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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

§ IAHE Taiwan Chapter Steering Committee Report §

Message from IAHE Taiwan Chapter President

I hereby pleased to announce the Taiwan Chapter for IAHE has established on February 17, 2010. As a window for IAHE to hydrogen professionals in Taiwan, we are happy to convey this platform for closely linking those exciting development towards the hydrogen economy ongoing in the nation and over the globe.

The Chapter is hosted by Feng Chia University (FCU) in Taichung, Taiwan. The kindness of FCU by offering three full-time staffs, over 300 m^2 office and lab space and sufficient financial support is highly cosiderable. FCU has also hosted the APEC BioH2 Research Center (www.APEC-bioh2.org) and the Asia Bio-hylinks (www.asia-biohylinks.org), thereby providing a unique chance to clustering the planned activities of the Chapter with those that will occur locally.

As the founding President of Taiwan Chapter, I witness its birth, and look forward to its rapid growth in the near future. All IAHE members are welcome to have link with Taiwan via this Chapter. I assure that we are ready to serve your needs at any cost and it gives us much pleasure.

Research Report

§ A biohydrogen patent analysis in Japan and the European Union §

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The importance of hydrogen as a fuel has been increasing during the last decade, due to its potential to be efficiently converted into electricity. Further, the use of hydrogen as a fuel has the advantage of being a clean combustible and avoiding CO_2 emissions.

In this sense, there is the need to perfectionate and to develop new low-cost, energy-saving and pollution-free hydrogen production methods and associated technologies, which achieve a good HPR, aiming for future comercialisation in the market. In order to understand the better potential, limitation and value of the own invention, a patent analysis can be useful, whilst comparing with other inventions. It also may serve as a tool to find out potential rival techniques and technologies.

Feng Chia University has been a leading academic institution in the development of biohydrogen production methods in Taiwan and 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 Japan Patent Office and the European Patent Office. The time scope of the present search has ranged from 01.01.2000 to 25.05.2010 at both patent offices. All patents found related ones to the invention were selected

Japanese Patent Office (JPO)

The search carried out at JPO gave a total of 36 related patents to the invention, most of the patents found were related to the use of organic-wastewater or different kinds of organic matter for hydrogen production (Fig. 1). Also most patents were granted to Japanese companies(holding some of them complementing patents), whilst few to research-academic centres. Most of patents found were granted between 2005-2009 (see Fig. 2), during the time when the green movement for finding alternative fuels was stronger.

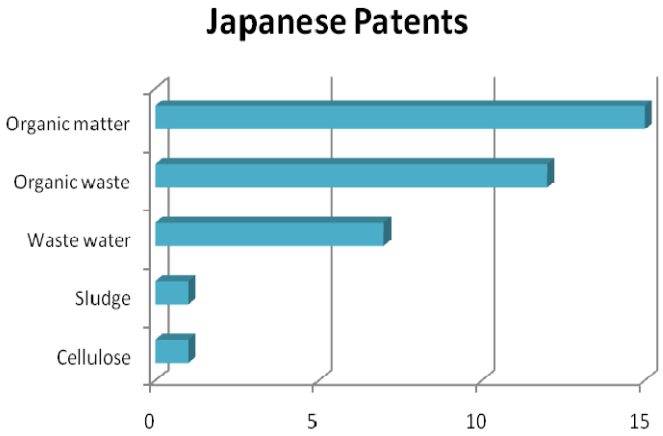

FIGURE 1. Number of patents found at the Japanese Patent Office per category of search

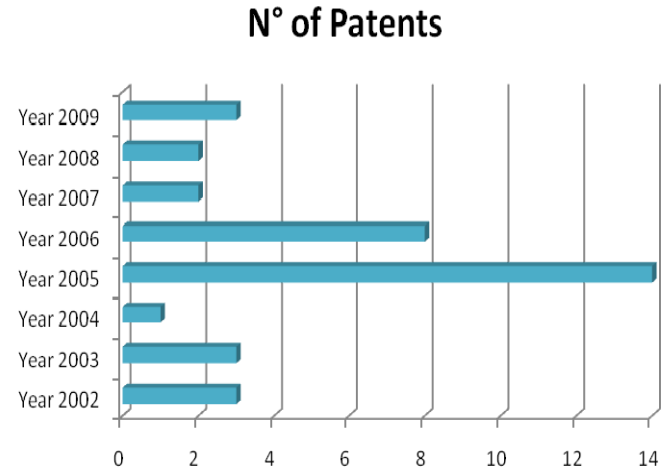

FIGURE 2. Number of patents granted per year at the Japanese Patent Office.

