Industrial scale demonstration biorefinery on lignin-based aviation fuel

Welcome to the second BIOREFLY newsletter issue.

BIOREFLY is co-funded by the European Commission under the 7th Framework Programme (Project No. FP7-612747).

The duration of the project is from January 2015 until December 2018.

In this issue we would like to present you an overview of the project, its objectives and relevant news from the partners during the first months of the project. Please do not forget to visit our website www.biorefly.eu.

About BIOREFLY

Aviation is one of the fastest growing transport sectors and this trend will continue in the coming years. According to the International Air Transport Association (IATA), global aviation is expected to grow by 5% annually in the period up to 2030. Currently, petroleum derived liquid fuels are the main energy carrier in the aviation sector. Due to different environmental and economic concerns there is a need for the sustainable supply of aviation fuels.

Bioenergy will play a key role in the EU's long term energy strategy for all applications, especially in the transport sector. The supply of feedstock and the biofuel conversion technologies which are currently deployed already provide a significant contribution, but diversification of feedstock and advanced technologies will be necessary for further development.

The aviation industry considers aviation biofuels to be one of the primary means to reduce the carbon footprint of the industry. In this context, the BIOREFLY project will develop and build the first industrial scale demonstrative lignin-to-jet fuel facility in Italy.

The combined production of a high annual volume of cellulosic ethanol and lignin-based jet fuel through sustainable and innovative technologies will be the first step towards biofuel commercialisation and market deployment.

The overall goal of the BIOREFLY project is to develop technologies allowing an increased and more economical utilization of selected renewable lignocellulosic raw materials for the production of second generation biofuel for aviation. The sustainable supply chain will be demonstrated, environmental and socio-economic impacts will be assessed and results gathered from tests in engines and demonstration flights will be disseminated to relevant stakeholders.

For further information please contact the project coordinator or visit our website www.biorefly.eu

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Project partners

BIOREFLY Annual Meeting

The BIOREFLY project consortium had its annual meeting on the occasion of the 24th European Biomass Conference and Exhibition in Amsterdam. The consortium met on 7th of June 2016 to discuss the progress of the project and to develop further strategies for the upcoming phase of the project.

One of the latest news within the project is the relocation of the demo plant. Since the coordination of the project faced severe difficulties and delays with the original plans, foreign to the project, the decision to relocate the demo plant was taken on time. At the moment, the plant would be relocated to the north of Italy and is under authorization. After all, during the first eighteen months of the project, the processes reached with the scale-up demonstration activities, performed by the partners, had been validating the optimization for the second generation technology on real operational grounds. The following step is the construction of the plant to start-up with the implementation phase.

Scale-up of the technology

In order to define the working parameters for engineering scale-up, a significant research activity has been carried out both at the lab and pilot scale. Several key parameters of the process, such as the lignin slurry concentration, H_2/lignin ratio, catalyst/lignin ratio and residence time, has been studied and optimized.

The process optimization from lignin co-produced to jet-fuel relies first on a good phenolic oil production by catalyst screening, yield increase, lignin purification, and a further optimization of the operating conditions (T, P, residence time). The second focus relies on the improvement of quality of jet fuel to achieve the standard requirements (Jet A/A-1). Currently, the main purposes are focused on the reduction of the oxygen content in the samples and the removal of poisoning (S and N).

Finally, an alternative research and development solution is to evaluate the jet fuel production from lignocellulosic second generation sugars through a fermentation process.

Modelling of hydrodeoxygenation of phenolic oil

The model is intended to provide quantitative estimation of the changes of oil composition during the process as a function of process-variables (temperature, time, etc.).

The challenges of the mathematical modelling are:

- Phenolic oil is a complex mixture which contains a lot of different compounds;
- From both experimental and modelling points of view, it is challenging to characterize the changes in concentrations of all species;
- Few literature data available.

