Introduction to the Proceedings of the Twelfth Symposium on Biotechnology for Fuels and Chemicals

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INTRODUCTION

At this point, commercial attention is largely focused on the application of biotechnology to the production of health care and other high-value products. However, interest is growing in the use of biological processes to treat effluent streams and restore contaminated water and soil. Bioprocessing also shows promise to produce low-cost fuels that can address mounting concerns about energy security, international trade, urban air pollution, and global climate change. Chemicals and materials can also be made by biologically catalyzed reactions from renewable feedstocks that are available domestically.

This Twelfth Symposium on Biotechnology for Fuels and Chemicals continues to provide an annual forum for researchers from industry, universities, and government laboratories to exchange information on recent developments in emerging bioprocessing technologies. As in the past, innovative processing concepts are stressed that are in the early stages of development. The meeting began with a session on Thermal, Chemical, and Biological Processing, followed by two sessions on Applied Biological Research. Next, topics in Bioengineering Research were presented, and a special session on Biotechnology, Bioengineering, and the Solution of Environmental Problems concluded the Twelfth Symposium. Both presentations and posters provided information exchange among meeting participants, and several discussion groups were organized to consider special topics of interest to the meeting participants.

The meeting was sponsored by the Department of Energy Biofuels Systems Division and the Energy Conversion and Utilization Technology Program, as well as Oak Ridge National Laboratory, the Solar Energy Research Institute, the Gas Research Institute, Badger Engineers, and the Division of Biochemical Technology of the American Chemical Society. Organization of the symposium was as follows.

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Session Chairpersons and Cochairpersons

Session 1. Thermal and Chemical Processing
Alvin O. Converse, Dartmouth College
Robert J. Evans, Solar Energy Research Institute

Session 2. Applied Biological Research I
Nancy W. Y. Ho, Purdue University
Karel Grohmann, Solar Energy Research Institute

Session 3. Applied Biological Research II
Stephen C. T. Lien, DOE Idaho Operations Office/Idaho National Engineering Laboratory
Gerald W. Strandberg, Oak Ridge National Laboratory

Session 4. Bioprocessing Research
Henry R. Bungay, Rensselaer Polytechnic Institute
Jack S. Watson, Oak Ridge National Laboratory

Session 5. Biotechnology, Bioengineering, and the Solution of Environmental Problems
Jon R. Geiger, Olin Research Center
Duane A. Graves, International Technology Corporation

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9. "Proceedings of the Ninth Symposium on Biotechnology for Fuels and Chemicals," (1987), *Appl. Biochem. Biotech.* **17,18.**

10. "Proceedings of the Tenth Symposium on Biotechnology for Fuels and Chemicals," (1988), *Appl. Biochem. Biotech.* **20,21.**

11. "Proceedings of the Eleventh Symposium on Biotechnology for Fuels and Chemicals," (1990), *Appl. Biochem. Biotech.* **24,25.**

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INTRODUCTION TO SESSION 1
THERMAL, CHEMICAL, AND BIOLOGICAL PROCESSING

A. O. Converse
Dartmouth College
R. J. Evans
Solar Energy Research Institute

Progress in the characterization and development of a number of important processes is presented. The bioremediation of contaminated soils has taken on great importance with the establishment of the superfund sites. The use of a differential flow reactor to characterize the degradation of polyaromatic hydrocarbons in soils, such as those found near manufacturers' gas plants, by mixed microbial cultures (presented in the first paper) should allow the design of bioremediation practices to be based on a more rigorous basis.

Activated carbon is one of the more valuable products that can be made from biomass. The effect of heating rate on the yield on quality is presented in the second paper. Higher quality activated carbon is formed at the higher heating rate; gaseous byproducts are used for process energy.

The control of anaerobic digesters is difficult because the proper control action depends on the feed composition (which **is not** available on line) and not simply on the methane production rate (which **is** available on line). Paper No. 3 presents a solution to this problem by basing the selection of the control algorithm on the response to previous controller action.

The effect of temperature on the solvolysis of a single lignocellulose wafer by hydrogen fluoride is reported. Glucose yields as high as 94% were obtained after a post hydrolysis. In the final paper, the virtues of the ammonia freeze explosion pretreatment process are explained. New developments in the ammonia recycle system have lowered the costs to approximately 1.5 cents/lb.

In conclusion, a number of advances in biomass processing techniques, that could be of benefit in many areas of biological as well as chemical conversion, are reported.

INTRODUCTION TO SESSION 2
APPLIED BIOLOGICAL RESEARCH I

N. W. Y. Ho
Purdue University
K. Grohmann
Solar Energy Research Institute

This session deals with diverse biological approaches to the improved production of enzymes and other metabolic products. The papers cover the following topics:

1. Fermentation of xylose and other sugars in wood hydrolyzates to ethanol,
2. Synergism of cellulase enzyme components in hydrolysis of cellulose,
3. Genetic improvement of cellulase production,
4. Glutamate production by marine cyanobacteria in a new bioreactor,
5. Production of oils by plants and tissue cultures by *Euphorbia* sp., and
6. Cloning of xylulokinase genes in yeasts.