European Patent Office (EPO)

The search carried out at the European Patent Office (EPO) gave a total of 5 related patents to Feng Chia University' invention, of these 2 were Japanse inventions, but only patented at European level. Another search at country level found 8 related patents in the German Patent Office (DPMA). European patents were found to be focused mostly on the use of organic matter or organic waste as raw material for hydrogen production, and do not foster the use of other raw material (Fig. 3). Similarly as Japan, most patents were granted between years 2006-2009 (Fig. 4).

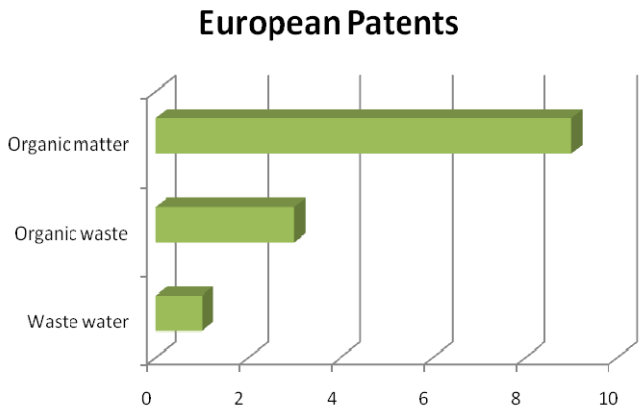

FIGURE 3. Number of patents found at the European and German Patent Offices.

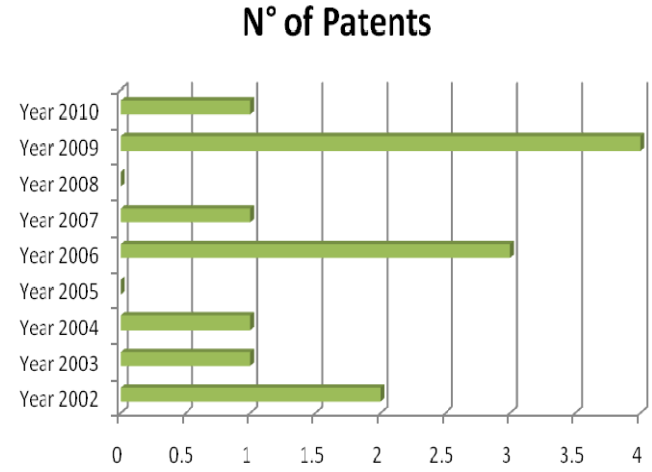

FIGURE 4. Number of patents granted per year at the European and German Patent Offices.

Patent value

1. SCOPE

When comparing all patents found in Japan and Europe, is interesting to notice that most European patents are limited to a country level, being therefore of local scope. Only companies from United States tended to patent in Europe and other countries, being therefore of long scope. Japanese showed the same tendency of Europeans, having therefore local scope.

In both Europe and Japan there is a tendency of using organic waste, organic matter or waste water as main raw material for hydrogen production, taking into account the wide range of possible raw materials (Fig. 5). This happens in an attempt to foster recycling and waste treatment. Only in Japan cellulose and sludge are used as raw materials, being therefore valuable.

The patented process of Feng Chia University has the advantage that is supported by other previous three patents but only at Taiwan level, since they are local. These patents have 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 CO_2.

Further, a new experimental (not fully finished to patent application) process use algae to transform the CO_2 produced as side product by the present patented process to produce biofuel.

