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APEC
Advanced Biohydrogen Newsletter

The food security, climate change, energy security and interlinked challenges for the APEC region.

Contents

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Main Story

§ Singapore Meeting Report §

Progress Report of APEC Research Network for Advanced Biohydrogen Technology (Phase I) – Chinese Taipei

Chinese Taipei reported the current results and the upcoming event of the APEC project as follows.

- The steering committee meeting and kick-off workshop of APEC Research Network for Advanced Biohydrogen Technology were held on February 3 - 4, 2010, Taichung, Chinese Taipei.
- The official website has been established in Feng Chia University, Chinese Taipei. (http://www.apec-bioH2.org)
- APEC biohydrogen newsletter has been published.

Chinese Taipei has also announced the upcoming event of the 2010 APEC Advanced BioH2 Technology Conference and Training Program.

- Date: Nov 15th – 20th, 2010.
- Venue: Feng Chia University, Taichung, Chinese Taipei
- Tentative Programs:
  - November 16-17 : The 2010 APEC Advanced BioH2 Technology Conference
  - November 16-20 : The 2010 APEC Short-term Training Course on Advanced Biohydrogen Technology
  - Technical and cultural tours

Accommodation, registration fees and other local expense will be free for one delegate and one student of all 21 APEC economies. Delegates and students should be recommended by the APEC economies and make a registration before July 31, 2010. (more details will be notified in the website: http://www.apec-bioh2.org)

Research Report

§ A biohydrogen patent analysis in Korea and United States §

Competitiveness of biohydrogen production methods II: A patent analysis of Feng Chia University biohydrogen technology in Korea and United States

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Currently, significant efforts are underway to develop biofuels in order to replace non-renewable fossil fuels. There are various options, among them hydrogen stands as an attractive energy carrier. Hydrogen has the property of being efficiently converted at high rates into usable power. Hydrogen must be generated from renewable resources aiming to reduce the global impact of CO_2 levels. Hence there is the need to emphasise further develop biological ways of producing hydrogen instead of physical-chemical ways, which will not produce the hydrogen as clean. Biological processes utilise algae and bacteria inside bioreactors in the light or only bacteria fermentatively growing in the dark inside bioreactors, which resembles the well-characterised anaerobic digestion process. However, there are significant remaining barriers to improve biological hydrogen practical application, such as low yields and production rates. Here, we concentrate on fermentative hydrogen production patent analysis of Feng Chia University's technology, which is a leading academic institution in the development of biohydrogen production methods in Chinese Taipeiand the world in the last years. Aiming to determine the value of its patented invention and potential competitors, a search of similar patented methods based on a series of keywords was carried out at both the Korean Intellectual Patent Office and the United States Patent and Trademark Office. The time scope of the present search ranged from 01.01.2000 to 25.05.2010 at both patent offices. All patents found related ones to the invention were selected.

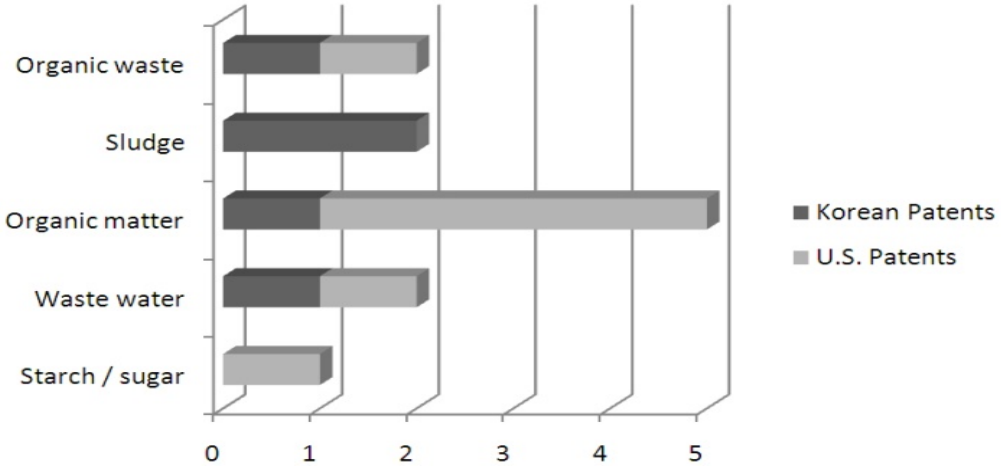

FIGURE 1. Number of patents found at both the Korean Intellectual Patent Office and the United States Patent and Trademark Office per category of search.

