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Knowledge Import from outside EU on Advanced Biorefineries

Workshop, 29th January 2009, Osnabrück, Germany

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Speakers:

- Prof. Shiro Saka, Kyoto University, Graduate School for Energy Science, Japan
- Prof. Telma Franco, State University of Campinas (UNICAMP), Brazil
- Prof. Bruce Dale, Michigan State University, USA

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Introduction

As part of the BIOREF-INTEG project on development of advanced biorefinery schemes for integration into existing industrial (fuel producing) complexes, a workshop " Knowledge Import from outside EU on Advanced Biorefineries" was organized on 29th January in Osnabruck, Germany. The aim of the workshop was to provide an overview of the current status of biorefineries outside EU through participation of representative scientists from Japan, Brazil, and USA. Shiro Saka (Kyoto University), Telma Franco (University of Campinas), and Bruce Dale (Michigan State University) presented their views and activities on biorefineries in their countries.

Topics discussed in the presentations covered wide range of techniques for extracting valuable chemicals and materials from biomass. Current status quo in commercial biofuels production with conventional bioethanol and biodiesel technologies was presented. Novel approaches in the treatment of biomass were also discussed, involving efficient methods for conversion of lignocellulosic materials into already known and also novel chemicals and materials. A strong focus was set on utilisation of waste materials for the production of conventional and advanced biofuels.

Recent Progress in Biorefineries as Introduced by Supercritical Fluid Science and Technology

Shiro Saka presented several novel processes based on supercritical conversion technologies. Beside water, methanol can also be used as solvent in this process. Advantage of the supercritical processes is the elimination of the pretreatment step, which consumes lots of energy and requires expensive equipment. Another advantage of the supercritical treatment is compatibility of waste oils as feedstock. Free fatty acids present in the waste oils, in higher extent than in the raw vegetable oils, are converted to biodiesel, and the process is both more environmentally friendly and more efficient. Another feature of the proposed processes is the conversion of glycerin to biofuels or biochemicals, which eliminates current overproduction of this byproduct of biodiesel production. A variety of chemicals could be obtained from lignin when supercritical treatment is applied, instead of burning lignin for energy purposes, which is the current practice.

Finally, the presentation was concluded with an option for integrated biorefinery that uses various waste materials, converting them to biofuels/chemicals/energy, while making use of proposed supercritical technologies.

Advances and opportunities towards a biobased industry in Brazil

Telma Franco gave a general overview of the Brazilian biofuels industry with the focus on sugarcane processing. Brazil is the world's largest bioethanol producer with about 6 million cubic meters production in 2008. Only 15% of this amount is exported and the rest is used internally.

Ethanol in Brazil is produced from sugarcane in a combined process with sugar production. The main challenge in the processing of the Brazilian sugarcane today is developing the 2nd generation technology for the conversion of fibrous residue (bagasse) into ethanol. At the moment bagasse is burned to provide the required process energy, while the surplus energy is converted to electricity and sold on the market.

Another component of the sugarcane plant is the cane trash, which is the field residue, dry leaves, and tops of the plant. Current harvesting practice includes burning the sugarcane field prior to harvesting, where the cane trash is burned and the stalks are used for ethanol production. This practice is gradually being abandoned, and more and more mechanized harvesting is used. Cane trash represents one third of the whole plant on energy basis. Using bagasse and cane trash in the process could lead to a doubling of ethanol capacity, which means a significant increase in the process efficiency.

In addition activities of the large petrochemical companies and other biotech SME's in Brazil were discussed, with the most interesting development being the production of bioplastic by Braskem. Braskem initiated a project on production of green polyethylene from sugarcane ethanol. Such polyethylene is essentially the same as fossil based polyethylene. The only difference is that green polyethylene is produced from renewable resources.

Finally, some activities of Dedini – the largest process design and engineering company in Brazil- were discussed. Dedini is the supplier of almost 80% of the Brazilian market. They provide integrated solutions in sugarcane processing, so called turn-key system with the wholly integrated system of sugarcane crushing, extraction, fermentation, separation, as well as cogeneration plants with option of selling extra electricity to the public grid. One of the new plant concepts is the combination of ethanol and biodiesel production into one fully integrated plant. Biodiesel and ethanol are produced in the campaigns, with ethanol being used for esterification instead of currently used methanol.

Current Status of Cellulosic Biofuels in the US

Bruce Dale's presentation discussed the incentives of the US Government, with the main objective being to reduce US dependency on foreign oil. Renewable resources including biomass are the key priorities in this regard. Dale points out the importance of pretreatment in the lignocellulosic ethanol as the central point of the ethanol processing. Currently sugarcane and corn processing to produce ethanol are well established processes, while lignocellulose-to-ethanol technology is at about half the way to commercialization. Cost drivers in the 2nd generation ethanol production are raw materials with about 30% of the total processing costs, and the enzyme for hydrolysis with estimated 10% of the total costs, but only after the optimisation of the enzymes production.

The structure of the investments in the development of second generation ethanol in the US reveals that private and corporate funding schemes represent a major share in the investments. Dale predicts shifting of the research focus from processing to more pretreatment and upstream activities in the biomass chain.

In addition Dale shows some details on the pretreatment method developed at Michigan State University. AFEX (Ammonia Fiber EXpansion) is an advanced method for pretreatment of lignocellulose, which uses ammonia in combination with high pressure and temperature for efficient preparation of the biomass for subsequent enzymatic hydrolysis. An economic objective of AFEX pretreatment is to produce free fermentable sugars at the cost of 0.13$/kg, which should be a reasonable starting point for further ethanol production.

Finally, Dale presented a biorefinery logistic scheme, with regional pretreatment and processing centers that are expected to result in sustainable rural economy, producing clean fuels from renewable resources.