PyNe

PYROLYSIS NETWORK

DEC 2000 ISSUE 10

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SPECIAL

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Aston University

Comments and contributions are most welcome on any aspect of the contents. Please contact your country representative for further details or send material to Claire Humphreys.

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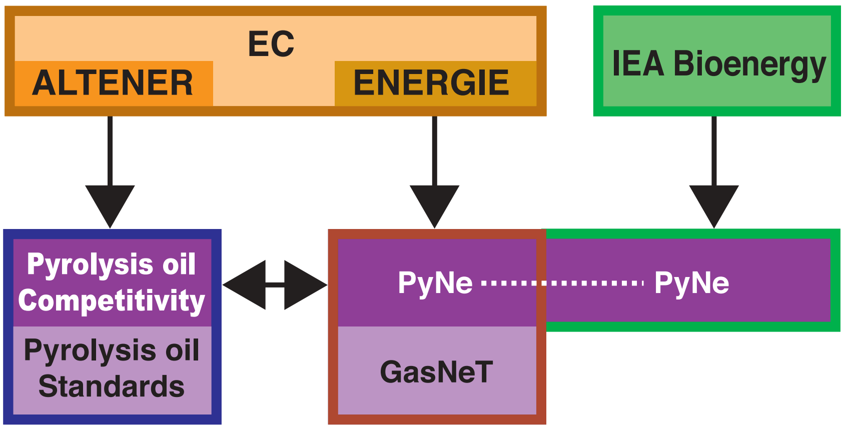
NEWSFLASH
The future of PyNe

The proposal to continue PyNe has been favourably evaluated by the EC and contract negotiations are currently in progress (November 2000). PyNe will be in a cluster with a parallel Network on Gasification. IEA Bioenergy has also agreed to continue their support, which will provide all the benefits of a global network.

In addition the EC has favourably evaluated an Altener proposal by Aston University, UK, and Joanneum Research, Austria, to examine the competitivity of bio-oil compared with fossil fuels in a range of applications.

This will be carried out in close association with PyNe in Europe and will be linked (clustered) to another Altener project on bio-oil standards proposed by CARE Ltd, UK.

These projects and their interlinkages are shown in the diagram below:



Successful pilot–plant project in the Netherlands

By Dr Wolter Prins, BTG, The Netherlands

The rotating cone fast pyrolysis process has been successfully scaled up to a biomass federate of 260 kg/h, dry basis, under an EC contract (FAIR-CT97-3203). KARA Engineering BV in Almelo was responsible for the construction and installation of the fully continuous plant, which was designed by BTG on the basis of their own patented reactor design.

The installation has been erected and operated in the BTG laboratory in Enschede. Various feedstock types, prepared and delivered by the Spanish research institute CIEMAT, have been processed, and the bio-oils produced have been tested for their combustion properties in a flame tunnel and turbine combustor in the laboratories of Rostock University in Germany.

A list of major achievements includes

- Longest test run 80 hours.
- Total bio-oil production 15 tonnes.
- Current capacity 260 kg/h.
- Maximum bio-oil yield 75 wt.% on dry feed.
- Wood types processed pine, poplar, beech, oak.
- Other feedstock types rice husks, wheat straw, Spanish thistle, organic waste.
- Particle sizes up to 6 mm, including fines.

Figure 1: BTG R&D facility.

Figure 2: Char combuster with hot sand recycle to rotating cone pyrolyser.

The technology has now matured sufficiently that the product quality can be controlled to an acceptable degree by the feedstock characteristics and process conditions. However improvements such as hot vapour filtration (or, alternatively, bio-oil filtering) are still under development.
The requirements, which are considered to be crucial for future market implementation, are:

- Demonstration of the earliest feasible applications of bio-oil including co-firing, heat boilers, diesel engines.
- Bio-oil characterisation and definition of the combustion properties for end-use purposes including warranty, specifications, health and safety.
- Large scale demonstration of the technology and production of large quantities of bio-oil.
- Industrial recognition and acceptance of bio-oil application routes.

The advantages of bio-oil utilisation have been pointed out extensively in earlier editions of the PyNe Newsletter. It is important to fully appreciate the benefits of the de-coupling of production and utilisation and the consequent advantages in handling such as transport, storage distribution and pressurisation for atomisation. Apart from the heat and electricity market, there may be long-term opportunities to produce transportation fuels on the basis of syngas production from bio-oil.

Figure 3: Hot sand and biomass feed to rotating cone pyrolyser.

BTG biomass technology group B.V.

BTG has recently completed its business plan for fast pyrolysis as a starting point for market implementation activities. The price of the bio-oil is estimated to be in the range of 6 €/GJ for an initial 2 tonnes biomass per hour demonstration plant, to 4 €/GJ for future installations larger than 5 tonnes per hour. The demonstration plant will be erected at the biomass park in Vriezenveen, where it can profit from some integration with the existing charcoal and sawdust briquetting factories and the current wood supply contracts. A demonstration project proposal submitted to the European Commission has been evaluated favourably. The EC subsidy, together with own contributions by the demonstration plant consortium, provides a sound financial basis for the first plant. The objective is to commercially exploit this demonstration plant in the future on the basis of bio-oil sales to the electricity and heat production sector.

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Vacuum Pyrolysis Breakthrough

By Christian Roy, Pyrovac Inc. Canada

Groupe Pyrovac inc. from Canada and Ecosun bv from the Netherlands have achieved the performance of the vacuum pyrolysis reactor at their Pyrocycling™ plant in Jonquière, Province of Québec. Pyrocycling™ is based on the vacuum pyrolysis technology. The joint venture has built, commissioned and operated the Pyrocycling demonstration plant in Jonquière at design performance levels. The reactor has been designed to operate at a capacity of 3.5 t/h of feedstock at 15% moisture content.

Figure 1a: 3.5 t/h pyrocycling™ plant.

Figure 1b: 3.5 t/h pyrocycling™ plant.

Process Performance

The test campaign, that took place during April 2000, enabled the transformation of softwood bark into wood oil, wood charcoal, gas and water. On an anhydrous feed basis, yields obtained at the industrial scale were:

Pyrolysis oils @15.7% water content	30.7%
Wood charcoal	29.2%
Water phase	19.6%
Pyrolysis gas	20.5%

Process Applications

A short term application of the Pyrocycling™ process is in the area of waste-to-energy projects. One potential application involves partial substitution of coal in a coal-fired boiler to generate electricity. In such a use, the wood charcoal and the crude pyrolysis oil derived from the waste biomass can be directly blended with coal fed to the boiler. New “Green” regulations that are being set-up by the EC make the process economically attractive.

In North America, the chemical route receives priority attention with the potential of using the pyrolysis oil as Biophen.

Figure 1c: 3.5 t/h pyrocycling™ plant.

The wood charcoal, apart from being a high calorific value solid fuel, is currently being investigated by the user sector as an oxygen reducer in the metallurgical industry and also as a soil enrichment material.
Its potential as an additive to upgrade road bitumen has already been established at the laboratory scale.

In Summary

Two decades of research and development efforts have led to the successful performance demonstration of this fast pyrolysis technology. To our knowledge this is the first time ever that such a high biomass throughput capacity (3.5 t/h) has been reached using a fast pyrolysis process.

The Pyrocycling™ plant in Jonquière is meant to become both a technology window for process applications in the area of bioenergy and waste recycling and a permanent R&D arm for Pyrovac to continuously improve the technology and find new product applications. Turn-key plants can be constructed and licensed by Pyrovac.

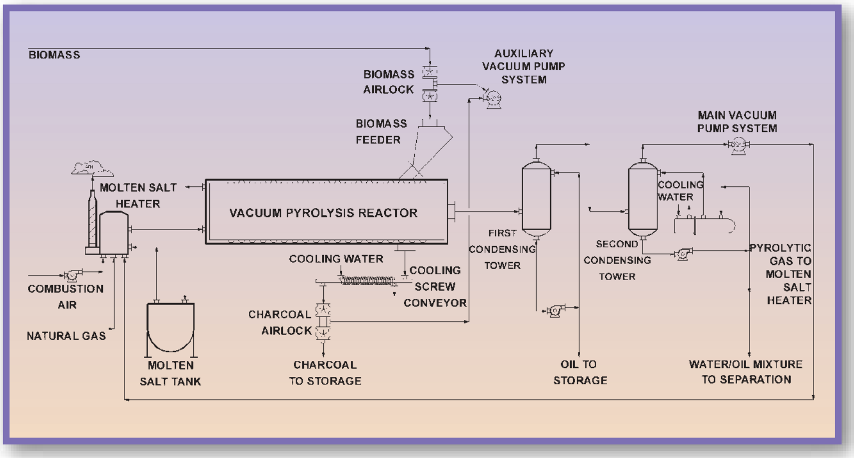

Figure 2: Pyrocycling™ process flow chart.

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The commercial development of bio-oil as a 'New Renewable'

By Daniel Grierson, Derwentside District Council, UK

The commercial application of bio-oil as a fuel for small embedded power stations is approaching reality in the north of England and the first planning approvals for the construction of plant have recently been granted.

Figure 1: Proposed site for the Consett bio-oil power station.