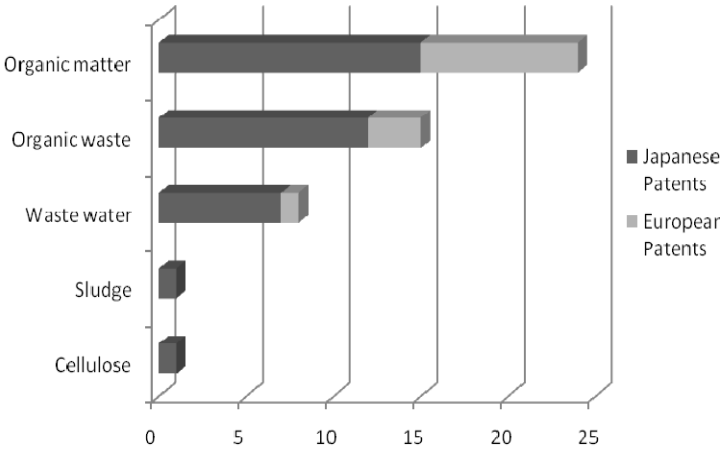

FIGURE 5. Comparison between the number of patents per category at the Japanese Patent Office and European patents.

2. COMPETITIVENESS

Competitiveness of the patent can be assessed by several factors, such as its local or international patent rights, its characteristics *per se*, prior art analysis and following patent strategy

a. Patent rights

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

• At international level even if the university lacks of other patents complementation, the invention has a great value by itself. Furthermore, since most Japanese and European patents are done at country level, having therefore lower competitiveness with inventions patented in several countries.

b. Invention characteristics per se

• he **low cost model**, including the use of cheap raw seed material, and little energy consumption.

• Hydrogen **high production rate**.

• The **Energy efficiency** of the process inside the **equipment design**.

• **Green image**.

Such characteristics can increase the attractiveness of a given invention, taking into account the competitiveness of other prior art or new inventions.

c. Prior art analysis and following patent strategy

• Although the university did not focus on using a prior art analysis to elaborate a patent strategy, its patent is unique, being advisable to plan a strategy which links previous patents with current research in order to come up with a stronger patent at national level.

• At international level, is highly advisable to increase the number of patents inside a well-planned strategy, in order to surpass the local competitiveness of other complementing prior art.

§ A Pilot-Scale High-Rate Biohydrogen Production System with Mixed Microflora §

Authors: BioH$_2$ research team of Feng Chia University. Update by Mr. Chyi-How Lay

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A pilot-scale high-rate dark fermentative hydrogen production plant has been established in the campus of Feng Chia University to develop biohydrogen production pilot-plant technology. This pilot-plant system is composed of two feedstock storage tanks (0.75 m^3 each), a nutrient storage tank (0.75 m^3), a mixing tank (0.6 m^3), an agitated granular sludge bed fermentor (working volume 0.4 m^3), a gas-liquid-solid separator (0.4 m^3) and a control panel. The seed mixed microflora was obtained from a lab-scale agitated granular sludge bed bioreactor. This pilot-scale fermentor was operated for 67 days at 35°C, an organic loading rate (OLR) of 40 to 240 kg COD/m^3/d, and the influent sucrose concentration of 20 and 40 kg COD/m^3. Both biogas and hydrogen production rates increased with increasing OLR. However, the biomass concentration (volatile suspended solids, VSS) only increased with an increasing OLR at an OLR range of 40-120 kg COD/m^3/d, whereas it decreased when OLR was too high (i.e., 240 kg COD/m^3/d). The biogas consisted mainly of H_2 and CO_2 with a H_2 content range of 23.2-37.8%. At an OLR of 240 kg COD/m^3/d, the hydrogen content in biogas reached its maximum value of 37% with a hydrogen production rate (HPR) of 15.59 m^3/m^3/d and a hydrogen yield of 1.04 mol H_2/mol sucrose. This HPR value is much higher than 5.26 m^3/m^3/d (fermented molasses substrate) and 1.56 m^3/m^3/d (glucose substrate) reported by other pilot-scale systems. Moreover, HPR was also greatly affected by pH. At an optimal pH of 5.5, the bacterial community became simple, while the efficient hydrogen producer *Clostridium pasteurianum* was dominant. The factors of energy output compared with the energy input (E_f) ranged from 13.65-28.68 on biohydrogen, which is higher than the E_f value of corn ethanol, biodiesel and sugarcane ethanol but in the similar range of cellulosic ethanol. Reference: International Journal of Hydrogen Energy (2010), doi:10.1016/j.ijhydene.2010.07.11