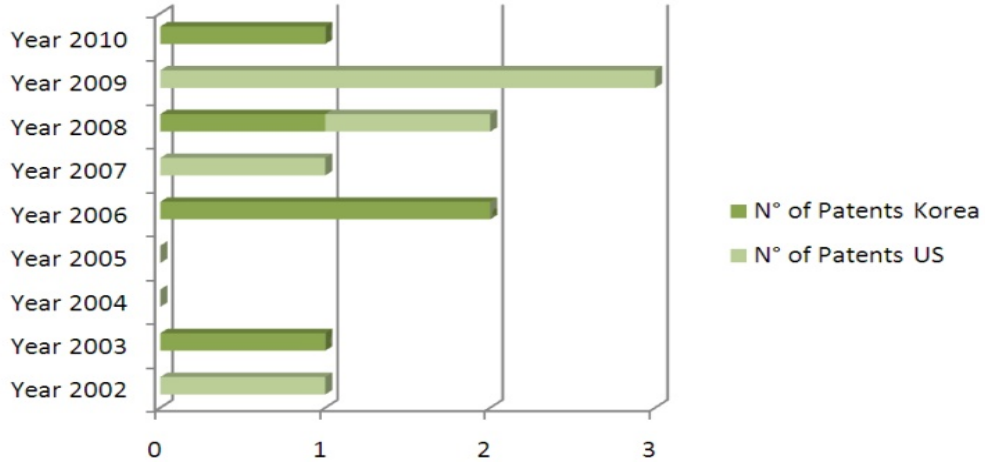

FIGURE 2. Number of patents granted per year at both the Korean Intellectual Patent Office and the United States Patent and Trademark Office.

Korean Intellectual Patent Office (KIPO)

The search carried out at KIPO gave a total of 5 related patents to the invention, most of patents found were related to the use of sludge and organic waste as feedstock (Fig. 1). All Korean patents were hold by research institutes, and were granted mostly between years 2003 – 2008 (see Fig. 2), following green energy tendencies. These institutions didn't apply for patent rights in other countries outside Korea.

United States Patent and Trademark Office

The search carried out at the United States Patent and Trademark Office (USTPO) gave a total of seven related patents to Feng Chia University' invention, without including the university' patent into these.

Of all patents found, four patents belonged to other countries, one of them used starch as feedstock but none with sludge as found in Korean patents (see Fig. 1). When compared to Korea, most US patents are recent, being granted between years 2007-2009 (see Fig. 2). There is no patent belonged to a research or academic institution.

Patent value

1. SCOPE

When comparing all patents found in Korea and United States, we noticed that Korean patents are limited to a country level, being therefore of local scope, contrary to US patents, which tend to have patent rights in other countries outside the US.

Korean patent rights on biohydrogen production were granted to research institutions, whilst in the US, patent rights were requested by private companies, showing a higher growing tendency in the hydrogen production industry than in Korea.

Most methods patented in both countries were of bioreactors or pre-treatment environmental conditions adjustment, few used combined methodologies. Further, Feng Chia University' patent is supported by other previous three patents, although only at Taiwan level. These patents has the advantage to enhance the scope of the present patent, since they complement with additional processes the one described in the claims by including

related ways to produce hydrogen and associated valuable side products such as liquid methane and CO2. As it is true when comparing the university' patent with patents of Japan, Europe, Korea and United States, there is few patent complementation to enhance inventions with prior art.

2. COMPETITIVENESS

The scope of an invention, the number of countries where it is patented, along with its connections and support of prior art of the same institution-company, and its characteristics *per se* can determine altogether the competitiveness and value of a given invention.

a. Patent rights

• At Chinese Taipei level the patent can be quite competitive due to other Feng Chia University's patents complementation.

• At international level even, there is few prior art which may compete against FCU's patent. Korean and United States patents, although use similar methods, are different to Feng Chia's patent, and luck of appropriate related patents to enhance their value at international level. Some Korean patents complement each other but have only local scope, being therefore their competitiveness is low.

b. Invention *per se* characteristics due to:

• The **low cost model**, by using cheap wet organic waste from factories or similar sources for the production of hydrogen, thereby requiring little amount of energy to run the process.

• The **Hydrogen production high rate**, due to the use of wet organic waste as seed, allowing an easy production of hydrogen, which combined with the high production rate of the invention with non-modified bacteria increase the invention competitiveness.

• **Energy efficiency** of the process inside the **equipment design.** The production of commercially valuable side products (methane or alcohol), plus the potential reuse or sale of CO2 produced enhance the utility of the invention. Further, the design allows setting up an easy to operate on-site treatment plant, which requires few trained personnel to operate and maintainence

• **Green image**, which is highly valuable for many companies which want to enhance their products value or increase the price of them. This can be achieved by the green label of their manufacturing process through the proper treatment of their waste. Also can be offered to city governments for waste water treatment.

c. Prior art analysis and following patent strategy

• Although the university lacks of a patent strategy at both national and international level, its patent is unique, and therefore requires of such a strategy to be competitive.