There are now planning permissions in place for both a combined pyrolysis and power plant in Carlisle, north-west England and the satellite plant in Consett, north-east England, which will use oil manufactured in Carlisle. Additional approval is currently being sought for another combined site in Powys, Wales and applications for further satellite power stations are being prepared.

The company behind these developments is Border Biofuels who have been featured in previous issues of this newsletter (PyNe Newsletter 8). The company initially intends to manufacture bio-oil from forestry residues, but also intends to develop sources of feedstock from short rotation coppice on a similar scale to the ARBRE (biomass gasification) project in Yorkshire. Such developments are of great interest from a planning viewpoint both because of their potential environmental impact and also because of the economic benefits from development of the industry. At Consett the environmental impact of the power plant was, after careful consideration and much consultation, felt to be acceptable and the benefits of the plant as an aid to inward investment and source of employment helped to allay local concerns.

Figure 2: Border biofuels pyrolysis sites.

There is, however, a range of potential impacts of the development, which are beyond the immediate control of environmental regulators such as town and country planners. These include the implications of creating large areas of coppice, changing the management regime within existing woodland to extract brash and developing combined heat and power networks in existing urban areas.

The identification of all these potential impacts is being carried out as a life cycle assessment of this bio-oil renewable energy industry. This will help to promote its sustainability and identify and subsequently address any adverse impacts.

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DynaMotive 2000
Progress Report

By Antony Robson, DynaMotive Europe Limited, UK

At the 1st World Conference & Exhibition on Biomass for Energy and Industry held in June in Sevilla, Spain, DynaMotive's Chief Technology Officer Keith Morris outlined the Company's recent progress and presented a joint technical paper with Orenda Aerospace on its successful bio-oil test program in Orenda's OGT2500 – 2.5 MWe industrial gas turbine. The tests demonstrated that DynaMotive's bio-oil, used directly from its pilot plant without any additional upgrading or refining, can both effectively power a gas turbine engine and simultaneously reduce NOx and SOx air emissions compared to traditional fossil fuels. In September, DynaMotive announced a second phase program with Orenda to develop a commercial gas turbine package to operate on DynaMotive's bio-oil fuel.

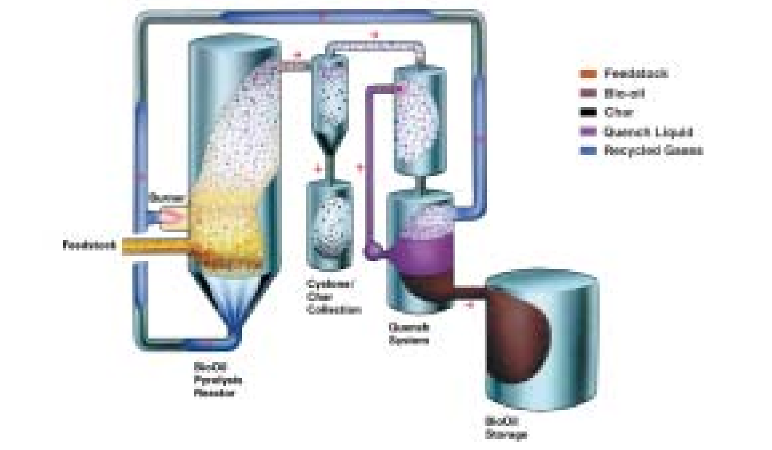

Figure 1: BioTherm™ flow sheet illustrating Dynamotives bio-oil production process.

Also in Sevilla, DynaMotive announced a second test program with Genergy, the only UK packager of Solar Turbines. Solar, a wholly owned subsidiary of Caterpillar Inc., is the world leader in industrial turbines in the 1-15 MWe capacity. Further bio-oil testing programs are anticipated.

Additional highlights from the year 2000 include:

- Outright acquisition of the Fast Pyrolysis Patent from Resource Transform International (RTI) as well as a right of first refusal for new products derived from bio-oil, including fuels and slow release fertilizers.
- Construction has begun on a new 10 tonne per day (tpd) bio-oil plant which will be completed in 4th quarter of 2000. The plant, with a production capacity of 6,000 litres of bio-oil per day, has been built to industrial specifications complete with state of the art control systems used worldwide in commercial facilities. This increased production will provide much larger quantities of bio-oil for engine and combustion test programmes.
- Once the new 10 tonne per day plant is fully commissioned, the Company plans to build a 25 tonne per day commercial demonstration plant in 2001 which will serve as a springboard for design and construction of full scale, 100 to 400 tonne per day commercial plants to be built in Canada, Europe, Brazil, Asia and other international markets.
- Completion of the new round of financing totalling US $4,389,900 which will be used primarily for scale up of the Company's bio-oil technology.
- Completion of a successful production run of high quality bio-oil made from sugar cane bagasse, expanding bio-oil market applications to sugar producing countries and creating significant potential demand for its bio-oil technology worldwide. A second stage bagasse program is underway.
- Completion of successful production of bio-oil made from 100% softwood bark.
- Corporate restructuring, including establishment of an expanded new Technology Group, opening of offices for DynaMotive Europe Limited in London, UK and DynaMotive Corporation in Los Angeles, CA to take advantages of opportunities in these markets, and establishment of DynaMotive Canada Ltd. to develop, build and operate bio-oil production plants in Canada.
- DynaMotive received a CDN $250,000 contribution from Natural Resources Canada (NRCan) to support ongoing R&D for bio-oil production and characterisation.

A copy of DynaMotive's 1999 Annual Report is now available from the Company or on its website.

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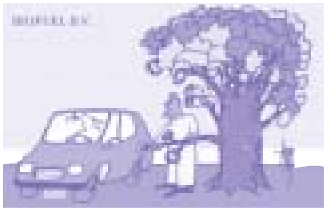
HTU pilot plant
on stream

By Frans Goudriaan., Biofuel B.V., The Netherlands



The HTU process was originally developed by Shell Research at Amsterdam. After Shell abandoned the project in 1988 a 'HTU consortium' resumed it in 1997. The consortium consists of Shell Netherlands, Stork Engineers and Contractors, TNO-MEP, BTG and Biofuel BV. With financial support of the Dutch Government the first part of a process design and development project was conducted from 1 November 1997 till 1 September 2000. The main achievements are the design, construction and operation of the pilot plant, screening of feedstocks in autoclave experiments, study of phase equilibria, exploration of product applications and conceptual process design with special attention for heat integration (1).

Process description

The HTU process treats biomass in liquid water at a temperature of 300-350°c, at a pressure of 120-180 bar and a residence time of 10-30 minutes. The main feature of the chemistry is deoxygenation by formation of carbon dioxide. Thus, the oxygen content of the feedstock (typically 40 %wt. on a dry basis) is reduced to 10-15%wt. in the product. The resulting organic product is 'Biocrude'. It does not mix with water and it has a high calorific value (LHV is 30-35 GJ/tonne on a dry and ash free basis). It solidifies at about 80°c. Its heating value and other properties make it attractive for co-firing in coal fired power stations. Catalytic hydrodeoxygenation has been shown to convert biocrude into hydrocarbons of which the diesel fraction has excellent ignition properties.

The nature of the HTU process makes it also very suitable for the conversion of wet feedstocks such as municipal organic waste, sugar beet pulp, verge grass etc., with moisture contents of typically 80%w.

Figure 1: HTM pilot plant located at TNO-MEP, Apeldoorn, The Netherlands.

The photograph shows the HTU pilot plant at TNO-MEP, Apeldoorn, The Netherlands just after its completion. In October, 1999, the Dutch Minister of Economic Affairs performed the official opening of the plant. The plant has an intake capacity of up to 120 litres per hour.

The future of HTU

At present we are setting up the financing of the second and last part of the HTU project. It is intended to run from early 2001 to mid 2003. It will encompass extensive operation of the pilot plant, and product research. At its completion sufficient data should be available for the design of a commercial plant.

In the mean time we have performed a feasibility study (2) for a commercial demonstration plant with a capacity of some 25000 tonnes/year (dry basis). The aim is to start construction of this plant in 2002.

References

(1) See F. Goudriaan, B. van de Beld, F.R. Boerefijn, G.M. Bos, J.E. Naber, S. Van der Wal and J.A. Zeevalkink, "Thermal efficiency of the HTU process for biomass liquefaction", presented at conference "Progress in Thermochemical Biomass Conversion", Tyrol, Austria, 18-21 September 2000

(2) This study was supported by Shell Netherlands and the Dutch Government (Novem-EWAB program).

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BIO-EMULSION – Development of a bio-crude-oil/diesel emulsion

By Piero Baglioni, CGSI, University of Florence, Italy

Bio-Crude-Oil (BCO) has the potential to replace fuel oil or diesel in many applications such as boilers, turbines and alternative engines for electricity production. However, technological development for BCO upgrading in order to obtain a fuel easier to handle, store and utilise for power generation is still a problem to be solved. The aim of the BIOEMULSION project (supported by the EC within the JOULE Programme, contract JOR3-CT98-0307) is to develop a process for improving BCO utilisation in diesel engine units.

Figure 1: 5kWe test engine running on bio-emulsion at Pasquali, Italy.