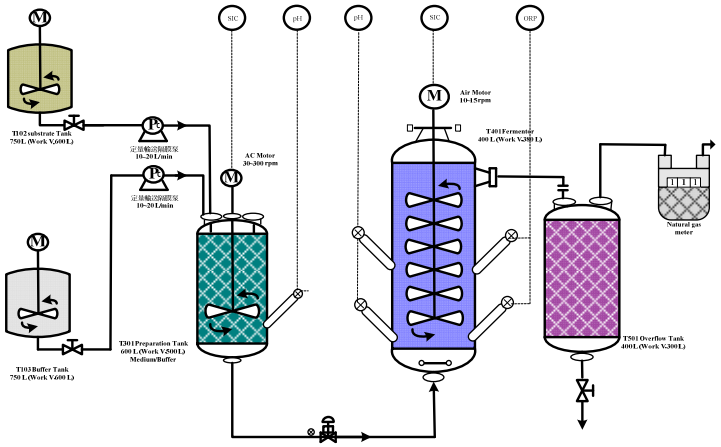

Figure 1 The layout of the 0.4 m^3 hydrogen production pilot plant

Special Column

§ Introduction to the APEC advanced biohydrogen conference §

The 2010 APEC Advanced Bio-Hydrogen Technology Conference with a short-term training course

The challenges and solutions to development of technology for sustainable energy is a major issue that bridges the academic endeavors of the scientific community to the real problems of the global community. In this light, bio-hydrogen stands as a remarkably useful energy source for alleviating the pressures of limited resources as well as promoting the use of environmental friendly energy. Being produced from renewable resources such as wastewater and organic wastes by biological means, biohydrogen represents a hopeful solution to some of the everyday problems that people face in terms of energy needs, not only in Asia, but also all around the world.

The 2010 APEC Advanced Bio-Hydrogen Technology Conference will be held at Feng Chia University, Chinese Taipei, on Nov 16th – 17th, 2010, provided with an exciting opportunity to reflect on these imperatives. We would like to welcome participants from private sectors, research institutes and academies to contribute and add value to this international conference. Accommodation (4 nights), registration fees and other local expense will be free for two delegates (delegate and/or student) who should be recommended by the APEC economies contact person of all 21 APEC economies

The themes of the 2010 APEC Advanced Bio-Hydrogen Technology conference includes,

Hydrogen Economy

- Biomass to hydrogen
- Biohydrogen by dark fermentation
- Biohydrogen by photobiological fermentation
- Bioreactor design for biohydrogen production
- Biohydrogen applications

This event will be sponsored by Department of International Cooperation, National Science Council and Bureau of Energy, Ministry of Economic Affairs, Chinese Taipei. FCU will offer the facilities, such as laboratories to the students from the APEC member economies for short-term study or visit. The aims of this conference were to facilitate the communication and exchange of ideas, evaluate current progress on early-stage findings and inform to identify promising research and development directions in the field of bio-hydrogen in APEC region.

We are pleased to announce that during the conference we will provide the oral presentation awards and poster awards to the winners. For more detail information please access to the 2010 APEC Advanced BioH2 Technology website at www.apec-bioH2.org.

Organizers

- APEC Advanced Biohydrogen Technology Center, Chinese Taipei
- Green Energy Development Center, Feng Chia University, Chinese Taipei

Sponsors

- National Science Council, Chinese Taipei
- Bureau of Energy, Ministry of Economic Affairs, Chinese Taipei

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- Dr. Alissara Reungsang, Professor, Khon Kaen University, Thailand

Honorary-Adviser

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