66-6

New uses for agricultural byproducts and wastes

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The agricultural processing industry generates a large variety of byproducts and wastes, ranging from oat hulls to corn steep water. Researchers at the University of Iowa and Iowa State University are working through the Iowa Biotechnology Byproducts Consortium (BBC) to develop technologies that reduce environmental costs to the agricultural processing industry by developing new uses for these materials. Specific industries of interest in Iowa are grain and food processors and swine and cattle producers. The historical objectives of the BBC include characterization of wastes; analysis of byproduct streams; isolation of stream components; development of new processes for isolation of components; production of value-added products; anaerobic fermentation; microbial and enzymatic transformations to fine chemicals; and evaluation of byproduct streams as livestock feeds and as land applications. The BBC is increasingly focusing on the use of byproduct streams in the production of biobased products. This talk will focus on projects that are currently being conducted at Iowa State University (ISU). Projects at ISU are organized into two categories: 1) chemical transformations of waste streams; and 2) biological transformations of waste streams. The first category has two projects: the production of methyl esters from fatty acids and the production of ethylene glycol from pyrolyzed agricultural residues. The nine projects in the second category are: conversion of corn kernel fiber into cellobiose; isolation of thermostable, hydrolytic enzyme-producing microorganisms; anaerobic yeast production; fungal protein cultivation; biological hydrogen production; biological sulfide removal; composting technologies; and soil amendment studies.

Handout (.pdf format, 781.1 kb)

Session 66, Energy resource shortage: An inevitable challenge to food industry
9:00 AM - 12:00 PM, 2002-06-18 Room 303 B

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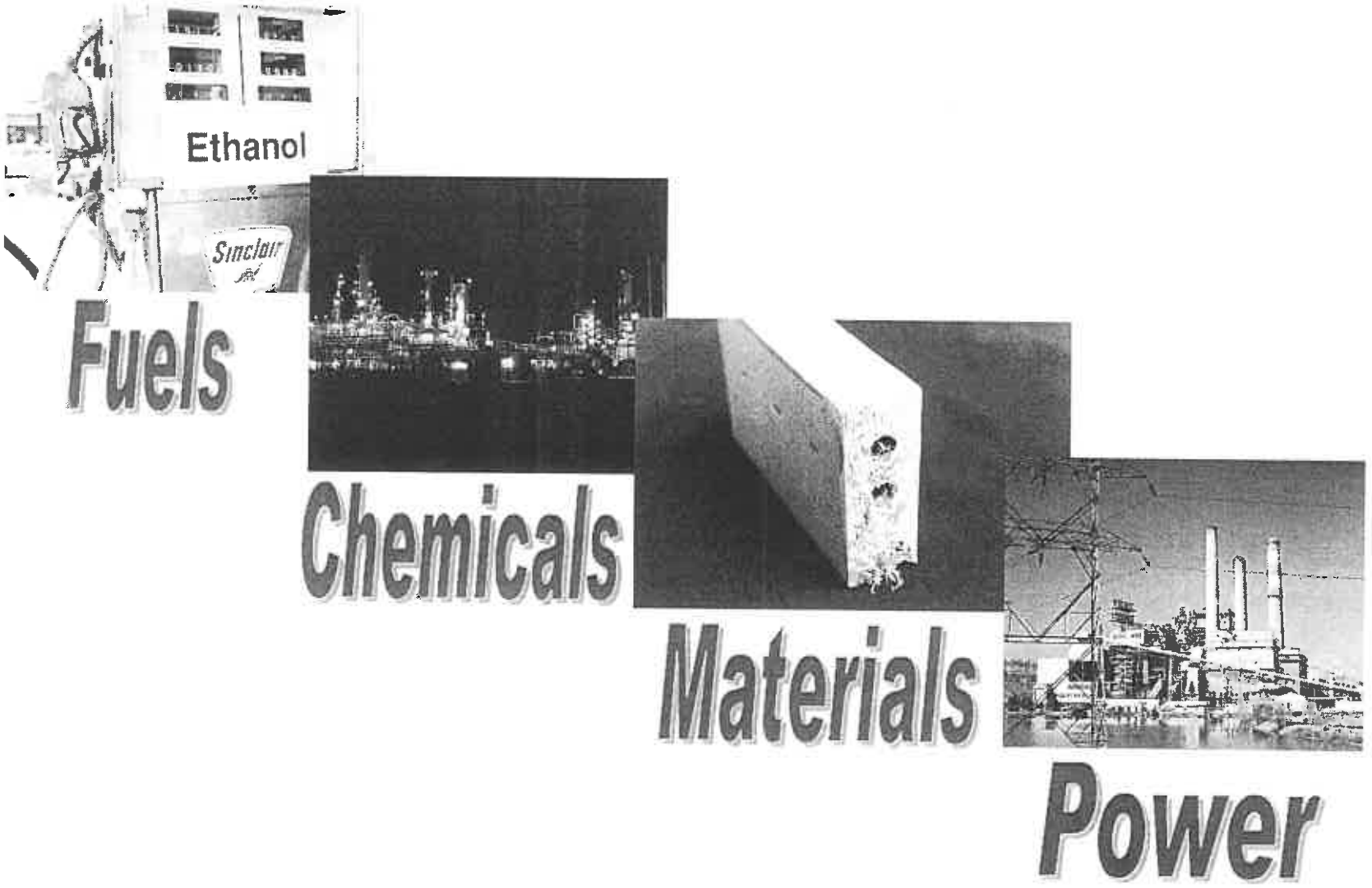
New Uses for Agricultural Byproducts and Wastes