Emulsions

This process is based on the production of a stable emulsion between BCO and conventional diesel oil. BCO and diesel is a two-phase system, that is diesel oil and BCO are not miscible; therefore an emulsifier (or surfactant) has to be added to obtain a stable emulsion to change the interfacial properties of the system and avoid or delay the breaking of the emulsion. The emulsions developed at CGSI (University of Florence) are based on different BCOs in terms of feedstock and production facility. BCO from BTG and Dynamotive has been successfully tested. A semi-automatic emulsification system has been designed and constructed to produce approximately 50 l/h of emulsions. Very stable emulsions have been prepared, some of which have survived intact for over a year.

Tests

The emulsions, containing between 10 and 75% BCO in diesel, have been tested in small diesel engines of a few kWe at Pasquali Macchine Agricole (Italy) and Kassel University (Germany), as well as in a 250 kWel engine at Ormrod Diesels (UK). The tests aimed to assess combustion quality, operating performances and emission levels of the engines. These tests have demonstrated that the engines are able to successfully and efficiently burn this fuel. Many of the early problems in the injection system of the engines have been successfully resolved, although further work is required to verify the preliminary results.

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Figure 2: Bio-emulsion production facility at Pasquali, Italy.

Slow release fertilisers by pyrolytic recycling of agricultural waste

By Tony Bridgwater, Aston University, UK

Figure 1: Project team reviewing the results of the growing trials in Denmark.

Fertilisers are being produced from agricultural wastes and biomass by three different methods:

- reaction of nitrogen containing compounds with pyrolysis liquid.
- addition of the nitrogen containing compound to the biomass before pyrolysis.
- direct reaction of nitrogen containing compounds within the pyrolysis process.

The products are being tested on different plants in different growing regimes in order to compare their effectiveness with each other and with conventional fertilisers. These are initially being tested on pot plants, with some early and very encouraging results shown in Figure 1 & 2. Later trials will focus on larger scale trials.

Figure 2: Results of fertiliser trials on hebe plants. The plant with no fertiliser is on the left, the control with a standard fertiliser is the three pots next to it. The new fertiliser is in the six pots on the right.

The key attraction of this overall process is the sustainable recycling of agricultural wastes and residues into a unique and valuable fertiliser for agricultural and horticultural applications. Thus not only are wastes reduced or even avoided, but a unique and valuable commodity is produced.

The product is also flexible as a range of nutrients and additives can be included in the product as required for different applications. The pyrolysis process to be used to process the agro-materials is a well established technology. It produces no wastes as all the by-products are either used in the process as energy source, or contained as essential components of the resultant product.

This work is being carried out within an EC Contract (FAIR-CT98-4042) and comprises the following members:

Aston University, UK (Co-ordinator)
IWC Germany
ADAS, UK
DIAS, Denmark
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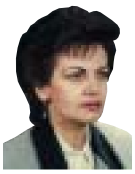
Wood adhesives made with pyrolysis oil



By Sophia Tsiantzi and Eleftheria Athanassiadou, Adhesives Research Institute Ltd., Greece

Introduction

Phenol-formaldehyde resins represent an important type of adhesives employed in the production of wood-based panels of superior water resistance (exterior use products). They are mainly the products of the reaction between phenol and formaldehyde, which is catalysed by alkali to provide a thermosetting polymer called a resole. Other phenolic compounds (e.g. resorcinol) can also react with formaldehyde to provide polymers of the same type.

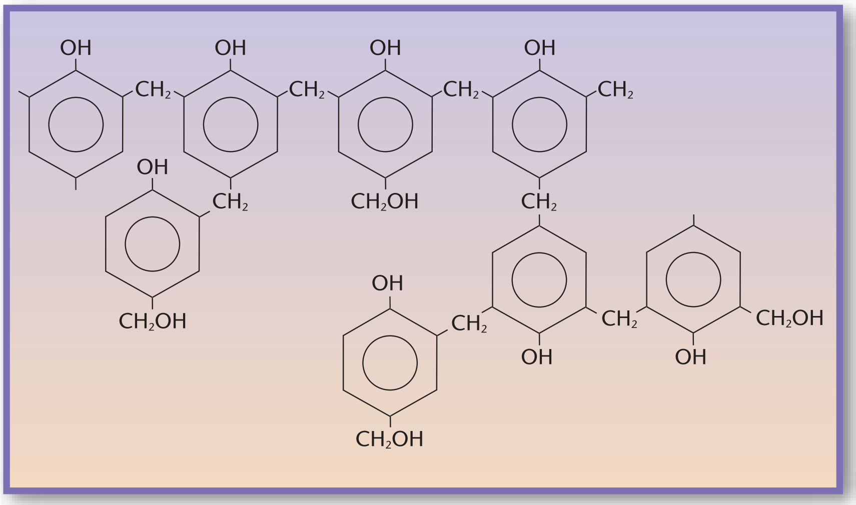


Figure 1: Resole structure.

Phenol is a toxic petrochemical substance and the recent increases in oil prices, together with the need to reduce demand on fossil fuels and promote environmentally friendly products, have encouraged the development of alternative resin feedstocks derived from renewable resources. Efforts in this field have accelerated in the latest two decades.

The research group of A.R.I. in this respect has studied the potential use of pyrolysis oil (bio-oil), a portion of which comprises phenolic compounds, for replacing part of the phenol needed in the formula of a phenol-formaldehyde resin. A successful phenol substitute should be:

- less toxic than phenol.
- of considerably lower cost than petroleum-derived phenol.
- able to provide resins with the same or enhanced quality than the ones conventionally synthesized.

The first two requirements are fulfilled by fast pyrolysis oil (bio-oil). The scope of this work was to evaluate, whether the third requirement can also be fulfilled by pyrolysis oil. Preliminary results presented in 1998 (1) showed that up to 30% phenol substitution by pyrolysis oil was possible. However, the resin efficiency was adversely affected, particularly for substitution levels over 20%. These results were, however, considered promising and worthy of further investigation, and further results are presented below.

Methodology and Results

Phenol-formaldehyde resins were successfully produced by substituting up to 50% of the phenol needed in the formula with bio-oil, using slight modification of the commercial synthesis know-how. The resins were intended for use in two different applications: production of either Oriented Strand Board (OSB) or plywood (PW) panels. This difference in resin application requires a different approach in resin production sequence. However, the use of bio-oil in both cases provided phenolic adhesives with reactivity (curing time) and performance equal to those of conventional resin.

Industrial scale production of plywood was carried out by employing the bio-oil modified phenolic resin. Representative results from testing the board properties are given in Figure 2. The board samples were tested according to the requirements of bond type WBP (Weather and Boil Proof, 72h boil pretreatment) of British Standard 6566, using the knife test for assessing the bond quality. Two different types of wood veneers were employed for forming of the panels: poplar (hardwood) and okoume (tropical) veneers. The bond quality of the modified resin was compared with that of the conventional resin (control) and the value of plant control. The panel bond performance, however, is highly dependent not only on the resin type but also on the type of wood veneers. The results show that the bond quality of the bio-oil modified resin is equal to or even better than that of the conventional resin and higher than the plant control value.

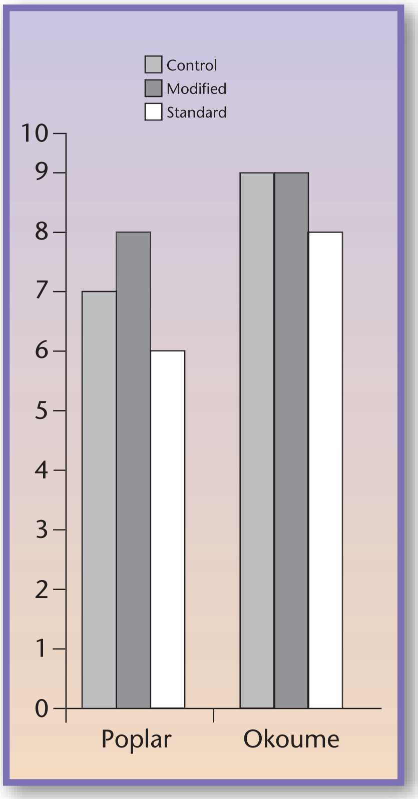


Figure 2: Bond quality of industrial plywood produced with bio-oil modified PF resin.

Furthermore, pilot scale production of OSB was carried out by employing bio-oil modified resin. In Figure 3, the values of tensile strength (IB N/mm²), bending strength (MOR N/mm²), % thickness swelling after immersion in water for 24h (TS) and bonding durability (BD, N/mm², MOR after 2h boiling of the board samples) are provided with a comparison with conventional phenolic resin and the standard requirements (CSA 0437). It is clear that the resin performance was not adversely affected by the incorporation of bio-oil. These results will be verified in planned industrial scale tests.

Conclusions

Pyrolysis oil can be used in the manufacture of phenolic resins for various panel types with good results. An up to 50% phenol substitution has already been realized and further increases in the level of substitution is envisaged.

To provide significant savings for the resin manufacturer the phenol substitution level should be above 40% and the price of the pyrolysis oil should be no more than 50% of the synthetic phenol price. Its lower toxicity compared to phenol and its conformity with the EU directive for sustainable development (it is produced from renewable resources) make it attractive for further investigation.

