Main Story

§ Strengthen the collaboration on developing green energy between APEC members §

Indonesia and Viet-Nam with their high populations need to develop an alternative energy resource, among which the most potential is biohydrogen which would be produced from conversion of waste biomass available abundantly in these countries. As being well known in the bio-hydrogen energy field, the **"APEC Research Center for Advanced Biohydrogen Technology"** is a leading institute in biohydrogen research and development in APEC region. Professors Chiu-Yue Lin, Shu-Yii Wu and Dr. Chen-Yeon Chu had been invited to visit LEMBAGA ILMU PENGETAHUAN INDONESIA-LIPI, Indonesian Institute of Sciences and Department of Biochemistry, University of Natural Sciences-Hochiminh, Viet-Nam. They gave a workshop in biohydrogen technology including lectures, discussions, and technical supports. The technical exchanges would like to strengthen the collaboration on developing green energy between APEC members. The workshops in Indonesia and Viet-Nam were arranged as follows:

Date	Activities in Indonesia	Place
Day 1	Arrival	◇ Jakarta
Day 2	1. Visiting LIPI (The Indonesian Institute of Sciences (*Lembaga Ilmu Pengetahuan Indonesia*, LIPI) 2. Technical Exchange and Workshop (I)	◇ Cibinong Bogor
Day 3	Technical Exchange and Workshop (II) and laboratory tour	◇ Cibinong Bogor
Day 4	*LIPI Pilot project* visiting	◇ Cibinong Bogor
Day 5	Departure	◇ Ho-Chi-Minh City
Date	Activities in Viet-Nam	Place
Day 1	Arrival	◇ Ho-Chi-Minh City
Day 2	1. Visiting University of Natural Sciences, Viet Nam National University - Ho Chi Minh City 2. Lab visiting and technical supporting (I)	◇ Ho-Chi-Minh City
Day 3	Lab visiting and technical supporting (II)	◇ Ho-Chi-Minh City
Day 4	Departure	◇

Research Report

§ Biological hydrogen production performance in a draft tube fluidized bed bioreactor with immobilized Cell §

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Hydrogen has become a promising energy source because it is clean and has high-energy potential. The research was carried out using a draft tube fluidized bed bioreactor (DTFBR) system with immobilized cell. The total working volume of the DTFBR including the buffer tank and pipe was 2.4 L. The aspect ratio of height/diameter in the fluidized bed bioreactor was 8/1. The cultivation temperature was 40 ℃. The anaerobic seed sludge was obtained from Li-Ming

Municipal Sewage Treatment Plant in Taichung, Chinese Taipei. The pH, volatile suspended solid (VSS) and total solid (TS) concentrations of the seed sludge were 6.8, 33.3 and 65.1 g/L, respectively. The H_2 productivity of the seed sludge was enhanced by thermal treatment at 100 °C for 1 h to inhibit the methanogenic activity in the sludge. The thermally treated sludge was used for cell immobilization. Cell immobilized was essentially achieved by silicone gel (SC) entrapment approaches. The entrapped-cell system can be stably operated at a low HRT without suffering cell wash-out. Hence, the H_2 production rate could be enhanced via increasing of organic loading rates. The system was fed with sucrose-based synthetic medium, and was examined for its H_2-production performance under different influent sucrose concentrations (C_{S0} 10, 20, 30, and 40 g COD/L), different solid volume (5, 7.5, 10, and 15% (v/v)) and hydraulic retention times (HRT 4, 2, 1, and 0.5 h).

It was found that the optimal solid volume content was 7.5% (v/v) with a maximun H_2 production rate of 1.55 H_2 L/h/L and H_2 content of 35.7% when the solid volume contents ranged from 5 to 15% in the DTFBR. The H_2 content in the biogas was essentially within the range of 26.2-44.7%. The maximum H_2 production rate of 2.59 H_2 L/h/L with H_2 content of 36.8% and sucrose conversion of 80.5% was obtained at CS0 20 g COD/L, 7.5% (v/v) of solid volume, and HRT 0.5 h. The DTFBR system was successfully operated till an HRT of 0.5 h. It was more stable to operate the anaerobic fermentative hydrogen production system in the DTFBR than a fluidized bed bioreactor (Shen Y. C., 2005). The features of well mixing, high H_2-producing performance and stable operation imply that the DTFBR system could be a feasible approach for continuous H_2 production in practice.

