

Ethanol Production Process Engineering Analysis

Corn Stover Design Report Case: 2012 model DW1102A
 Dilute Acid Pretreatment with Enzymatic Hydrolysis and Co-Fermentation
 All Values in 2007\$

Minimum Ethanol Selling Price (MESP):	\$1.76 /gal
Gasoline-Equivalent MESP:	\$2.68 /gal gasoline equivalent
Contributions: Feedstock	\$0.74 /gal
Enzymes	\$0.34 /gal
Non-Enzyme Conversion	\$0.68 /gal
Ethanol Production	61.0 MMgal/yr (Ethanol at 68 °F)
Ethanol Yield	79.0 gal / dry U.S. ton feedstock
Feedstock + Handling Cost	\$58.50 /dry U.S. ton
Internal Rate of Return (After-Tax)	10%
Equity Percent of Total Investment	40%

Capital Costs	
Pretreatment	\$29,900,000
Neutralization/Conditioning	\$3,000,000
Saccharification & Fermentation	\$31,300,000
On-site Enzyme Production	\$18,700,000
Distillation and Solids Recovery	\$22,300,000
Wastewater Treatment	\$60,200,000
Storage	\$5,000,000
Boiler/Turbogenerator	\$65,800,000
Utilities	\$6,900,000
Total Installed Equipment Cost	\$243,100,000
Added Direct + Indirect Costs (% of TCI)	\$198,100,000 45%
Total Capital Investment (TCI)	\$441,200,000
Installed Equipment Cost/Annual Gallon	\$3.98
Total Capital Investment/Annual Gallon	\$7.23
Loan Rate	8.0%
Term (years)	10
Capital Charge Factor (Computed)	0.131
Denatured Fuel Production (MMgal/yr)	61.7
Denatured Fuel Min. Sales Price	\$1.80
Denaturant Cost (\$/gal denaturant)	\$2.10
Maximum Yields (100% of Theoretical)	
Ethanol Production (MMgal/yr)	80.3
Theoretical Yield (gal/U.S. ton)	103.9
Current Yield (Actual/Theoretical)	76.0%

Manufacturing Costs (cents/gal ethanol)	
Feedstock + Handling	74.1
Sulfuric Acid	2.4
Ammonia	6.5
Glucose (enzyme production)	19.3
Other Raw Materials	51.7
Waste Disposal	2.5
Coproducts	-93.0
Fixed Costs	17.7
Capital Depreciation	22.8
Average Income Tax	12.8
Average Return on Investment	59.5

Manufacturing Costs (\$/yr)	
Feedstock + Handling	\$45,200,000
Sulfuric Acid	\$1,500,000
Ammonia	\$4,000,000
Glucose (enzyme production)	\$11,800,000
Other Raw Materials	\$31,600,000
Waste Disposal	\$1,500,000
Net Coproducts	-\$56,700,000
Fixed Costs	\$10,800,000
Capital Depreciation	\$13,900,000
Average Income Tax	\$7,800,000
Average Return on Investment	\$36,300,000

Specific Operating Conditions	
Enzyme Loading (mg/g cellulose)	20
Saccharification Time (days)	3.5
Fermentation Time (days)	1.5
Ethanol titer (wt%)	5.4%
Excess Electricity (kWh/gal)	0.4
Plant Electricity Use (kWh/gal)	5.3
Plant Water Usage (gal/gal)	5.4