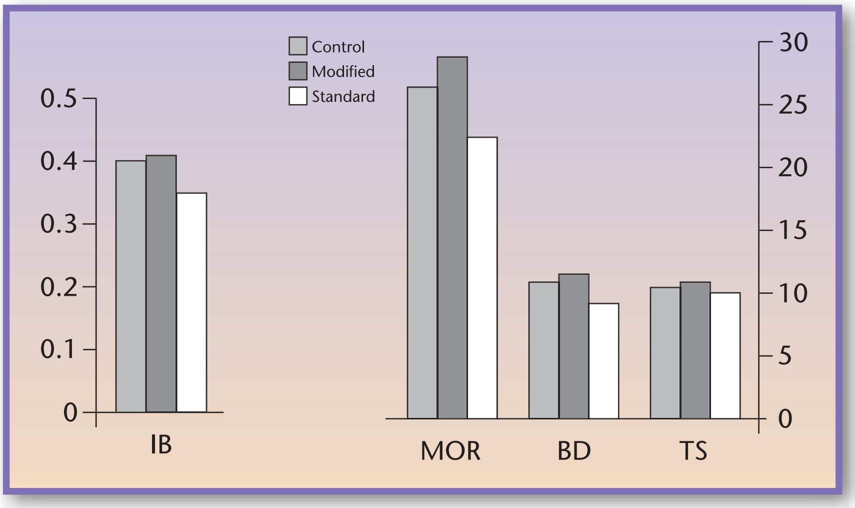


Figure 3: Tensile (IB) and bending (MOR) strength, 24h thickness swelling (TS) and bonding durability (BD) of pilot scale OSB produced with bio-oil modified PF resin.

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Reference

1 Nakos, P, PyNe Newsletter, No. 6, September 1998, (Aston University, UK)

A.C.M. WOOD CHEMICALS

A.C.M. Wood Chemicals plc is a world leader in the development and manufacturing of formaldehyde-based resins and resin additives for the production of wood-based panels. SAPEMUS CHEMIE GmbH is a a member of this group, producing resin additives in Germany and ADHESIVES RESEARCH INSTITUTE (A.R.I.) Ltd., based in Greece, is the research and development centre of the group, specialised in the wood and adhesives chemistry.

Wellman integrated fast pyrolysis pilot plant

By Richard McLellan, Wellman Process Engineering, UK

The project

Wellman Process Engineering is about to start up an advanced fast pyrolysis reactor designed to process 250kg/h of wood. Funding assistance for the project has been provided through an EU Contract (JOR-CT97-0197) The contract is being carried out in a consortium with Aston University, The Institute of Wood Chemistry in Hamburg, Biomass Technology Group, KARA Energy Systems and Ormrod Diesels.

Figure 1: 250 kg/h pilot plant at Wellman Process engineering.

Process

The process involves the fast pyrolysis of 1-2 mm softwood particles at a design feed rate of 250 kg/hr (dry basis) with an anticipated pyrolysis liquids yield of 75%. Pyrolysis is performed under reducing conditions in a bubbling fluidised sand bed. Once at operating temperature, all the heat necessary for the pyrolysis process is provided by combustion of the char and gas by-products. Cyclones remove char from the raw pyrolysis products prior to the pyrolysis liquid being condensed by direct contact with cooled circulating pyrolysis liquid. Two electrostatic precipitators connected in series collect all pyrolysis liquid aerosols from the gas stream. The gas, after pressure boosting, is used as fluidising gas for the fast pyrolysis reactor. A recent picture of the pilot plant accompanies this description.

Based on laboratory scale tests carried out by members of the project group, Wellman Process Engineering have designed, constructed, and cold commissioned the integrated fluidised bed fast pyrolysis reactor and the associated product recovery systems. The purpose of the pilot plant is to demonstrate that a good quality pyrolysis oil can be produced without the need for additional heating fuel by a process which is robust and capable of continuous operation.

Construction

The demonstration plant has been fabricated and assembled in Wellman assembly shops, Oldbury, England to meet applicable industrial codes and practices. Process, mechanical, pneumatic and electrical installations have all been completed and the plant has been pressure tested and cold commissioned. Instrument calibration, and logic testing of the Siemen's PLC control and data monitoring system has also been performed.

The plant has been built as five modules with each key process step contained on a separate skid. This provides flexibility enabling process stages to be modified enabling alternative biomass feedstocks to be tested at a later date. In addition, should the need arise, the modular design enables the complete plant to be transported to an alternative location for further project evaluations/demonstrations.

Approvals

A Hazard and Operability study as well as a Risk Assessment for the plant has been carried out to implement safe operation and maintenance procedures. Under the UK Environmental Protection Act 1990 the pyrolysis of carbonaceous materials is a prescribed process. Wellman have applied for and been awarded approval from the Environmental Agency to operate the pilot plant. Under this act the pyrolysis process as a whole must be justified as the Best Practicable Environmental Option (BPEO). The renewable nature of wood and hence it's use as a "carbon dioxide neutral" fuel is a significant advantage in this respect. An operating permit is issued only after a comprehensive appraisal of the complete process and a risk assessment of training and operating procedures has been satisfactorily carried out. The application for approval also involves a justification for all key process steps with particular emphasis on the abatement and monitoring of emissions using Best Available Techniques Not Entailing Excessive Cost (BATNEEC). Additionally, approval to operate the plant has been obtained and granted from the Health & Safety Executive (HSE), the local water authority and the local council.

Operation

Hot commissioning of the demonstration plant is taking place and will be followed by an operating campaign to convert 45 tonnes of wood into pyrolysis oil. The product oil will be subjected to analysis and characterisation and utilised by Ormrod Diesels to fuel a modified diesel engine.

The Wellman Group of companies

Wellman Process Engineering is a wholly owned subsidiary of the Wellman Group. Wellman Group comprises five UK based engineering companies specialising in thermal and process engineering, each providing design and manufacturing excellence in its field.

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Pyrolysis oil combustion tests in an industrial boiler

By Anja Oasmaa, VTT Energy, Finland
and Matti Kytö, Oilon Oy, Finland

Combustion Tests

The combustion properties of various pyrolysis oils derived from biomass have been studied at Oilon´s R&D Centre in Lahti, Finland. Oilon is the biggest burner manufacturer in Finland and is interested in boiler applications in the burner size class of 350 kW – 45 MW. The dimensions, operating parameters and characteristics of pyrolysis oils were tested and compared, and emissions were measured for each test.

Figure 1: Picture of the test boiler at Oilon R&D Centre.

There were clear differences in combustibility and in particular in emissions for different oil grades. The most important parameters for pyrolysis oil combustion are viscosity, water and particulates content, amount of methanol addition, bio-oil raw material and bio-oil age. There are clear differences in combustion between good and poor oils. Modifications to the burner and boiler improve the combustion result but cannot help much if the oil quality is poor.

When optimising combustion conditions for the test oils, the following effects of oil quality were found:

- feedstock and/or pyrolysis process yields various reactivities of oil components, which may cause blockages in the feed line.
- oil age and/or inhomogeneity gives uneven combustion.
- methanol addition homogenises poor-quality pyrolysis oil and improves its combustion.
- solids content affects mainly the amount of incombustibles.
- an increase in water content reduces NOx emissions and increases particle and soot emissions.

Concerning equipment modifications and adjustments, the following factors improved combustion and flame:

- clean nozzle.
- strong swirl.
- intense symmetrical flame.
- pressure air atomisation (compared to steam).
- increase of air coefficient and combustion power (having enough residence time though).
- suitable atomisation viscosity (abt 15 – 20 cSt).

At the optimum adjustments of this combustion system, the mean combustion results and emission values of typical pyrolysis oils were as follows:

- O_2 3.5 vol%.
- NOx 88mg/MJ.
- CO 4.6 mg/MJ.
- hydrocarbons 0.1 mg/MJ.
- soot 2.4 Bac.
- particles 86mg/MJ.

In addition to the characteristics of pyrolysis oils and burner settings, different furnace constructions were compared in the test runs. By insulating the front of the furnace, the mean temperature levels of the flame were increased and hence combustion was improved.

RESULTS

The main results of the combustion tests are:

- Pyrolysis oils can be burned relatively well in conventional furnaces and boilers. Boilers and oil burners may require small modifications or additions. The flame is larger and combustion takes a longer time than with mineral oils.
- Handling and pumping of pyrolysis oil should be performed according to exact recommendations of equipment providers.
- Support fuel is required at the start of combustion and possibly in the combustion of pyrolysis oil of poor quality to maintain good and stable combustion.
- The nozzles should be kept clean and in good condition. Extra cooling air for the nozzle could be useful during combustion.
- Emissions from combustion are in general between those from light fuel oil and the lightest heavy oil, but the particulate content is higher. There are no SOx and net CO_2 emissions.
- Quality specifications should be defined for pyrolysis oil, especially water and solids contents.
  The viscosity range is significant for good atomisation. The quality of pyrolysis oil has a strong effect on emissions. A high solids content in pyrolysis oil yields high particulate emissions, hence solids removal from pyrolysis vapours or oil is highly recommended. High (above 30 wt%) water contents also give high particulate emissions. These emissions can be reduced to a certain extent by using a support fuel and optimizing the atomization viscosity.
  Methanol addition (up to a maximum of 10 wt%) homogenizes inferior quality oils and decreases particulate emissions. The costs for methanol addition and oil combustion in a commercial boiler are most probably lower than those of incinerating poor-quality oil in a special incineration plant for hazardous wastes.
- Further research is required on combustion properties of different commercial pyrolysis oils in order to identify the reasons for emission behaviour, nozzle blockages and related phenomena.

