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ThermalNet meeting, Glasgow, UK, September 2006.

The ThermalNet newsletter is published by the Bio-Energy Research Group, Aston University, UK and is sponsored by the European Commission under the Intelligent Energy-Europe programme and IEA Bioenergy.

Aston University
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DECEMBER 2006 **ISSUE 03**

ThermalNet

PyNe/GasNet/CombNet

PyNe STARTS PAGE 2

Pyrolysis in South Africa

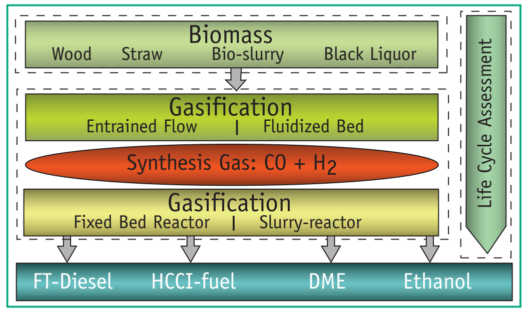
Since the new South African government was formed in 1994, a "whole-tree-utilisation" approach, coupled with silvicultural principals, has been developed to replace the traditional selective usage with discarding of the residues. *Full article on page 2.*

Don't forget bio€ - see page 38 for more information.

GasNet STARTS PAGE 11

RENEW

The Integrated European Project "Renewable Fuels for Advanced Powertrains (RENEW)" has brought together 32 European partners to co-operate in a four-year project to undertake a technical, economic and environmental assessment of production routes for renewable biomass-to-liquid (BTL) fuels. *Full article on page 13.*



CombNet STARTS PAGE 22

New Biomass Fired FBC Plant

The technical concept of the plant in Timelkam/Austria comprises a biomass combined heat and power plant (CHP) with a new bubbling fluidised bed boiler. *Full article on page 22.*

ThermalNet STARTS PAGE 31

Stirling Engines go Commercial

Investment by venture capital companies has geared Stirling Denmark for the commercial market. Now, R&D will live side by side with commercial sales goals and economic growth. *Full article on page 35.*

Intelligent Energy Europe

ISSN 1750-8363

Comments and contributions are most welcome on any aspect of the contents. Please contact Emily Wakefield for further details or to send material.

PyNe

Examples of Biomass Utilisation in South Africa – Application of Slow Pyrolysis

By Dagmar Honsbein, Aston University, UK

ASTON UNIVERSITY
IN THE HEART OF BIRMINGHAM

Background

Since the new South African government was formed in 1994, a "whole-tree-utilisation" approach, coupled with silvicultural principals, has been developed to replace the traditional selective usage with discarding of the residues. Up to the 1990s, the direct combustion of wood waste has been utilised as an energy source in downstream industrial activities in only a few cases in South Africa. Apart from limited production of "heat logs" from compressed sawdust and wood pellets, millions of tons of woody biomass still go to waste annually! A rough estimate (through personal discussions with various governmental institutions in South Africa) suggests that the waste is around six million tonnes annually.

To reduce wastage of raw materials in general, and particularly wastes from wood, the only renewable resource, the South African Department of Water Affairs and Forestry introduced the concept of complete utilisation of renewable resources. This also included the partial to full eradication of alien flora to South Africa in the late 1990s. One of the programmes introduced was "Working for Water", under the leadership of the Department of Water Affairs and Forestry and the Department of Environment and Tourism.

The South African Government is trying to:

- increase economic growth in South Africa in general
- satisfy the environmental standards set for future sustainable economic development (for example ISO 14000 and Clean Development Mechanism), by helping to restore ecological balances and countering environmental threats, making this an avenue for potential trades in CO_2 credits
- create employment and alleviate poverty
- increase value addition to natural, sustainable resources
- promote and facilitate an increase in productivity, quality of products, know-how and technology transfer to economic sectors that traditionally employ limited technology and standards, notably the optimal utilisation of forest resources.

Biomass Utilisation in a Slow Pyrolysis Process in South Africa

In consideration of the above issues and with the enthusiastic encouragement and support of the Department of Energy in South Africa, opportunities have been sought to add value to these primary biomass raw materials by establishing downstream industries that exploit these opportunities.

An example that is used to illustrate these policies is the Rodim Wood Chemicals cc slow pyrolysis process in South Africa. Numerous kiln processes for the primary production of charcoal still exist in South Africa. The charcoal produced as well as briquettes from the fines, is mainly sold for barbecue purposes in South Africa, Germany and the UK. A sizeable amount is also used in the silicon industry. The kilns, based on direct combustion, are usually batch and do not recover the gas produced during a production cycle. Forest waste materials and thinnings within a specific size range are mostly used to produce kiln charcoal.