Presented by
Robert C. Brown
Iowa Biotechnology Byproducts Consortium
Iowa State University

Iowa Biotechnology Byproducts Consortium (BBC)

- Mission
  - To support fundamental and applied research aimed at enhancing the recovery and utilization of byproduct materials arising from new and emerging industries in biotechnology. Byproduct recovery from fermentation and other waste streams generated by agribusiness is emphasized, with the goal of reducing the burden of waste products on municipal waste management systems.
- Organization
  - Partnership among Iowa State University, the University of Iowa, and Iowa industries
  - Funded by the USDA and administered by the Center for Sustainable Environmental Technologies at ISU

New Focus on Biobased Products



Selected Projects at Iowa State University

Hyperthermostable Microorganisms from the Food Processing Industry

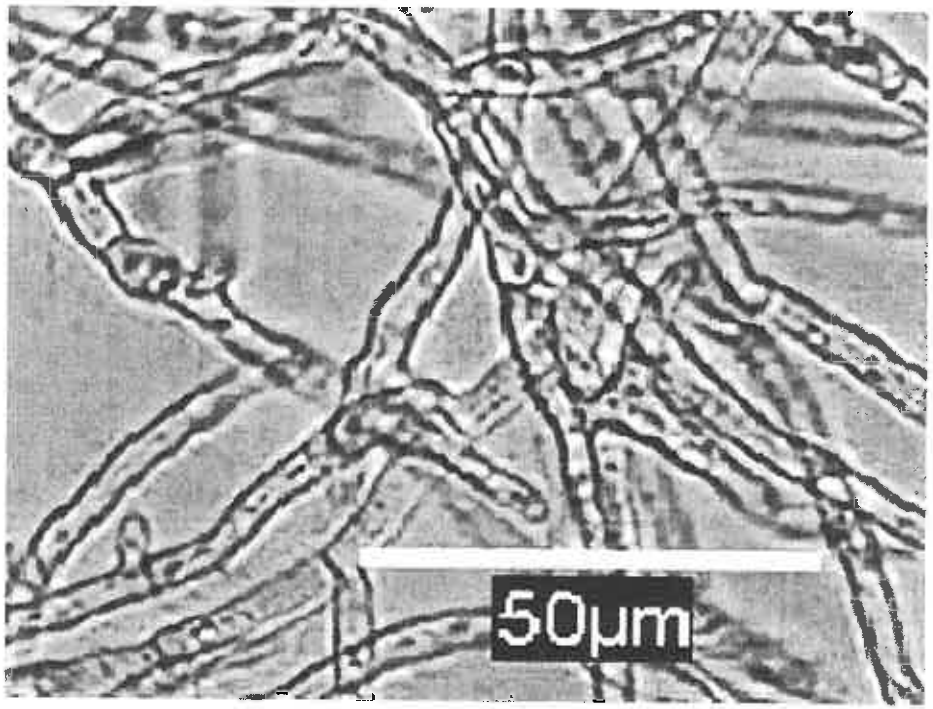
Anthony L. Pometto, III

- Results:
  - Developed a repeat batch reactor which operated at >90°C for isolation of hyperthermophiles.
  - Isolated over 12 different consortia via biofilms on PCS from corn wet milling facility and corn steep liquor (CSL).
  - Determined biological activity by CO_2 production, viable cell counts via flow cytometry in spent culture supernatants and PCS discs.
  - Isolates consist of Gram-positive cocci and rods, Gram-negative cocci and rods, and some endosporeformers.

Fungal Wastewater Treatment

J. (Hans) van Leeuwen

- Objective: Convert wastewater from food processing operations into value-added products.
- Approach: Fungal protein production:
  - *Rhizopus oligosporus;*
  - *Aspergillus oryzae.*

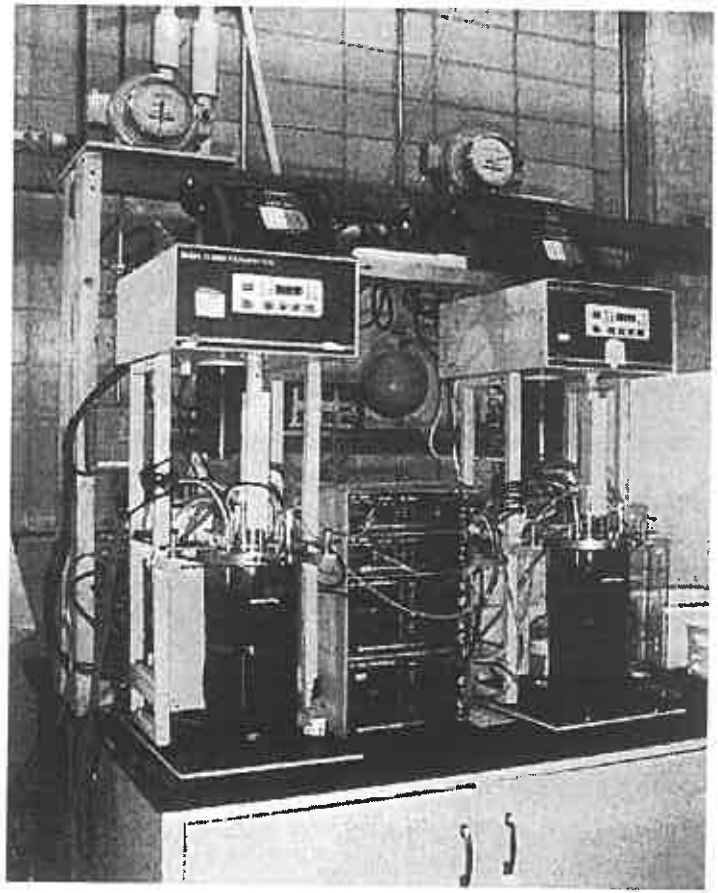


Rhizopus growths on wastewater from Archer Daniels Midland (ADM).