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Transport requirements for fast pyrolysis liquids

By Cordner Peacocke, CARE Ltd, UK

CARE Conversion And Resource Evaluation Ltd

Introduction

As demand for fast pyrolysis liquid increases, it is important that it is transported in a safe and environmentally secure manner. The appropriate national and international regulations need to be met and it is likely that fast pyrolysis liquid will be classed as a "dangerous" or a "hazardous" substance for transportation purposes. Pyrolysis liquids are not listed on the UN approved carriage lists, therefore its own classification has been determined. The classification derived is:

UN 1993 Flammable Liquid, n.o.s., (pyrolysis liquid), 3, 1°(a), 2°(a), 1

This code is valid for pyrolysis liquids containing less than 10 wt% acetic acid. A separate classification is required for liquids with an acetic acid content higher than this, although to date, no fast pyrolysis liquids have been reported with a content higher than 5wt%.

Label Requirements for Fast Pyrolysis Liquids

All packages of any size should be clearly marked with the following information both on the sample and on the relevant transportation documents. A set of Material Safety Data Sheets (MSDS) must also accompany any samples.

Table 1 Label information for packages

UN symbol:	Substance Identification No.	Name of Substance	Hazard Identification No.	Label Model Nos.	Class and Item Number
	1993	Flammable Liquid [Fast Pyrolysis Liquid]	33	3 6.1 11	3 1°(a), 2°(a), 2°(b), 3°(b), 5°(c)

Class 3 Flammable Liquid Label 3 | Class 6 Toxic substances Label 6.1 | Store this way up Label 11

Figure 1: Packaging labels. All should be used on all shipments.

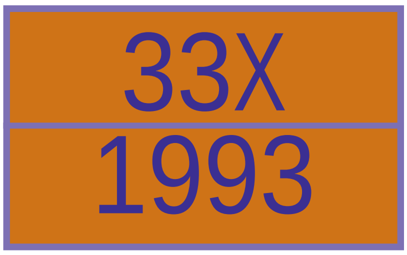

Figure 2: Placard for transportation in containers and bulk carriage.

Table 2 Label sizes for shipments

Capacity of Package	Dimensions of label
Not exceeding 3 litres if possible	at least 52 x 74 mm
Exceeding 3 litres but not exceeding 50 litres	at least 74 x 105 mm
Exceeding 50 litres but not 500 litres	at least 105 x 148 mm
Exceeding 500 litres	at least 148 x 210 mm
Exceeding 3000 litres	at least 250 x 250 mm

If the size of the package so requires, the dimensions of the label may be reduced, if they remain clearly visible.

IBCs [intermediate bulk Containers] are not suitable for transport, due to the potentially hazardous nature of the liquids.

In addition, for tankers, or other large bulk transport, placards are typically used for road and rail transport (Figure 2). The placard dimensions are typically a minimum of 30 cm high by 40 cm wide, numerals to be a minimum of 10 cm high. The requisite codes for a placard is:

Placard for large quantities [> 500 l] is shown below, with the correct transportation codes:

Substance Identification No. [Lower part]	Name of Substance	Hazard Identification No. [Upper part]
1993	Flammable Liquid [Fast Pyrolysis Liquid]	33X

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References

United Nations Recommendations on the Transport of Dangerous Goods Model Regulations, 11th Revised Edition, ISBN 92-1-139067-2, January 2000.

G.V.C. Peacocke and A.V. Bridgwater, "Transport, handling and storage of biomass derived fast pyrolysis liquid", paper presented at Progress in Thermochemical Biomass Conversion, Tyrol, September 2000, proceedings to be published by Blackwell, 2001

Conversion And Resource Evaluation Ltd., "Transport, handling and storage of biomass derived fast pyrolysis liquid", report to be published by PyNe Network early in 2001

Acknowledgements

CARE Ltd. would like to thank the PyNe Activity for funding this work.

Progress in utilisation of bio-oil in diesel engines

By D Ormrod and A Webster, Ormrod Diesels, UK

More than 400 hours of operation have now been achieved on the modified dual fuel diesel engine at Ormrod Diesels. Both bio-oil from a number of sources in Europe and North America have been tested and evaluated as well as more limited trials on a range of bio-emulsions made from emulsifying bio-oil with diesel from 25 to 75% bio-oil (see feature from CSGI on page 8).

Three cylinders of the six cylinder 250 kWe engine has been modified to run on a up to 95% bio-oil using diesel as a pilot fuel to initiate combustion. There is a well-defined and automated start-up procedure whereby the engine is started on 100% diesel fuel and transferred to bio-oil in the main injector when the engine is hot.

Emission testing has shown that apart from NOx, all other emissions are below those normally obtained with diesel.

The engine has now been operated entirely on a bio-oil feed using 5% diesel pilot fuel, with no fuel going to the un-modified three cylinders. This important milestone has provided confidence for a detailed proposal to install a 9 MWe bio-oil fuelled engine.

Figure 1: Rebuilding an engine at Ormrod.

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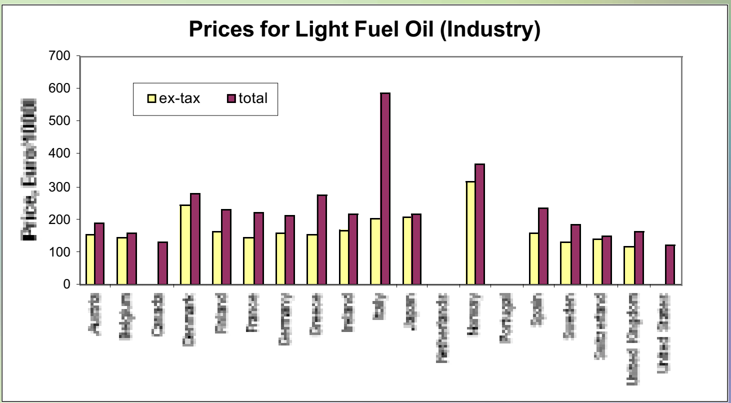
Energy

By John Brammer, Bio-Energy Research Group, Aston University, UK.

Fuel Oils

Country	Heavy Fuel Oil			Light Fuel Oil (Industry)			Light Fuel Oil (Domestic)		
	ex-tax	tax	total	ex-tax	tax	total	ex-tax	tax	total
Austria	119.0*	41.3*	160.3*	151.7*	38.0*	189.7*	168.0	124.4	292.4
Belgium	98.0	5.9	104.0	146.3	13.1	159.3	152.3	48.5	200.8
Canada			103.1			131.0			
Denmark	102.5	50.6	153.2	245.6	34.9	280.5	239.0	391.0	630.1
Finland	114.9	54.9	169.8	163.9	64.9	228.8	170.7	120.0	290.7
France	105.6	17.8	123.3	143.3	76.9	220.2	187.8	135.3	323.2
Germany	97.2	14.7	112.0	159.3	54.0	213.4	166.0	91.8	257.8
Greece	121.5	38.3	159.9	155.5	121.4	277.0	162.0	178.4	340.4
Ireland	137.7	14.3	152.0	169.2	45.5	214.7	241.6	83.5	325.1
Italy	112.6	30.1	142.8	201.0	386.6	587.6	209.3	525.1	734.5
Japan	218.9	10.9	229.8	207.9	10.4	218.3	332.9	16.6	349.5
Netherlands	128.4	29.3	157.7				210.0	180.7	390.7
Norway	191.0	89.1	280.1	316.0	53.2	369.2	344.2	147.3	491.5
Portugal	139.1	12.0	151.0						
Spain	138.1	12.9	151.0	159.8	75.6	235.5	166.5	118.0	284.5
Sweden	113.0**	57.0**	170.0**	129.7†	57.2†	186.9†	169.1†	295.7†	464.8†
Switzerland	104.1†	7.6†	111.7†	139.2	8.2	147.4	170.1	21.9	191.9
United Kingdom	97.6	37.9	135.5	116.9†	43.5†	160.4†	155.5	55.5	211.0
United States			95.1			122.6			238.5

Heavy fuel oil is low sulphur, except Canada, Ireland, UK and US (high sulphur). Heavy fuel oil density 0.96 kg/l



Energy Prices and Taxes 1999

Average prices over full year, except † part year only, *1998, **1997

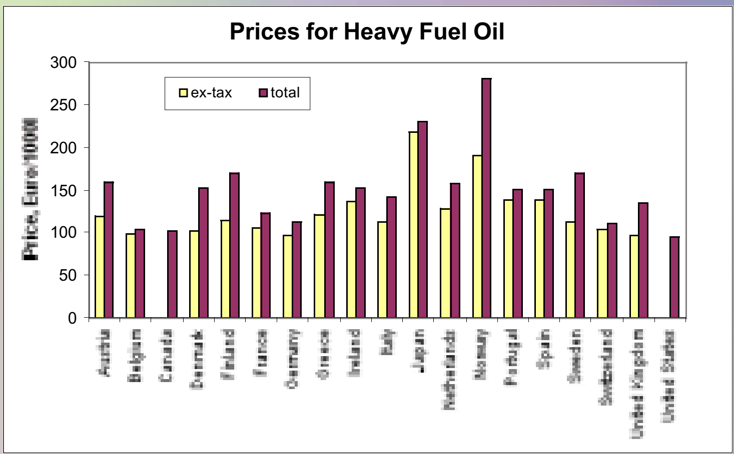
All liquid fuel prices in Euro/1000l

All gas and electricity prices in Euro/100kWh (or c/kWh), gas on GCV basis

All currency conversions based on exchange rates only: 1 Euro = 1.065 US$, 1.955 DM

