process performance

Introduction
• Large quantities of water needed in biomass-to-ethanol process (Approx. 6 Gal/Gal of EOH produced)
• Recycle waste water reduces fresh water requirements and downstream treatment needs
• Consequence of recycling is accumulation of non-metabolizable compounds that may inhibit fermentation
• Knowledge of inhibitors and how to minimize their effect on fermentation performance is key

Materials and Methods

Experimental Procedure

Problematic Feedstock

Nutrient/Inoculum

Water

Ethanol + Water

Distillation

Baseline 1st Recycle 2nd Recycle 3rd Recycle

Pretreatment

Media + Water

Fresh

Fresh Hydrolysate + Other Media + Water

Stillage

Recycled Water

Experimental Setup

For each Condition:
• Total of 4 Fermentations; Three with recycling of stillage at one condition in each replicate
• Sugar concentrations measured by HPLC using the Shodex SP0810 carbohydrate column (55oC, 0.6 mL/min, water mobile phase, RI detection)
• Analytical

Analytical
• Sugar concentrations measured by HPLC using the Shodex SP0810 carbohydrate column (55°C, 0.6 mL/min, water mobile phase, RI detection)
• Liquor densities measured using an Anton-Paar densitometer

Issues:
• Acetate inhibition of Zymomonas:
  – At lower pH as acetate concentration builds up inhibition becomes an issue
  – Other inhibitors may become an issue

Summary of the Results
• With 15% Solids loading & 25% RR there was little impact
  – Ethanol Yield: 75%
  – Glucose & Xylose Utilization: 95% & 60%
• With 20% Solids loading & 10% RR some impact was noticed
  – Ethanol Yield: 65%
  – Glucose & Xylose Utilization: 85% & 37%
• With 20% Solids loading & 25% RR, impact was very significant
  – Ethanol Yield: 10%
  – Glucose & Xylose utilization: 95% & 50%
• Increasing initial cell mass improved pure sugar performance but not in hydrolysate recycle

Conclusions
• Higher yield and sugar utilization in pure sugar compared to hydrolysate shows:
  – Other inhibitors besides acetic acid are producing negative impact on the process
  – With 20% solids loading and 25% RR, impact was very significant

Acknowledgements
Funding for this work was provided by the Office of Biomass Program in the Department of Energy’s Office of Energy Efficiency and Renewable Energy
We wish to thank Jody Farmer, Bob Lyons, and Wes Hjelm for performing the pilot scale pretreatment that produced the hydrolysate used in this study.

The information contained in this poster is subject to a government license.

Recent Advances in Fermentation Technology VIII • San Diego, CA • November 8-11, 2009 • NREL/PO-510-47183
NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.