§ Trends in Bio-hydrogen study in APEC Economies (Chinese Taipei) §

Biohydrogen in Chinese Taipei – Undergoing Projects

Project	Research group	Funding source
BioH2 production from waste activated sludge (WAS) and wastewaters	NCHU (CM Lee) FCU (CY Lin) ITRI (MD Bai)	National Science Council (NSC) Ministry of Economic Affairs (MOEA)
Integration of Bioenergy Processes with Non-food Feedstock and Demonstration of Pilot-scale Technologies	FCU (RCER)	Bureau of Energy (BOE)
Integration of dark/photo H2 fermentation and microalgae system	NCHU (CM Lee) HKU (PC Chen) NCKU (JS Chang)	NSC
Fermentative H2 production from kitchen (food) waste	NCKU (SS Cheng)	NSC, ITRI
Pilot plant studies on bioH2 production	FCU (RCER) ITRI (MD Bai)	MOEA

- **Summary of bioH2 R&D activities in Chinese Taipei**

【Topics】

- Dark/photo fermentation (sugar-based & non-food feedstock)
- Process Integration (dark-photo-microalgae)
- Pilot scale demonstration (up to 1 ton working volume)
- Microbial fuel cell
- Hydrogen economy & H2 energy education

【Performance, 2004-2009】

- 114 SCI-indexed papers
- 13 patents

Research funding: US$ 26.2 M

Special Column

§ ABHL and APEC Advanced Biohydrogen Conferences §

- **Date: November 15th-20th, 2010**
- **Venue: Feng Chia University, Taichung**
- **Program**

Time	Nov.15	Nov.16	Nov.17		Nov.18		Nov.19	Nov.20
08:30	Arrival	Opening and Registration			Technical Tour (I)	Short –term Training Course (First day) -Bioenergy	Short –term Training Course (Second day) - Biofuels	Technical Tour (II)
9:00-10:20		Keynote speech	Keynote speech					
10:20-10:30		Coffee Break						
10:30-12:30		Section A -Hydrogen Economy	Section D -Molecular Biological					
12:30-13:30		Lunch						
13:30-15:40		Section B -Biohydrogen Application	Section E -Molecular Biological					
15:40-15:50		Coffee Break						
15:50-17:50		Section C -Biohydrogen Application	Section F -Bio-Process	IAHE-Business Meeting				
17:00-18:00		Asia Bio-HyLinks Meeting						
18:00	Reception Dinner	Dinner	Banquet					

- **Keynote Speakers**
  - **Dr. T. NEJAT VEZIROGLU** (USA): Saga of Hydrogen Civilization
  - **Dr. Michael Seibert** (USA): International Energy Agency (IEA) Hydrogen Implementing Agreement (HIA) Task 21—Bio- inspired and Biological Hydrogen
  - **Dr. Sheng-Shung Cheng**(Chinese Taipei): Process Study on BioHydrogenation of Kitchen Waste with Dark Fermentation
  - **Dr. Hang-Sik Shin** (Korea): Fermentative hydrogen production from marine algae, Korea
  - **Dr. Mi-Sun Kim**, Photo-biological Hydrogen Production by Purple Non-Sulfur Bacteria, Korea
  - **Dr. Bruce Logan** (USA): Biohydrogen generation from renewable biomass sources using microbial electrolysis cells (MECs)
  - **Dr. Jun Miyake** (Japan): Local BioEnergy System with BioHydrogen
  - **Dr. Patrick-C. Hallenbeck** (Canada): Recent Progress and Future Prospects
  - **Dr. Alissara Reungsang** (Thailand): Biohydrogen Production from Glycerol by Anaerobic Mixed Cultures,
  - **Dr. Vasily Borzenko** (Russia): Hydrogen technologies for power production
  - **Dr. D. R. Ranade** (India): Bioenergy R & D at ARI, India : Prospective & Retrospective
  - **Dr. Ashok Pandey** (India): New generation alternative energy sources: Indian perspectives
  - **Dr. Dwi Susilaningsih** (Indonesia): Current Status of Biohydrogen Research and Its Application in Indonesia
- **Invited Speakers**
  - **Dr. Tong Zhang** (China): Applications of molecular techniques in bio-hydrogen studies
  - **Dr. Patrik Jones** (Finland): Knowledge-transfer between Fermentative and Photobiological H2-production
  - **Dr. Duu-Jong Lee** (Chinese Taipei): Assessing Biohydrogen Economy with Models
  - **Dr. Pieternel A.M. Claassen**(Netherlands): Non-thermal production of pure hydrogen from biomass
  - **Dr. Debabrata Das** (India): Amelioration of hydrogen production by two stage biological production processes
  - **Dr. Yu-You Li** (Japan): A pH and Temperature-phased two stage process with internal circulation for stable hydrogen and methane production from food waste
  - **Dr. Biswarup Sen** (India): Metabolic engineering and functional genomics of hydrogen producing bacteria to enhance production rate and yield
  - **Dr. Sunghoon Park** (Korea): Hydrogen production by new chemoheterotrophic bacterium Citrobacter amalonaticus Y19
  - **Dr. Ming-Der Bai** (Chinese Taipei): ITRI's Biohydrogen Technologies Developed to Convert Waste Biomass to Bioenergy
  - **Dr. Min-Ray Lin** (Chinese Taipei): The promoting strategy for Anaerobic Hydrogen Production
  - **Dr. Chun-Hsiung Hung** (Chinese Taipei): Exploring the interactions of microorganism co-existed in anaerobic fermentative biohydrogen production reactors