A South African registered company, Rodim Wood Chemicals cc, has built on the research and knowledge accumulated over some 20 years. Rodim Wood Chemicals cc owns the only known South African slow pyrolysis process, shown in Figure 2. The slow pyrolysis system employed is based on well-documented wood pyrolysis principles. The main objective of the plant currently is to produce high quality charcoal for use in metallurgical processes in South Africa.

Figure 1: Map of South Africa

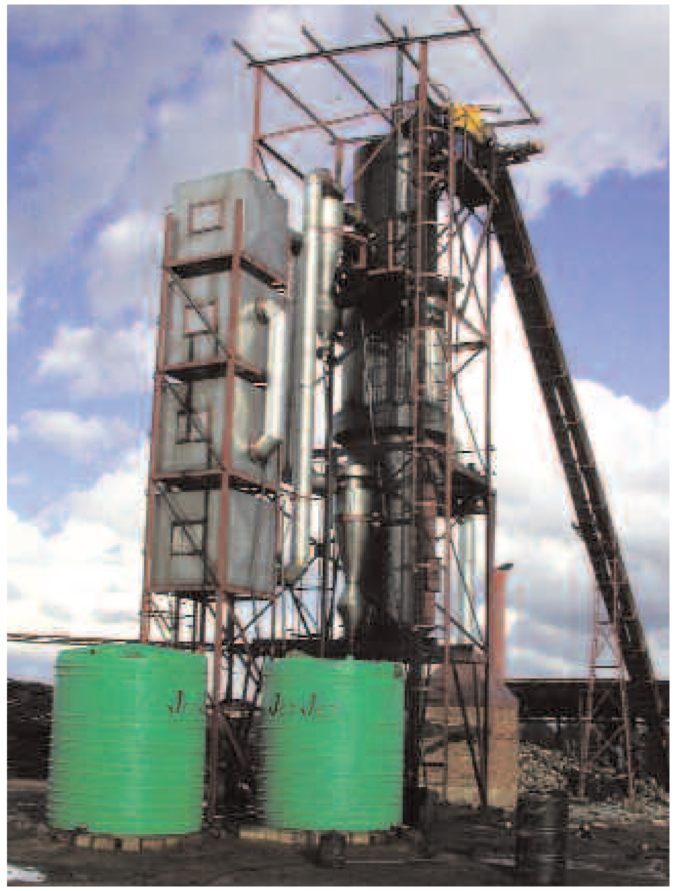


Figure 2: RWC's Slow Pyrolysis facility

The production of charcoal and other by-products is drawn from a wood distillation or carbonisation plant with a relatively low capital investment, making use of wood-based biomass waste, which would otherwise be declared as unrecoverable waste, and non-useable in kiln processes. This wood waste is sourced from sawmills, plantation-felling waste and forest thinnings within a 50km radius of the plant.

Continuous to semi-continuous slow pyrolysis is achieved by heating the woody biomass (mainly Acacia mearnsii – wattle, Eucalyptus spp, and Pine species) with a feed gas at a temperature of 600 to 700ºC in an oxygen free environment. Off-gases are condensed and non-condensable gases are re-circulated to a heat exchanger for complete combustion that in turn heats the feed gas for the process. The production capacity of this plant is approximately 600 lt. of charcoal in 30 to 40 minutes depending on the moisture content and species of the feedstock to be carbonised. The primary products obtained from the process are charcoal at a yield of 33 to 40 wt.%, with a fixed carbon content at 88 to 92 per cent; ash content of around 2 to 3 per cent; and liquids in the form of wood-oils and wood-acids (light and heavy pyrolysis liquids). The products are obtained in approximately equal proportions, but no formal mass balance has been carried out on the plant.

This pyrolysis process technology is of local origin and has been well defined and is comparable to the technology used in the Reichert Retort process. Similar plants are operational in Namibia with further installations to follow in Zambia and Zimbabwe. The plants currently in operation are manned by non-skilled or low skill workers. As experience and skills grow, it is anticipated that technologies will become more sophisticated and fast pyrolysis could be introduced to maximise the production of wood-oil for energy or other relevant purposes. The production facilities fully comply with the environmental standards set by the Government of South Africa. Sampling of the air found that no poisonous liquids or gases, nor increased CO or CO_2 emissions are registered within 1 - 2 or more kilometres from the plant.

