Treatment of Waste Paper Sludge to Produce Bioethanol

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ABSTRACT

This poster examines the potential of generating ethanol from waste paper sludge

OPPORTUNITY

- Current disposal methods for waste paper sludge are costly
- Land applications of sludge are restricted by environmental concerns
- Dried sludge can be burned, but sludge from waste paper mills has low heating value due to the high mineral content
- Combining generation of bioethanol with recovery of the mineral fillers would generate income and reduce costs
  - ❖Sludge would not have to be dried
  - ❖Sludge could be sold to bioethanol producers
  - ❖Recovered fillers could be used on site for paper generation

Waste Paper Sludge consists of mineral fillers and short fibers

Separate and treat fibers

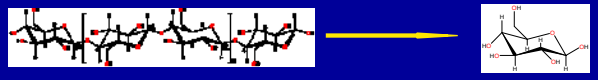
PROJECT OBJECTIVES

- Evaluate treatability of sludges from various waste paper mills
  - Old newspaper
  - Old corrugated cardboard
  - Mixed waste papers
- Demonstrate conversion technology on a laboratory scale
  - Lower cellulase loading
  - Demonstrate xylose conversion
  - Optimize reactor operating parameters
- Compare the affect of enzymatic and acid hydrolysis treatments on the yield of bioethanol
- Evaluate the effectiveness of simultaneous saccharification and fermentation (SSF) for bioethanol production

PROJECT BACKGROUND

Hydrolysis (saccharification) of cellulose

Cellulose must be hydrolyzed to release glucose



Acid hydrolysis
- uses sulfuric acid and severe conditions
- acid must be neutralized before fermentation

Enzymatic hydrolysis
- mild conditions
- may have to add xylanase in addition to cellulase

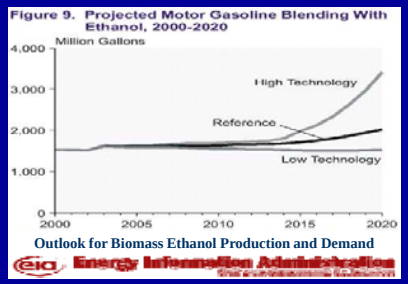
Need to minimize production of fermentation inhibitors such as furfural and 5-hydroxymethylfurfural often produced by hydrolysis of hemicellulose

Fermentation to produce bioethanol

Yeast are added to the hydrolyzed solution

Yield Factors due to Reaction Conditions
- Type of yeast
- Yeast culture conditions prior to fermentation (can acclimate yeast by maintaining yeast culture on hydrolyzate solution)
- Fermentation conditions
- Presence of inhibitors produced during hydrolysis

Yield Factors due to Sludge
- Type of paper furnish
- Non-cellulosic materials such as
  - Lignin
  - Adhesives/stickies
  - Dyes



RESEARCH TASKS

Phase I: Characterization of the composition of various waste paper sludges

Chemical	Physical:
Mineral content	Particle size distribution
Lignin content	Bulk density
Sugar content	pH

Phase II: Investigation of the effects of different hydrolysis paper conditions

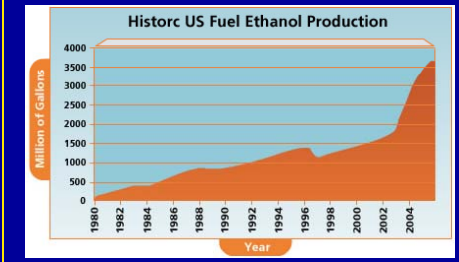
Compare Acid hydrolysis vs. Enzymatic Hydrolysis

Criteria: % of cellulose converted to glucose
Formation of known inhibitors - furfural and 5-hydroxymethylfurfural

Phase III: Comparison of yields from different sludges

Sludges:	Experimental conditions
Old newspaper	Acid hydrolysis
Old corrugated cardboard	Enzymatic hydrolysis
Mixed waste papers	Simultaneous saccharification and fermentation (SSF)

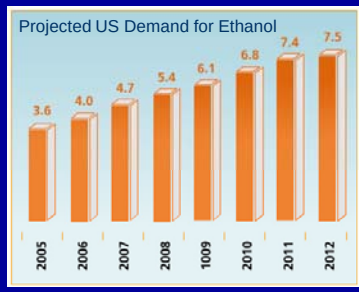
Yield calculation based on the theoretical maximum of 100% conversion of initial cellulose



Potential Market

>700,000 tons/yr of dry waste paper sludge (50% is cellulose fibers)
By EIA calculations of 173 gallons ethanol / dry ton feedstock)

Yield: 60.6 million gallons of ethanol
Worth $9 Million,
based on prices for March 28, 2006



PROJECT BENEFITS

- New Energy Resource from Waste
- No need to dry sludge
- Reduced disposal costs
- Reduced operating costs by recovery of fillers for paper production