

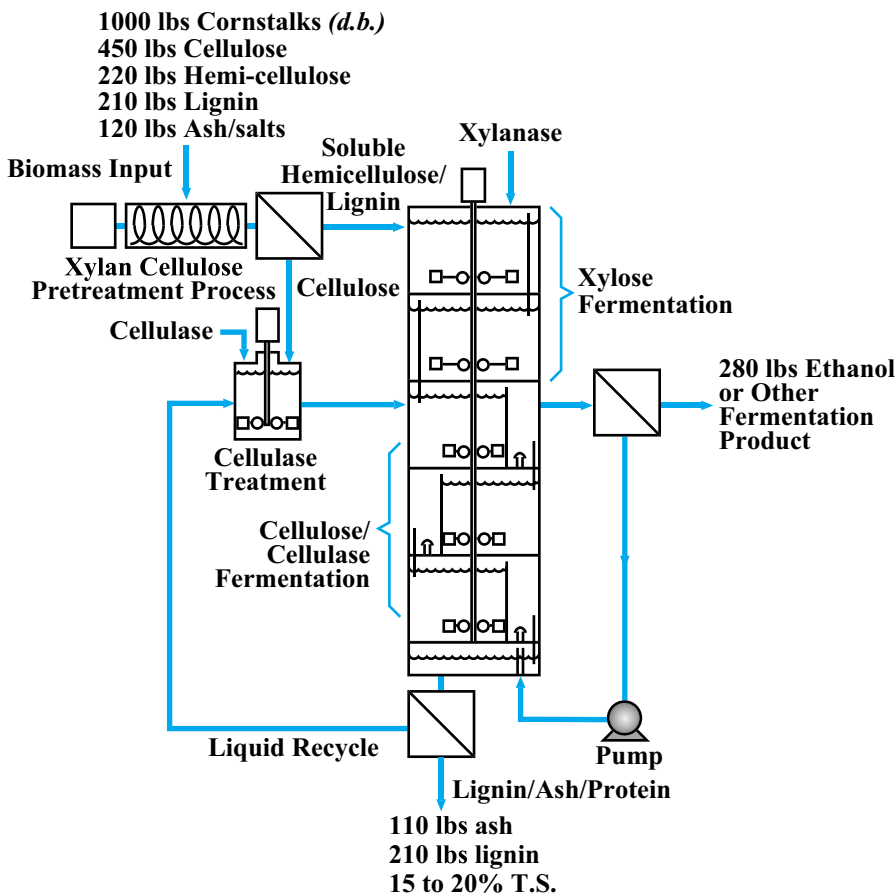
Continuous Cascade Fermentation System for Chemical Precursors



Continuous Cascade Fermentation System Increases Yields and Cuts Process Time for Converting Carbohydrates to Ethanol and other Chemical Precursors

With assistance from DOE's Inventions and Innovation Program, Bio-Process Innovation (BPI), Inc. developed a proprietary cascade reactor for ethanol production from carbohydrate feedstocks that eliminates the need to fill, empty, and wash a fermenter as part of a batch operation. Feed is introduced continuously into the first of three to five stirred reactors placed in series, with the outflow of one reactor flowing into the next reactor. The effluent from the reactor is then taken to a low-energy solvent absorption/extractive distillation system for separating and purifying ethanol. Separating the ethanol as it is produced increases the rate of ethanol production. BPI, Inc., also developed a highly flocculent yeast that further speeds the reaction of sugar to ethanol by maintaining cell densities of over 30 grams/liter. Continuous operations can more than double the fermentation capacity of a batch ethanol facility.

A five-stage unit of 40,000 gallons reactor volume has been operating at an Iowa site since June 1996 on waste starches/sugars. It produces about 1 million gallons of ethanol per year. A small pilot unit operating on cellulosics is currently being tested at BPI, Inc. A small plant in Wisconsin is using this technology to convert permeate mother liquor to ethanol.



*Commercialized Fermentation Technology Applied
to Emerging Concept of Biomass Fermentation*

Overview

- ◆ Commercialized by Bio-Process Innovation (BPI), Inc. in 1996
- ◆ Over 7 years operational experience
- ◆ 1 United States installation operating in 2003

Energy Savings (Trillion Btu)

Cumulative through 2003	2003
0.703	0.074

Emissions Reductions (Thousand Tons, 2003)

Particulates	SO _x	NO _x	Carbon
0.0	0.0	0.0	1.56

Applications

Converting carbohydrate feed stocks, which comprise 65% of municipal solid waste, to ethanol or other chemical precursors

Capabilities

- ◆ Continuous rather than batch system allows quick and complete saccharification and fermentation of feedstocks and removal of ethanol into a gas phase as it is produced.
- ◆ Uses abundant cellulosics as a feedstock for alternative chemical precursors.

Benefits

Productivity

Conventional reactor processing time of 36 to 48 hours is reduced to 24 hours or less. Dramatically improves throughput by maintaining a high cell density in the reactors and operating continuously.

Profitability

Lowers the cost of producing ethanol or other fermentation chemicals from carbohydrates by cutting production labor. Can be retrofitted on fermenters currently in use in batch-process ethanol production facilities.