Although not many markets for the liquid products have been found in South Africa or other neighbouring countries, the plants installed in Namibia and South Africa have already been proven to be economically viable for the above-mentioned reasons. Promising markets exist for using the liquids as a fertiliser and soil-conditioning component (patent pending), and as a wood preservative as shown in Figure 3 (see overleaf). The South African Department of Minerals and Energy are fully aware of Rodim's initiative and support its endeavours.

Continued overleaf.

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PyNe contents

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Figure 3: Preservative tests using slow pyrolysis liquid that have been running for more than two years (left pole treated with pyrolytic material from RWC's plant)

Conclusion

The initial idea of setting up a semi-continuous plant was to achieve optimal utilisation of the off gases produced during the process for example by reducing drying time of wood in the process, optimising wood to products ratio and eventually to connect a power generator to the plant to use the surplus gas which is currently flared off. This idea was, however, postponed due to financial constraints at Rodim Wood Chemicals, which originated from a lack of policies for independent power producers, particularly the absence of policy frameworks or regulations, which could guarantee feeding independently produced power into the national grid.

As a result, Rodim Wood Chemicals has decided to sell production facility rights to interested entrepreneurs in South Africa, Zambia and Zimbabwe. Furthermore, the operation of the plant set up by Rodim Wood Chemicals has been leased to the foreman of the plant on a medium term contract. The charcoal and liquids are marketed through Rodim Wood Chemicals.

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Fast Pyrolysis of Biomass in a Circulating Fluidised Bed (CFB)

By Manon Van de Velden and Jan Baeyens University of Birmingham, School of Chemical Engineering, UK and University of Leuven, Belgium

Introduction

Biomass is widely viewed as the renewable energy source with the highest potential with biomass pyrolysis offering considerable potential [1, 2]. Kinetics, reaction modelling and reactor hydrodynamics have been studied. High oil yields require a very fast particle heating; a reaction temperature of ~500°C; short residence times and fast char separation and vapour condensation to avoid secondary cracking. While fluidised bed reactors can meet these requirements, only a circulating fluid bed (CFB) can achieve a short, controllable residence time.

Kinetics and Endothermicity [3]

The endothermic heat was measured by differential scanning calorimetry as between 210 kJ kg^{-1} for eucalyptus and 430 kJ kg^{-1} for sawdust. The pyrolysis kinetics were measured by TGA and demonstrated a 1st order reaction in respect of biomass with an Arrhenius-type reaction rate constant (k), defined by the activation energy (E_a) and the pre-exponential factor (A). E_a depends on the biomass type and A depends on the heating rate, which should exceed 100 K/min. Values of k at 500°C (Table 1) mostly exceed 0.5 s^{-1}: therefore a high conversion can be achieved in short reaction times, thereby limiting secondary reactions.

Table 1: Kinetic constants, E_a, A and $k_{500°C}$ (determined at 100 K/min).

Sample	E_a, kJ/mol	A (s^{-1})	k (s^{-1})
Spruce	68.4	$3.47.10^4$	0.824
Eucalyptus	86.4	$1.06.10^6$	1.52
Poplar	54.1	$1.00.10^3$	0.219
Sawdust	75.8	$9.12.10^4$	0.684
Corn	77.0	$2.55.10^5$	1.59
Sunflower	63.9	$2.48.10^4$	1.19
Straw	76.3	$3.16.10^5$	2.21
Sewage sludge	45.3	$8.95.10^1$	0.078

Conversions, Bio-Oil Yield and Modelling

The pyrolysis-yields of bio-oil, gas and char were measured in a laboratory scale batch reactor and in the pilot CFB fast pyrolysis unit at CRES, Athens. Both experiments were performed in the same temperature range. Figure 1 depicts the experimental oil-yields, literature data and model predictions. All results show the same trend and the same yield of bio-oil with a maximum (60 – 65 wt%) around 500°C.

To model the reaction, the Waterloo concept [4], with primary and secondary reactions is used, but without secondary char formation, as this has been found to be irrelevant from TGA experiments. The reactions follow the continuous reaction model with a 1st order reaction rate [3]. The reaction time can be accurately controlled by operating the CFB in plug flow mode (see below) with a uniform residence time of all particles. Small particles (< 300 µm) are used so that the internal thermal resistance is negligible [3]. The temperature is nearly constant in the reaction zone and a high heat transfer almost instantaneously heats the biomass particles to bed temperature. Secondary reactions are suppressed by short residence times.

Continued overleaf.