§ Biohydrogen research in Indian Prospective §

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India is the 2nd largest populated country and one of the rapidly growing in industrial and technology sector as developing country. Nowadays Indian government is concerning more about environment and funding to encourage green energy projects to make the environment more clear and green. Global interest in biohydrogen has taken long stride with remarkable contributions to the science. In India only a few research and development organizations are focusing on biohydrogen production. There is an immediate need for impetus and conglomeration of these workgroups to build a network focusing on biohydrogen research. The International Workshop on Biohydrogen Production Technology and conferences held in New Delhi and few other places in India will not only bring together the various workgroups within India but also give them an opportunity to interact with international scientific community. It will also abet in conceiving a necessary interdisciplinary research. A panel discussion to understand the present state of the different biohydrogen production processes would be organized. Prof D Das is one of the leading researchers not only in the India but worldwide known in the area of biohydrogen research in molecular and engineering aspects as well. Moreover various researchers like Dr. Venkata Mohan (IICT), Dr. V. Hima Bindu (JNTUH) are involved in the biohydrogen research. Thus ultimately results in the hydrogen fuel cell car in the nearby 2020 as per Prof D Das vision. Here we enlighten only major research institutes in India, involving various aspects of Biohydrogen production. In addition, various research institutes and government universities, NGO's are encouraging this research to make the environment clean and green.

§ Optimizing biohydrogen production from mushroom waste using anaerobic mixed cultures §

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The mushroom bag is a polypropylene bag stuffed with wood flour and bacterial nutrients. After being used for growing mushroom for one to two weeks this bag becomes mushroom waste (MW). About 150 million bags (80000 tons) of MW are produced annually in Taiwan and are usually burned or discarded. The cellulosic materials and nutrients in MW could be used as the feedstock and nutrients for anaerobic biohydrogen fermentation. This study aims to select the inoculum from various waste sludges (sewage sludge I, sewage sludge II, cow dung and pig slurry) with or without adding any extra nutrients. A batch test was operated at a MW concentration of 20 g COD/L, temperature 55°C and an initial cultivation pH of 8. The results show that extra nutrient addition inhibited hydrogen production rate (HPR) and hydrogen production yield (HY) when using cow dung and pig slurry seeds. However, nutrient addition enhanced the HPR and HY in case of using sewage sludge inoculum and without inoculum. This related to the inhibition caused by high nutrient concentration (such as nitrogen) in cow dung and pig slurry. Peak HY of 0.73 mmol H_2/g TVS was obtained with no inoculum at nutrient addition. However, peak HPR and specific hydrogen production rate (SHPR) of 10.11 mmol H_2/L/d and 2.02 mmol H_2/g VSS/d, respectively, were obtained by using cow dung inoculum without any extra nutrient addition.

Special Column

Green Energy Development Center, Feng Chia University

Energy Research, Energy Saving, and Resource Recycling

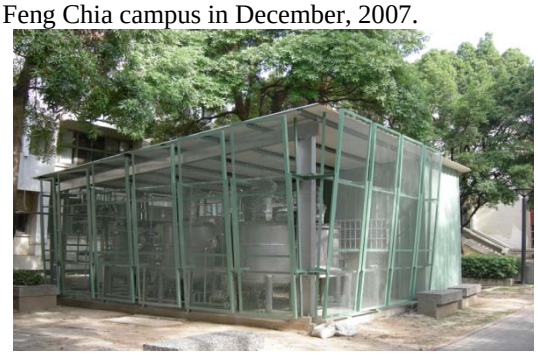
Overview

The Green Energy Development Center (GEDC) was founded in August, 2010. The mission of the GEDC is to develop energy research, energy saving, resource recycling, and personal training of the science and technology. Besides, GEDC seeks the international cooperation to boost up the research quality and technology on the innovative energy research for the next generation. This center has 10 professors, 15 staffs and around 60 students.

The GEDC is currently focusing on the research and development of Fermentative Biohydrogen Energy Technology. This project is supported by the Bureau of Energy (BOE), MOEA, and it uses technologies such as immobilized cell technology (ROC patent: I317381) of selectivity for hydrogenase cell, induced granular cell hydrogen fermentation, and preparation of electro chromic materials by chemical depositions (US patent: 6 652 980 B2). In the past 5 years, 7 patents have been awarded and further applications have been submitted for 9 more patents. The GEDC also promotes regional cooperation by holding international meetings such as the APEC Advanced Bio-hydrogen Technology Conference and Short-term Training Course, Asian Biohydrogen Symposium and the Asia Bio-HyLinks Meeting. The GEDC is currently networking with several research institutes, including TUT, KKU, HIT and SIUC.