Principal source: IEA Energy Prices and Taxes, 4th Quarter 1999 (ISBN 92-64-17493-1)

Brazil omitted as no data available

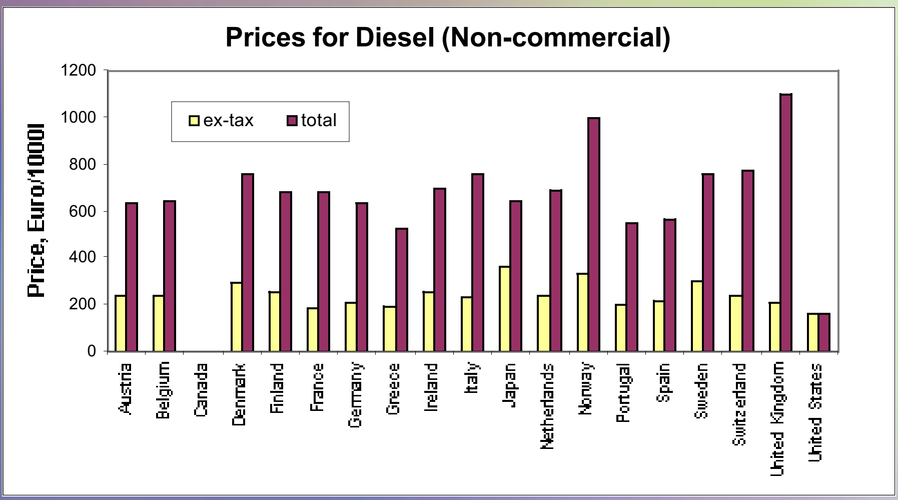


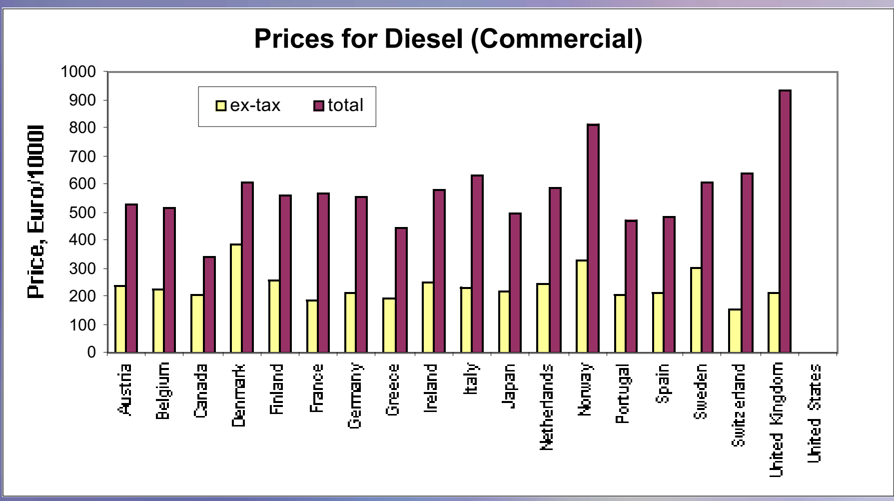
Prices & Taxes 1999

Transport Fuels

Country	Diesel (Commercial)			Diesel (Non-Commercial)			Gasoline		
	ex-tax	tax	total	ex-tax	tax	total	ex-tax	tax	total
Austria	240.9	289.5	530.4	240.8	395.6	636.4	264.1	550.1	814.2
Belgium	228.6	290.1	518.7	238.5	401.1	639.6	236.8	663.5	900.3
Canada	207.8	135.2	343.0				241.3	193.3	434.6
Denmark	384.6	219.3	603.9	296.2	459.1	755.3	283.8	704.9	988.7
Finland	254.9	304.1	559.0	254.9	427.1	682.0	256.0	738.6	994.7
France	184.8	381.0	565.7	184.8	497.6	682.4	198.3	751.9	950.2
Germany	210.8	342.8	553.6	210.3	428.2	638.5	229.2	645.1	874.3
Greece	191.2	254.9	446.1	191.2	335.1	526.4	241.8	409.5	651.2
Ireland	252.7	326.4	579.2	252.7	447.1	699.8	242.6	508.0	750.6
Italy	229.4	403.0	632.4	229.4	529.6	759.0	256.3	701.1	957.4
Japan	220.1	275.3	495.3	362.6	282.7	645.3	328.0	482.2	810.2
Netherlands	242.0	345.9	587.9	242.0	449.0	690.9	268.3	736.8	1005.1
Norway	332.2	481.8	813.9	332.6	669.0	1001.7	281.8	830.7	1112.5
Portugal	204.4	264.7	469.2	204.4	344.5	548.9	259.4	544.0	803.4
Spain	216.0	270.0	486.0	216.0	347.8	563.8	231.3	468.4	699.7
Sweden	303.3	301.0	604.3	302.4	453.2	755.6	254.2	692.5	946.7
Switzerland	156.1	480.3	636.4	237.3	534.0	771.3	231.7	515.9	747.6
United Kingdom	211.1	726.0	937.1	211.1	890.0	1101.2	197.5	867.3	1064.7
United States				161.5	108.9	270.4	241.3	94.8	336.1

Gasoline is premium unleaded 95 RON, except Canada (97 RON), Denmark (98 RON) and Japan (Regular)

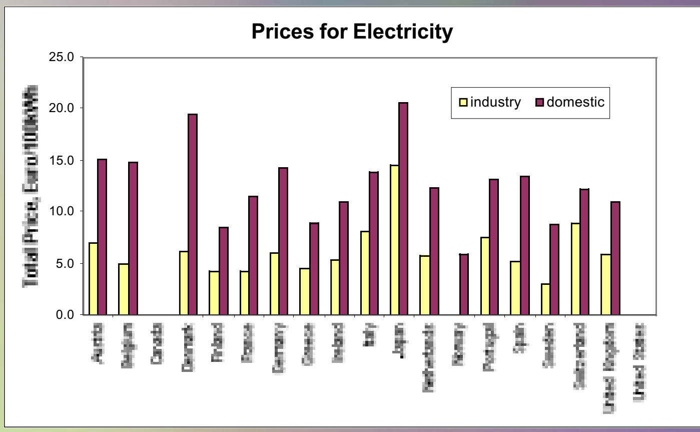




Energy Prices & Taxes 1999

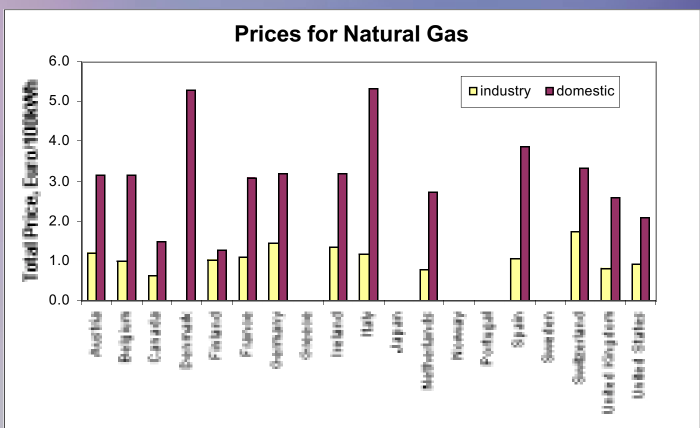
Electricity

Country	Electricity (Industry)			Electricity (Domestic)		
	ex-tax	tax	total	ex-tax	tax	total
Austria	7.06*		7.06*	11.85*	3.24*	15.10*
Belgium	4.89**		4.89**	12.14**	2.71**	14.86**
Canada						
Denmark	4.90	1.25	6.15	7.57	11.88	19.46
Finland	3.87	0.43	4.30	6.33	2.25	8.58
France	4.20*		4.20*	8.88*	2.72*	11.60*
Germany	6.06*		6.06*	12.36*	1.94*	14.30*
Greece	4.51*		4.51*	7.58*	1.37*	8.95*
Ireland	5.31		5.31	9.78	1.22	11.00
Italy	6.53	1.53	8.06	10.25	3.58	13.83
Japan	13.47**	1.06**	14.53**	19.32**	1.35**	20.67**
Netherlands	5.62†	0.11†	5.73†	8.84†	3.59†	12.43†
Norway				4.11	1.82	5.93
Portugal	7.58		7.58	12.57	0.63	13.20
Spain	4.98	0.25	5.23	11.03	2.42	13.45
Sweden	2.96**		2.96**	5.59**	3.19**	8.78**
Switzerland	8.99		8.99	11.40	0.86	12.25
United Kingdom	5.94†		5.94†	10.42	0.52	10.94
United States	3.09			7.66		