Biohydrogen Production from Agricultural Wastes

Shih-wu Sung

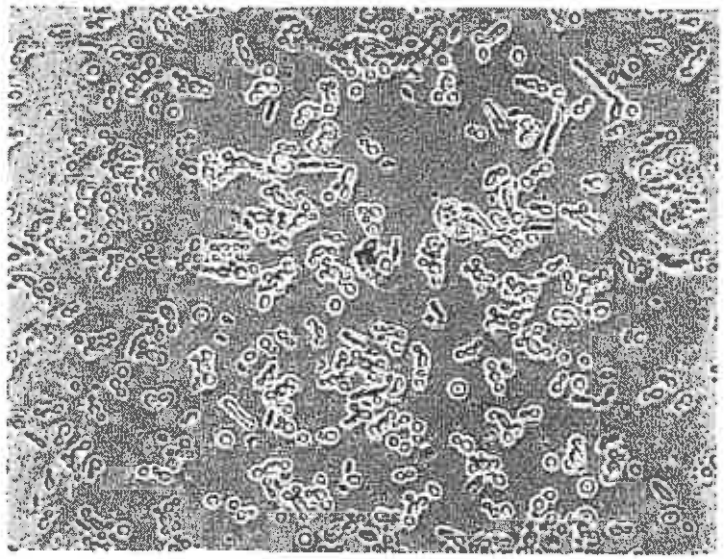
- Objective: Convert negative-value wastewater into hydrogen.
- Approach:
  - Optimization of H_2 production with synthetic wastes.
  - Process optimization of continuous-flow reactors.



Yeast Biomass Production

Timothy G. Ellis

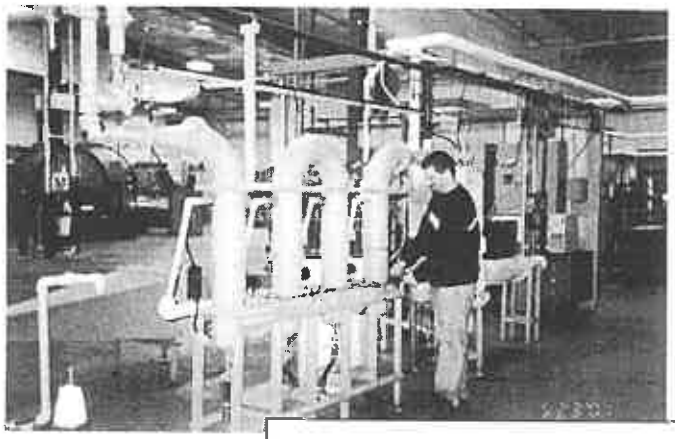
- Objective: Generate a high quality protein source from food processing wastewater.
- Approach: Continuous yeast production by kinetic selection:
  - *Candida utilis;*
  - *Candida tropicalis.*

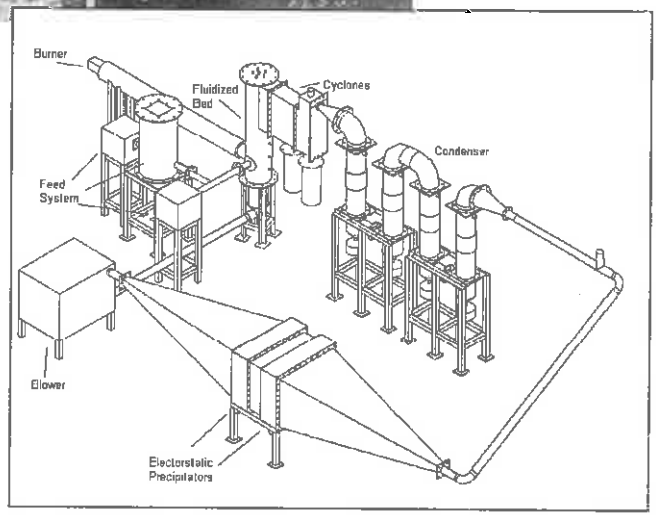


Yeast population in continuous flow reactor at SRT of 2d and pH 4.5.