Research fields:

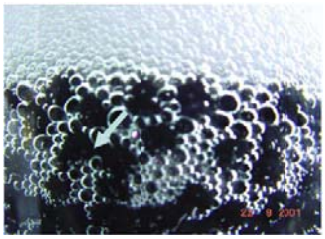
The theme of the research is anaerobic fermentation for bio-hydrogen production, and the key technologies are (a) Culture enrichment technology, (b) High-rate three-phase bioreactor, (c) Molecular biological technology, and (d) Pilot plants. Based on the established key technologies, the GEDC is leading the bio-hydrogen production rate among the world by constructing a 400-liter dark fermentation pilot plant on Feng Chia campus in December, 2007.



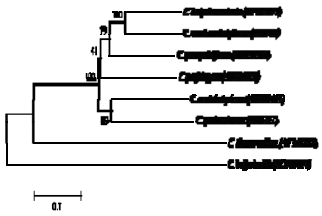
400-litre Pilot Plant on Feng Chia Campus

Recent projects:

1. Research and Development for Fermentative Bio-hydrogen Energy Technology (2005-2008)
Objective: (a) Selection and acclimation of hydrogen producing bacteria, (b) Sludge granulation and immobilization, (c) Bio-hydrogen pilot plant design, and (d) Bacterial community structure analysis



Immobilization



Bacterial Community

2. Development and Demonstration of Bio-hydrogen Energy System
Feng Chia University, (2006-2008)
Objective: (a) H_2-ICE design and test and (b) Bio-hydrogen pilot plant demo system

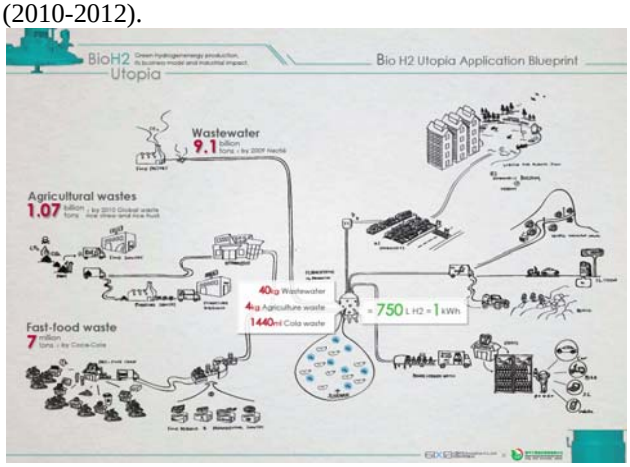
Bio-hydrogen Lab Scale Demo System

3. Research of Hydrogen Energy
Feng Chia University, (2008-2011)
Objective: (a) High Performance of Bio-hydrogen Production and (b) High Efficiency of Hydrogen Storage Alloy Fabrication and Characteristics Analysis

4. Hydrogen Education
(a) Graduate Program for Green Energy Science and Technology
The Master of Science (MS) degree reflects mastery of core and specialized areas of green energy science and technology.
(b) Undergraduate Program for Biomass Energy and Green Energy Science and Technology, (2008-2010)
(c) Resource Center for Talent Training in Biomass Energy Technology, (2011-2013).

5. The Promotion Program of Research Centers for Energy Technology- Biomass Energy
(2009-2012)
Objective: (a) Bio-hydrogen pilot plant operation; (b) Selection and acclimation of hydrogen/butanol producing bacteria, (c) Hydrolysis of cellulosic materials, (d) Bio-hydrogen/butanol pilot plant design and operation, and (d) Bacterial community structure analysis.

7. Green Hydrogen Energy Technology and Economy, (2010-2012).



Bio H2 Utopia Application Blueprint

International Technical Exchange Platforms
1. Research Center for Biomass Energy Technology,
2. APEC (Asia-Pacific Economic Cooperation) Research Center for Advanced Biohydrogen Technology
3. Secretary's Office of Asia Bio-HyLinks (ABHL)
4. One of Chapter in International Association for Hydrogen Energy (IAHE)

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