Gas

Country	Natural Gas (Industry)			Natural Gas (Domestic)		
	ex-tax	tax	total	ex-tax	tax	total
Austria	1.20*		1.20*	2.30	0.88	3.17
Belgium	1.00**		1.00**	2.50*	0.67*	3.17*
Canada			0.64†			1.50†
Denmark				2.27	3.01	5.28
Finland	0.87	0.16	1.03	0.87	0.39	1.26
France			1.09	2.57	0.53	3.10
Germany	1.26**	0.18**	1.45**	2.58**	0.60**	3.18**
Greece						
Ireland	1.34		1.34	2.85	0.36	3.20
Italy	1.04†	0.13†	1.17†	2.88*	2.45*	5.33*
Japan						
Netherlands	0.73†	0.07†	0.80†	1.78†	0.96†	2.74†
Norway						
Portugal						
Spain	1.06		1.06	3.30	0.58	3.88
Sweden						
Switzerland	1.71	0.02	1.74	3.07	0.25	3.33
United Kingdom	0.83†		0.83†	2.47	0.12	2.59
United States			0.92			2.08



Biomass Fast Pyrolysis Liquid Feed to a Stirling Engine with FLOX® Burner

By Andreas Bandi, ZSW, Stuttgart, Germany

BCO flow l/h	At. air press., bar	Emissions				Qth kWth	Pel, kWe
		Soot number	HC mg/m³	NOx mg/m³	CO mg/m³		
4.40	2.5	0.07-0.09	20-40	58	100	8	3.1
6.64	2.0			95	125	13	5.4
7.85	3.0			94	35	15	6.1
7.95	5.0			20	37	14	6.2

Table 1. Emission measurements at different BCO flow rate.

German Emission Standards for diesel engine up to 5 Mwe:
NOx: 500 mg/m³; CO: 650 mg/m³: HC: 100 mg/m³; Soot number: 2

Feedstock	Pine	H_2O, %	24.1 – 24.4
Density, g/cm³	1.188 – 1.191	Char content, %	0.31 – 0.37
Ash, %	0.02	Particle size of char, um	8.3 – 8.4
Carbon, %	46.24 – 47.07	Absolute viscosity, centipoise (cP)	< 100
Hydrogen, %	6.81 – 7.09	Kinematic viscosity,	
Nitrogen, %	< 0.1	centistokes (cSt):	
Sulphur, %	< 0.1	20°C	53.3 – 61.6
Oxygen, %	46.95 – 45.84	50°C	11.6 – 18.0
Flash point, °C	44 – 55	Higher heating value, MJ/kg	16.5 – 16.8
Pour point, °C	-27 to -24	Lower heating value, MJ/kg	15.0 –15.3
pH	2.2 – 2.4		

Table 2: Characteristic properties of the DynaMotive BCO used in experiments.

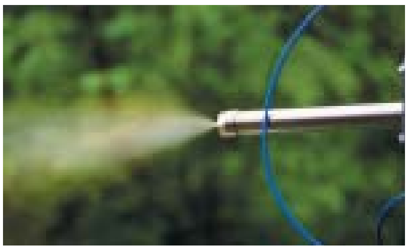


Figure 1: Typical spray cone with pyrolysis liquid (nozzle hole diameter 0.8mm; air pressure 2 bar and liquid flow 8 1/h).

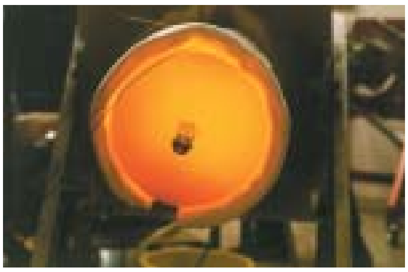


Figure 3: FLOX® burning chamber heated with pyrolysis liquid.

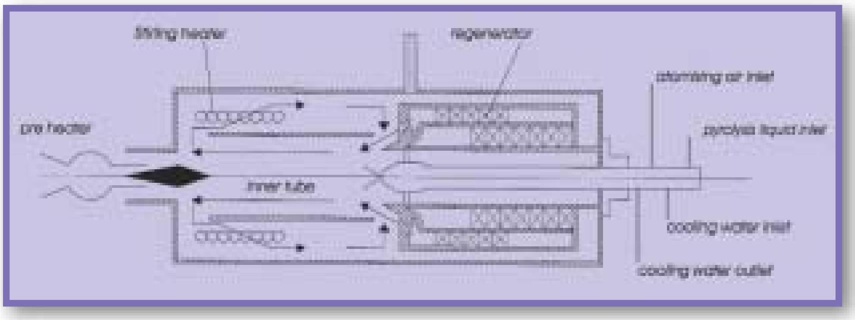


Figure 2: FLOX® burner pre heater and atomisation system assembly.

In the frame of an EU-project (JOR3-CT98-0310, co-ordinator: CRES), in close collaboration with industry partners, SOLO and WS, Germany, ZSW has been investigating the use of fast pyrolysis liquids in a Stirling CHP unit. A propane burner was modified with an atomiser designed specially for pyrolysis liquids and attached to a SOLO Stirling engine 161 (4-9 kWe, 10-25 kWth). The atomisation quality was controlled by the atomising air pressure and a droplet size of 10-40 μm was estimated when using 2-5 bar atomisation and a liquid flow of up to 10 l/h. A typical pyrolysis liquid spray cone of the atomiser is shown in Figure 1.

The Stirling tests proved that pyrolysis liquids can be efficiently burned in FLOX® mode with low emissions. The special feature of FLOX® (Flame-less Oxidation) is that above 850°C, the thermal NOx is drastically lowered by mixing combustion air and exhaust gas, avoiding temperature peaks of a flame. FLOX® has an additional advantage for burning of pyrolysis liquids because the residence time of the fuel in the burning chamber is higher than in normal burning, and thus more efficient carbon burnout becomes possible. Figure 2 shows the modified burner, atomisation system and combustion chamber for FLOX(®) burning. Figure 3 shows the FLOX(®) burning chamber heated with pyrolysis liquid.

Emission measurement results are shown in Table 1. Some characteristic properties of the pyrolysis liquid used in the experiments are shown in Table 2.

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Progress In Thermochemical Biomass Conversion Conference

The Progress In Thermochemical Biomass Conversion Conference (PITBC) was held in Tyrol, Austria from 17 to 22 September 2000. It was the fifth in the series of these meetings organised by Tony Bridgwater.

The Scientific Committee for the conference.

The conference covered all aspects of thermal biomass conversion systems from fundamental research through applied research and development to demonstration and commercial applications reflecting the progress made in the last four years. The technical programme included formal presentations, posters, workshops and discussions. A wide range of papers were offered and they were grouped into three main topics:

- Combustion.
- Gasification.
- Pyrolysis.

126 papers were presented at the conference as oral presentations or posters. There were 165 delegates from 29 countries around the world representing the majority of the major researchers in biomass combustion, gasification and pyrolysis.

Ton Beenackers presenting the prize for the best poster at the conference to Dr Ralph Stahl representing his co-authors E Henrich, E Dinjus and S Rumpel. The poster was entitled " A two stage pyrolysis/gasification process for herbaceous waste biomass from agriculture.

Josef Spitzer of Joanneum Research and Chairman of IEA Bioenergy, with the conference chair.

Pyrolysis attracted the most interest with 40% of the papers. These ranged from fundamental studies on mechanisms and modelling through a wide range of papers describing research in fast pyrolysis technology and in applications, to the latest developments in pilot plant activities.

All the papers have been peer reviewed and the proceedings will be published by Blackwell Science early in 2001.

Kyriakos Maniatis, Vice Chairman of IEA Bioenergy and Operating Agent for PyNe.

Ralph Overend of NREL presenting his vision for thermochemical biomass conversion in the opening address.

Tony Bridgwater proudly displaying his congratulatory plaque from the PITBC Scientific Committee and members of PyNe in appreciation of his contribution to Thermal Biomass Conversion.

PITBC was sponsored by:

- IEA Bioenergy.
- Austrian Federal Ministry of Transport.
- Innovation and Technology.
- Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management.
- Natural Resources Canada.
- Department of Trade and Industry, UK.
- VTT – Technical Research Centre of Finland.
- PyNe.

Summary Report

14th International Symposium on Analytical and Applied Pyrolysis, April 2-6, 2000, Seville, Spain

By Dietrich Meier, Institute for Wood Chemistry and Chemical Technology of Wood, Hamburg, Germany

The conference took place at Instituto de Recursos Naturales y Agrobiología de Sevilla, in the CSIC building (Centro de Investigaciónes Científicas Isla de la Cartuja) located in the area of the World Exhibition 1992. The local organizers were Dr. F.J. Gonzáles-Vila and Dr. J.C. del Río. About 170 people from 30 different countries attended the meeting.

Traditionally, the focal points of these kind meetings have been mechanistic and kinetic investigations using pyrolysis as an analytical tool. During the last few years the scope has been broadened towards applications and environmental aspects. These conferences started in 1965 and are now held every two years.