Hybrid Thermal/Biological Production of Value-Added Chemicals*

Robert C. Brown





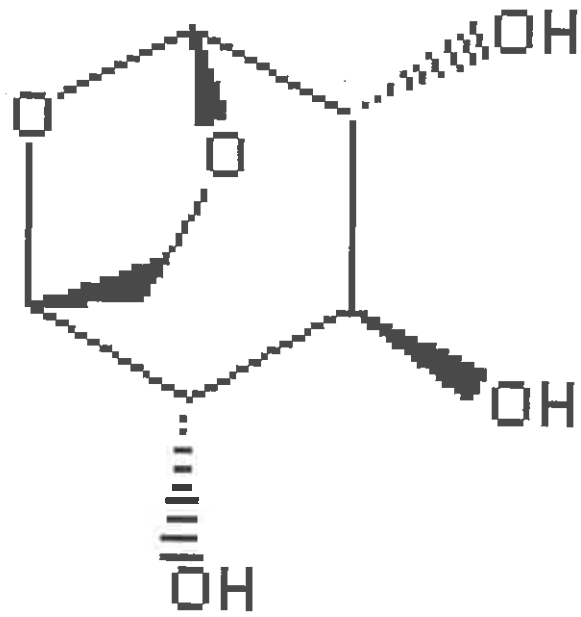
- Objective: Utilize fiber byproducts in production of value-added chemicals.
- Approach: Direct liquefaction of biomass by flash pyrolysis (fast heating in absence of oxygen).
- Results:
  - Selective condensation of products.
  - Enhancement of levoglucosan yields (an anhydrosugar).

* *This work is also supported by the Iowa Energy Center under Grant No. 98-05.*

Polyol Production

Brent H. Shanks

- Objective: Catalytic conversion of lignocellulose-derived sugars to ethylene glycol and propylene glycol.
- Approach: Sugar sources:
  - Pyrolysis syrup;
  - Pith cell hydrolysate.
- Currently produced from fossil fuels:
  - Ethylene glycol - 7 billion lbs/yr (U.S. production)
  - Propylene glycol - 1 billion lbs/yr (U.S. production)



Molecular structure of levoglucosan.

Biodiesel Pilot Plant*

Jon Van Gerpen

- Objective: Convert animal fats and waste restaurant grease into biodiesel fuel.
- Approach: Construct biodiesel plant to demonstrate new processing approaches. A 35 kW diesel generator has been installed to evaluate combustion characteristics of the fuel.

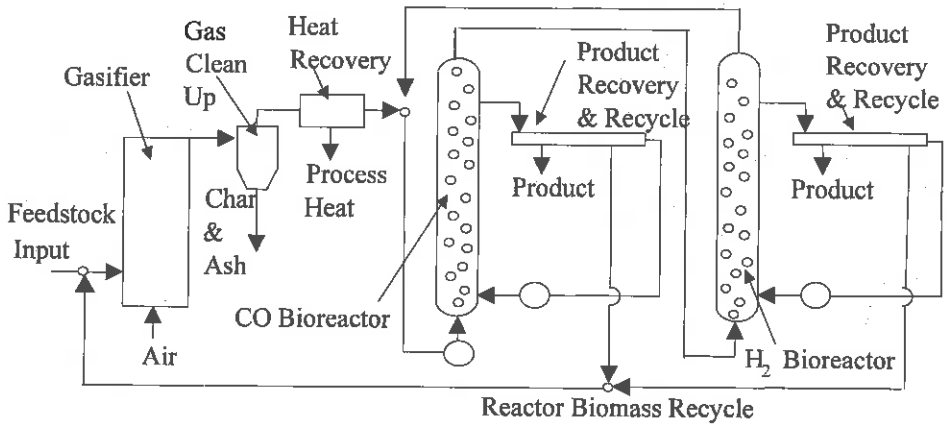
Biodiesel pilot plant.