The variety of approaches and systems studied should be of interest to all specialists in biotechnology.

INTRODUCTION TO SESSION 3
APPLIED BIOLOGICAL RESEARCH II

S. Lien
DOE Idaho Operations Office/
Idaho National Engineering Laboratory
G. W. Strandberg
Oak Ridge National Laboratory

As in the previous session, this session's papers cover a diverse array of research topics. Although numerous organisms have been found which can solubilize coals, particularly lignites, instances where organisms can grow on macromolecular components of coal are relatively few. Polman et al. present evidence that a strain of bacterium they isolated can indeed grow on alkali-solubilized lignite components. Two papers from D. L. Crawford's laboratory address lignin peroxidase, an enzyme active in lignin degradation. First, Adhi et al. describe methods to increase the yield of this potentially useful enzyme. Secondly, Magnuson et al. report detailed enzyme characteristics. When an originally scheduled paper was canceled, we were fortunate to have D. P. Chynoweth from the University of Florida fill in at the last minute. We are pleased to include his paper describing interesting work on a novel process for anaerobic composting of municipal solid waste. Bare et al. from Belgium discuss the stereoselective conversion of octyl-4-chloroacetoacetate to the chiral alcohol, a precursor of L-carnitin, by *Saccharomyces cerevisiae*. Both mono- and biphasic liquid systems were investigated. In their continued effort to develop a system to microbially convert synthesis gas to methane, E. C. Clausen's group (Kimmel et al.) reports the results of a comparison of two sizes of trickle-bed bioreactor systems using a consortium of *Rhodospirillum rubrum*, *Methanosarcina barkeri*, *Methanobacterium formicicum*. Lastly, Gangl et al. describe an interesting metabolic model for fumaric acid production which may prove useful in proving productivity.

INTRODUCTION TO SESSION 4
BIOENGINEERING RESEARCH

H. R. Bungay
Rensselaer Polytechnic Institute
J. S. Watson
Oak Ridge National Laboratory

Papers for bioengineering research were gleaned from submissions that could have filled three sessions with first-rate presentations. Our choices were a review to provide perspective and those papers that seemed most original. Ethanol is still the featured target of biomass refining, and three potential process improvements and a method for starch hydrolysis are reported. Two papers address alternative products; one emphasizes the bioconversion while the other is about product recovery.

This session can be summarized by stating that research aimed at fuel alcohol is alive and well but other products or coproducts deserve serious attention. It is particularly interesting that after so many years of research on ethanol that exciting new approaches to its production and recovery continue to appear. One difference is the widening of the scope of research to include several operations that are interrelated. Reactor designs may permit simultaneous bioconversion and a first step in product recovery.

Multiple authorship and our international blend of institutions attest to the wide interest in and the need for team approaches to biotechnology aimed at fuels and chemicals. We thank our authors for submitting their best work to this meeting to continue its rise as the best opportunity for exchanging information in an area of vital concern to all nations.

INTRODUCTION TO SESSION 5
BIOTECHNOLOGY, BIOENGINEERING, AND THE SOLUTION OF ENVIRONMENTAL PROBLEMS

J. R. Geiger
Olin Research Center
D. A. Graves
International Technology Corporation

Realization that the earth is ultimately a closed ecosystem has forced careful examination of anthropogenic insults to the environment. The results of environmental insults can be seen on both small and large scales. Examples include localized inconveniences such as foul odors, serious health hazards for living organisms including man, contaminated water supplies, "acid rain", "ozone holes", and global warming. Many of these insults result from the way we dispose of our wastes. Restoration and preservation of the environment has reached an unprecedented degree of urgency. Many technologies have emerged from a variety of industries and scientific disciplines to provide safe and effective means to mitigate the effects of hazardous and non-hazardous waste in the environment. Bioremediation is one of the most versatile and unobtrusive of these technologies.

Biological treatment can provide permanent solutions to environmental problems. In addition, changing technological and economic factors suggest that bioremediation may become the most cost-effective approach for dealing with organic pollutants in a variety of situations. Industry has long used bioremediation, and will use this method more in the future. One business forecasting company predicts a 45% yearly growth in biotechnology-based pollution control products and services (from $5 million in 1990 to $200 million by 2000).[1] The success of bioremediation in the Exxon Valdez oil spill cleanup and the publicity that incident generated will spur even more interest.[2]

New technology will increase both the role and capabilities of bioremediation in environmental cleanup. Recent development reported in this session address a variety of pertinent aspects of biological pollution control and waste remediation. Issues including the risks associated with the introduction of microorganisms to affect biodegradation, laboratory assessments of the biodegradation of organic compounds, and field implementations of actual treatment processes are presented.

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[1]Consulting Resources Corporation. 1990. Biotechnology...What's in Store for the 1990's? March Newsletter.

[2]Crawford, M. 1990. Bacteria Effective in Alaska Cleanup. *Science* 247, 1537.

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