The conference had five topics:

- Polymer analysis and thermal decomposition.
- Pyrolysis in geochemistry and environmental science.
- Pyrolysis of biological materials.
- Pyrolysis mechanisms and kinetics instrumentation.
- Pyrolysis in industrial processes.

There were 42 oral presentations and 129 poster presentations. A special issue of the Journal of Analytical and Applied Pyrolysis will be published with papers that are accepted after reviewing.

The titles and authors of papers and posters dealing with all aspects of biomass pyrolysis are given below. This list shows highlights and innovations in analytical and applied pyrolysis of biomass. Abstracts and the addresses of authors are available on request from the writer of this report.

Kinetics & Mechanisms

Pyrolysis behaviour and kinetics of biomass
Fisher, T., Waymack, Hajaligol, M, Kellogg, D. Philip Morris Inc. Research Centre, Richmond, VA, USA

Investigations of the pyrolysis of biomass by thermogravimetric analysis and differential scanning calorimetry
Stenseng, M, Jensen, Johansen K.D., Department Chemical Engineering, Technical University of Denmark, Lyngby, Denmark

Studies on kinetics of cellulose fast pyrolysis
Visintin, V., Rizzardi, S., Canu, P. Istituto di Impianti Chimici, Universitiy of Padova, Italy

An investigation of the volatility of primary pyrolysis tar from biomass and biomass-derived materials
Oja, V., Hajaligol, M., Philip Morris Inc. Research Center, Richmond, VA, USA

Thermokinetic investigation of the cellulose pyrolysis – impact of final mass on kinetic results
Völker, S., *Riekmann, Th., +Klose, W., University of Kassel, Inst. of Thermal Engineering, Kassel, Germany, *Univ. of Appl. Sci. Cologne, Germany

Wood pyrolysis in the formed layer
Pialkin, V.N., Tsyganov, E.A., Yagodin, V.I., Tchalova, A.V., Serguta, A.M., St. Petersburg State Forest Technical Academy, Russia

Pyrolysis mechanisms of lignin model compounds: flash vacuum pyrolysis of methoxy-substituted aromatics
Britt, P.F., Buchanan, A.C, Cooney, M.J., Martineau, D.R., Oak Ridge National Laboratory, Oak Ridge, TN, USA

Aromatic hydrocarbons formation from plant materials part 1: tar pyrolysis, part II: char pyrolysis
Kellogg, D., Waymack, B., Hajaligo, M., Philip Morris Inc. Research Center, Richmond, VA, USA

Pyrolysis with Steam

The aqueous pyrolysis of dimeric lignin model compounds
Drage, T.C:, Abbott, G.D., Fossil Fuel and Environmental Geochemistry, The University Newcastle upon Tyne, UK

The influence of biomass type and reaction conditions on the product composition in closed, aqueous pyrolysis
Barth, T. Borgund, A.E., Department of Chemistry, University of Bergen, Norway

Steam-pyrolysis of olive cakes: preparation of a new activated carbon
Bacaoui, A., Chemical Dept., University of Morocco. Marrakesh, Morocco

Analysis & Characterization

Structural characterization of natural products such as shellac resins, lipids in zooplanktons, silk, and lignin in woods by means of pyrolysis-GC
Tsuge, S., Nagoya University, Japan

Characterization of the water-insoluble fraction from fast pyrolysis liquids (pyrolytic lignin): Py-GC/MS, GPC, and 13C-NMR
Scholze, B., Hanser, Ch. D. Meier, Federal Research Centre for Forestry and Forest Products, Institute for Wood Chemistry and Chemical Technology of Wood, Hamburg, Germany

Method Development

Development of a TG-MS method for monitoring the thermal degradation products of forest fuels
Pappa, A., Kyriakou, S., Sianos, S., Statheropoulos National Technical University of Athens, Greece

Py-GC/MS analysis of cellulose derivatives with and without TMAH
Schwarzinger, B., Tanczos, I., Schmidt, H., Johannes Kepler University, Linz, Austria

Chars

Characterization of chars from biomass-derived materials
Sharma, R. K., Hajaligol, M.R., Wooten, J.B., Philip Morris Research Center, Richmond, VA, USA

Catalysts

The effect of different catalysts on transformation of clean and mixed biomasses during hydrous pyrolysis
Borgund, A.E., Barth, T., Department of Chemistry, University of Bergen, Norway

Volatile products of catalytic fast pyrolysis of cellulose
+Dobele, G., *Meier, D., *Faix, O., *Radtke, S., +Rossinskaja, G., +Telesheva, G., +Latvian State Institute of Wood Chemistry, Federal Research Centre for Forestry and Forest Products, Latvia
*Institute for Wood Chemistry and Chemical Technology of Wood, Hamburg, Germany

Influence of Ni/Al coprecipitated catalyst pretreatment on gas yields from pyrolysis of biomass
García, L., Salvador, M.L., Arauzo, J., Bilbao, R., Chemical Engineering & Environment Department, University of Zaragoza, Spain

Applications

Stability in the operation of flash-pyrolysis industrial pilot plant
Bao, M, Crespo, M.I., Dept. Chem. Eng., University of Santiago de Compostela, Spain

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1st World Conference and Exhibition on Biomass for Energy and Industry

Sevilla, 5-9 June 2000

This conference broadened the content and scope of the traditional biennial European Bio-energy conferences by providing a global platform and focus. Over 1000 delegates from over 60 countries enjoyed the opportunity to learn about bio-energy activities from all over the world. Topics ranged from commercial and demonstration activities on all aspects of biomass conversion and utilisation to consideration of externalities, socio-economics and policies.

Pyrolysis was well represented with an overview and a wide range of posters describing the most recent developments and was supported with a dedicated workshop.

The proceedings will be published in 2001.

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Diary of Events

Information compiled by Claire Humphreys, Aston University, UK

World Sustainable Energy Day 2001

Venue: Stadthalle Wels, Austria
Date: 28 February - 2 March 2001
Contact: O.Ö. Energiesparverband
Landstra_e 45
A-4020 Linz, Austria
Tel: +43 732 6584 4380
Fax: +43 732 6584 4383
Email: office@esv.or.at
Website: http://www.esv.or.at

Energiting – 2001

Venue: Eskilstuna, Sweden
Date: 14-15 March 2001
Contact: Sveriges Energiting
Konferenssekretariatet
Box 426
581 04 Linköping, Sweden
Tel: +46 13 14 29 87
Fax: +46 13 12 61 62
Website: http://www.stem.se

The 2nd International Exhibition on New Energy & Clean Energy 2001

Venue: Shanghai Everbright Convention & Exhibition Centre
Date: 3-5 April 2001
Contact: Coastal International Exhibition Co., Ltd.
Rm 3808 China Resources Building,
26 Harbour Road,
Wanchai
Hong Kong
Tel: +852 2827 6766
Fax: +852 2827 6870
Email: general@coastal.com.hk
Website: http://www.coastal.com.hk

The XIIth Global Warming International Conference & Expo

Venue: Cambridge, UK
Date: 8-11 April 2001
Contact: GWIC
PO Box 5275
Woodridge
IL 60517-0275, USA
Fax: +1 630 910 1561
Website: http://www.globalwarming.net

23rd Annual Biotechnology Symposium

Venue: Breckenridge, Colorado
Date: 6-9 May 2001
Contact: National Renewable Energy Laboratory
c/o Conferences & Visual Services
1617 Cole Boulevard,
MS 1623 Golden, Colorado
80401-3393, USA
Tel: +1 303 275 4321
Fax: +1 303 275 4320
Email: megan_Maguire@nrel.gov
Website: http://www.nrel.gov/biotech_symposium/registration.html

Sustain2001 – The World Sustainable Energy Exhibition & Conference

Venue: Amsterdam, The Netherlands
Date: 8-10 May 2001
Contact: Sustain 2001
PO Box 77777
NL-1070 MS Amsterdam
The Netherlands
Tel: +31 20 549 1212
Fax: +31 20 549 1843
Email: sustain2001@rai.nl
Website: http://www.sustain2001.com

WasteTech 2001, 2-nd International Trade Fair and Congress on Waste Management

Venue: Moscow, Russia
Date: 5-8 June 2001
Contact: The Exhibition Management and the Congress Secretariat
PO Box 173
Moscow 107078, Russia
Tel: +7 95 975 1364/ 975 5104
Fax: +7 95 207 6376/207 6310
Email: waste-tech@sibico.com
sibico@dialup.ptt.ru
Website: http://www.sibico.com/waste-tech

18th World Energy Congress: Energy Markets: The challenges of the New Millennium

Venue: Buenos Aires, Argentina
Date: 21-25 October 2001
Contact: 18th WEC
c/o Congresos Internationales SA
Moreno 584 - Piso 9
1091 Buenos Aires, Argentina
Tel: +54 1 4342 3216/4342 3283
Fax: +54 1 331 0223/334 38111
Email: 18th-wec@congresosint.com.ar

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The PyNe Steering Group meeting during the PITBC Conference in Tyrol (Philippe Girard was not present).

IEA Bioenergy

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For further details or offers to contribute, please contact Claire Humphreys (see inside front cover for details). Any opinions published are those of the contributors and do not reflect any policies of the EC or any other organisation. EoE