* *This work is also supported by the Iowa Energy Center under Grant Nos. 98-06 and 01-02.*

Syngas Fermentation

Theodore (Ted) J. Heindel

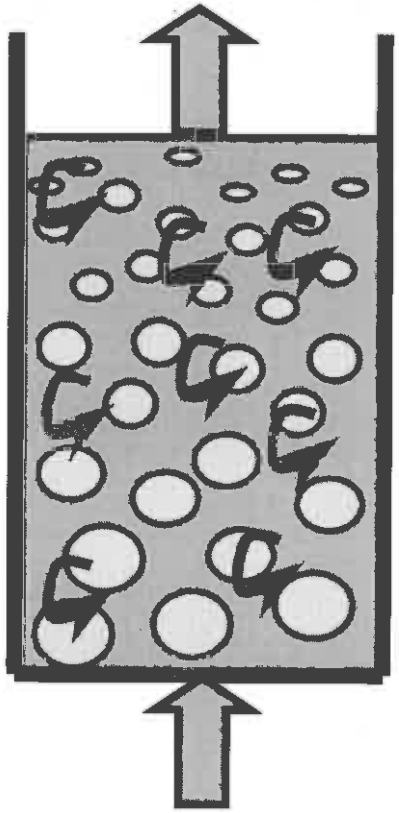
- Objective: Convert oat hulls, corn hulls, and other fiber byproducts into value-added products.
- Approach: Gasify fiber to syngas (carbon monoxide and hydrogen) and ferment gas to acetate, vitamin B_{12}, and polyhydroxy-alkanoic acids.



Product and Byproduct Recovery from Plant Extracts

Charles E. Glatz

- Objective: Recovery of proteins produced in transgenic plants.
- Approach: Using tools of biology (host), chemistry (adsorbent), and engineering (expanded bed mode seen at left) to solve recovery challenge.

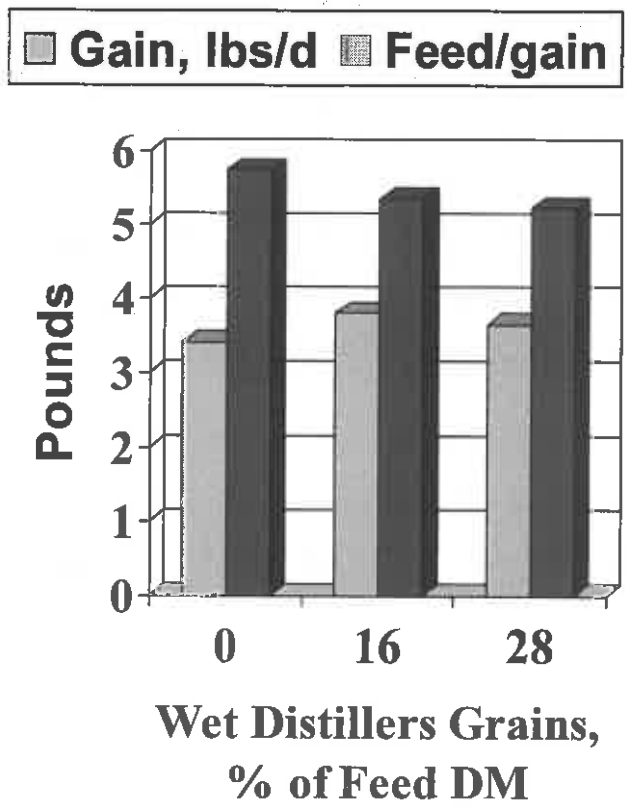


Expanded bed capture of recombinant protein.

Evaluation of Fermentation Byproducts as Feeds for Cattle

Allen H. Trenkle

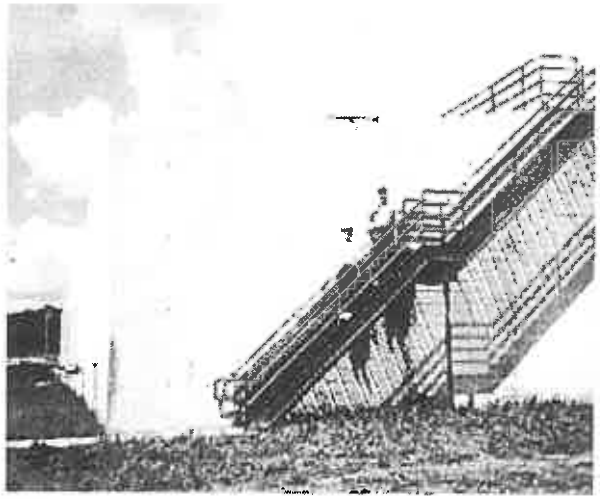
- Results:
  - Wet Distillers Grains are superior to corn grain as source of both protein and energy.
  - Value is 125% of corn.
  - No effects on carcass quality.
  - No effects on sensory value of meat.