The model aims to characterize the changes in compositions of the entire phenolic oil (light and heavy fractions). The modelling approach proposed by ETH intents to describe the changes in compositions taking into account of the main functional groups. A lumped effective kinetic scheme is then proposed assuming an instantaneous adsorption of the species on catalyst; adsorption is reasonable at steady state; the effect of adsorption is not treated explicitly but lumped in the kinetic constants; hydrogen is in excess and is not explicitly included in the kinetic rate; all reactions are assumed to be verified during the fitting of experiments; kinetic constants are expressed according to Arrhenius formulism.

At the light of these considerations, 12 parameters must be estimated:

6 pre-exponential factors: k_1^0, k_2^0, k_3^0, k_4^0, k_5^0, k_6^0

6 activation energies: $E_{att,1}$, $E_{att,2}$, $E_{att,3}$, $E_{att,4}$, $E_{att,5}$, $E_{att,6}$

The experimental activity concerning HDO process will be carried out by Biochemtex, and the analytical results will be used for parameters estimation. The influence of the most relevant process-variables (temperature, pressure and residence time) will be assessed.

Biofuel testing and utilization in the aviation sector

Two kinds of bio jet-fuels samples produced by Biochemtex had been analysed by RE-CORD in order to have data for a comparison with Jet A/A-1 standard quality. Such samples have to be optimised since some oxygen is still present, while biokerosene is composed by bio-hydrocarbons only. However these samples, if necessary, could be subject of preliminary test in modified micro gas turbines.

RE-CORD has been preparing the set up test bench for pump and nozzle testing. They started working on a predisposition of small scale stationary turbine for testing the biofuel. Fuels suitable for testing are traditional fossil fuels (i.e. gasoline, kerosene, jet and diesel fuel), renewable fuels HEFA, FT-derived fuels, and other full-hydrocarbons fuel), and biofuels (i.e. oxygenated fuels such as biodiesel, bioethanol)., having the following characteristics:

- Viscosity range: 1 – 12 cSt.
- Density range: 750 – 1150 kg m-3.
- Mass flow rate: 1.5 – 15 kg h-1.
- Injection pressure: 4 - 25 bars (light fuels); 4 - 15 bars (diesel range).
- Fuel temperature: 0 – 60°C.
- Suitable for PIV and P/DPA analysis.

In the next months, experimental tests will be carried out by RE-CORD using bio jet-fuels produced by Biochemtex.

The ASTM process

The ASTM International applies three phases to approve new fuels. The first phase is the testing phase to evaluate the fuel or additive, the second phase reviews the process by OEMs, and the third phase is the approval phase that includes ASTM international balloting on the new specifications, or revision to an existing specification for the fuel.

BIOREFLY must fulfil the ASTM requirements and standards in order to perform the final demonstrative flight. There are two relevant standards that support the certification of alternative jet fuels.

1. ASTM D4054 – Standard Practice for Qualification and Approval of New Aviation Turbine Fuels and Fuel Additives
2. ASTM D7566 – Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons

In the BIOREFLY project these requirements are being taking into account, and after the testing phase is over, the jet-fuel developed could go through the ASTM process. The results of this phase will be available on further issues.

BIOREFLY Dissemination Activities

During the 24th European Biomass Conference and Exhibition (EUBCE) in Amsterdam taking place from 6th to 9th of June 2016, BIOREFLY participated in the exhibition centre with a stand dedicated to the project. Staff members from the project participated as exhibitors in order to disseminate and present the project to visitors.

As part of the dissemination strategy of the project, diverse dissemination materials were presented, together with posters from project partners indicating the objectives and developments achieved so far. Beside the stand, oral presentations from RE-CORD were accompanied by the dissemination strategy of the project within the conference. David Chiaramonti participated in the conference presenting: *Fuelling the aviation sector* and *Aviation biofuels: a novel lignin-based biorefining route to paraffinic fuels,* among others.

BIOREFLY being part of the exhibition could enjoy fruitful talks with different experts, and increased stakeholders' awareness of the BIOREFLY project.

BIOREFLY Communication and Dissemination

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