Sugar platform and beyond

“Concepts for producing advanced biofuels and bioproducts”

Birgitte K. Ahring, WSU
Waste Biomass → Pretreatment Process → Cellulose → Enzyme Process → Fermentable Sugars → Fermentation → Bioethanol

Waste Biomass → Pretreatment Process → Cellulose → Enzyme Process → Pathway Bioprocess → Biochemicals

1st Generation Process

2nd Generation Process

Starch → Enzyme Process → Fermentable Sugars → Fermentation → Bioethanol

Starch → Enzyme Process → Pathway Bioprocess → Biochemicals
Cellulose Process

Corn Process

Sugar Cane Process

Sugar Cane → Sugar → Fermentation → Distillation → Drying → Biofuels

Corn Kernels → Starch Conversion

• Corn Stover
• Grasses
• MSW
• Forest Residues
• Ag Residues
• Wood Chips
BioGasol’s Concept

Biomass → Pretreatment → Fermentation (glucose) → Biogas production → Enzymes → Fermentation (xylose) → SOLID FUEL

HYDROGEN → METHANE → ETHANOL

Temperature:
- 55°C → Biogas production
- 32°C → Enzymes
- 70°C → Fermentation (xylose)
Straw, wood, etc..

Klinke et al., 2000

xylose, arabinose, galactose, mannose, glucose.

Lignin 5-25%

Cellulose 35-45%

Hemicellulose 25-40%

C6 sugar

C5 sugar

Yeast / BG1

Ethanol

BG1
Lignocellulosic biomasses

Tested with success in the laboratory

1 tonnes wheat straw

300-320 liters of ethanol

Wheat straw

Coffee Husks

Willow

Eucalyptus Wood

Corn Stover

Sugarcane Bagasse

Rice Straw
Pilot plant under construction
Pilot plant
Biomass is macerated
Biomass cut in small pieces to increase surface area and ease handling

Wet oxidation
Temperature: 160-180°C (12 to 20 bar)
Additions: Oxygen & Water

Exothermic process
Heat will be produced
Enzymatic treatment and glucose fermentation

**Pretreatment**

**Fermentation (glucose)**

**Fermentation (xylose)**

**Biogas production**

**SOLID FUEL**

**Enzymes**

- **METHANE**
- **ETHANOL**
- **HYDROGEN**

**Biomass**

Hydrolysate cooled

*No* detoxification required

**Enzymes added**

Commercial enzyme mixture: Cellulases & β-glucosidases

**Mesophilic fermentation**

*Saccharomyces cerevisiae*
C6 fermentation

Yield: 0.45 – 0.48 g ethanol / g C6 sugar
Productivity: 1 - 2 g ethanol / l / h
Pretreated straw 20% DW
Enzymatic hydrolyzed straw 1.5 hours
After SSF 48 hours
The aviation problem

• Energy density
• Freezing point
• Sulfur and particle generating content
• Availability
• Prize
Different quality Fuels
Ways of making biomass into fuels

- In operation
- In development
- In theory

Food Crops (Corn, cane, etc.)
Sugar
Ethanol
Other Feedstocks (Corn stover, wood, wastes, energy crops, etc.)
Drop-ins

Source: The Economist, 10/28/2010
The fermentation technology builds on isoprenoids. The primary (5-carbon) building block is isopentenyl pyrophosphate (IPP).

Will be looking at organism development for C5 sugar utilization and biomass hydrolysate compatibility.

Mevalonate pathway for diesel fermentation intermediate production (Amyris)
Woody biomass

Hydrolysis → Microbial processing

Pretreatment → Heat

Gasification → Syngas → Fischer-Tropsch

Pyrolysis → Bio-oil → Hydrotreating

Gasoline
Diesel
Jet fuel

Forest waste
Corn stalks
Switchgrass

Algae
Full biomass utilization & feedstock flexibility

Integrated biorefinery process concept maximizes the utilisation of the biomass resource (i.e., converting the biomass available into a number of high energy products). We call it the: "the carbon slaughterhouse"

The Integrated Biorefinery concept can use many different types of biomass materials:
Equipment for the pilot testing of the BioCat* process