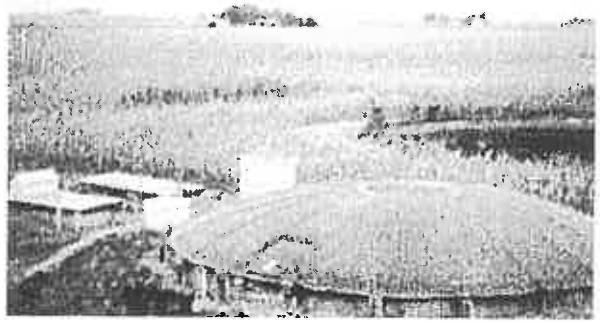


Anaerobic Bioconversion of Organic Wastes

Shih-wu Sung

- Objective: Convert agri-industrial wastes into biogas (methane), organic fertilizer, and chemicals.
- Approach: Development of new anaerobic digestion technologies.

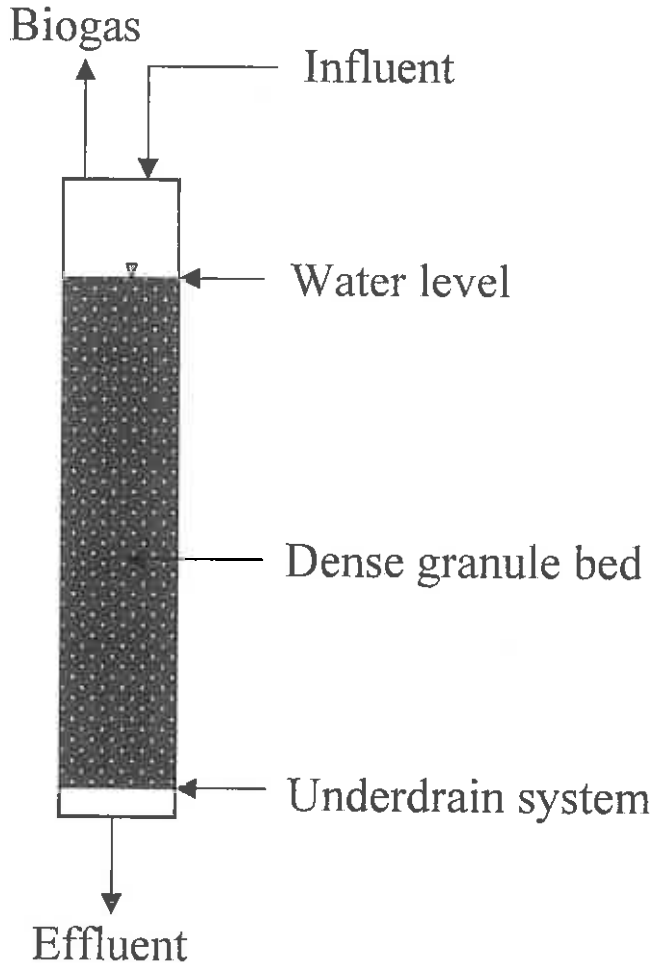




Static Granular Bed Reactor (SGBR) Development

Timothy G. Ellis

- Objective: Develop a high-rate anaerobic system that is relatively unaffected by operating changes.
- Approach: Use a down-flow reactor with dense-granule bed.



For Further Information

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- *Fungal wastewater treatment*
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- *Biohydrogen from ag wastes / Anaerobic bioconversion*
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- *Yeast biomass production / SGBR*
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- *Fast pyrolysis*
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