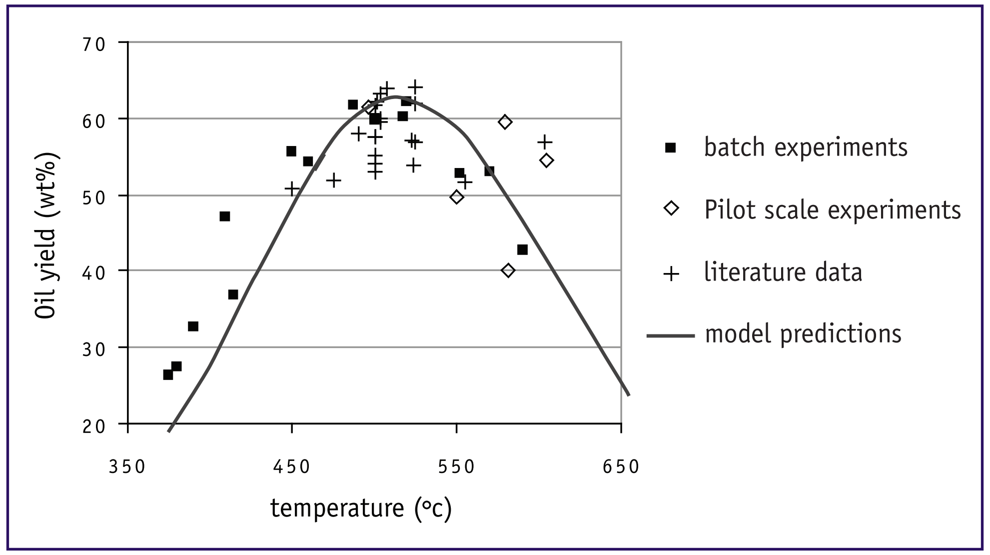

Figure 1. Bio-oil yield, own experiments, literature data and model predictions.

Table 2: Relevant model predictions for various types of biomass.

	Optimum Temperature (°C)	Oil yield (wt%), at			
		Optimum	400°C	500°C	600°C
Spruce	520	62.5	27.1	61.6	43.4
Eucalyptus	480	71.2	46.5	70.1	55.0
Sawdust	490	74.7	47.7	74.5	59.2
Corn	510	55.8	29.1	55.9	46.2
Sunflower	420	59.2	58.8	56.3	45.4
Straw	490	65.8	42.3	65.4	51.5

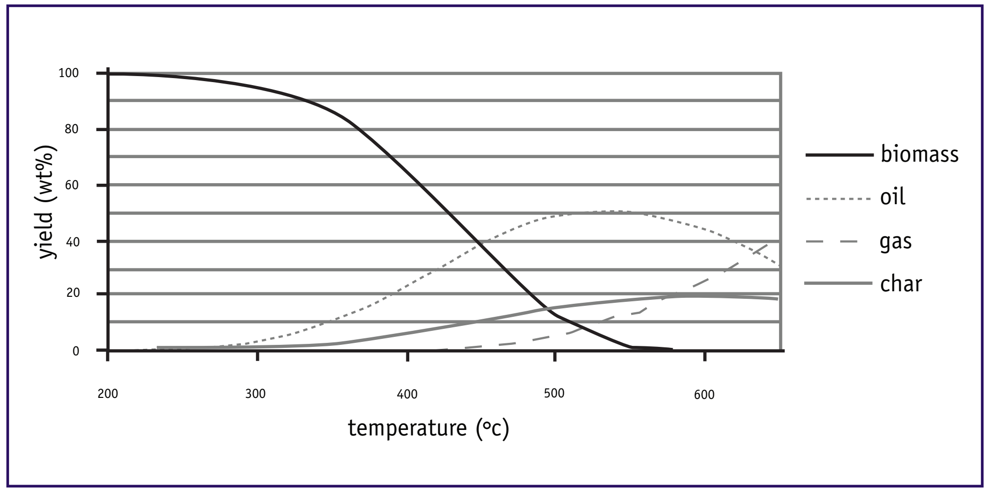

Figure 2: Model predictions of converted spruce and formed products.

The conversion equations define the fractions of bio-oil, gas and char, calculated from the residence time [5, 6] and the different kinetic constants, either measured or taken from Di Blasi [7] for the primary and secondary gas formation. The relevant overall results are presented in Table 2, and given as the oil yield at different temperatures and at the temperature of optimum yield. The model results shown in Figure 2 illustrate the conversion of spruce at a residence time of 2.5 s. A similar trend is predicted for all biomass species tested. The optimum T lies between 420 and 520°C: at higher temperatures, more gas is produced by secondary reactions. Figure 1 (see previous page) compared model predictions and data and this shows fair agreement. At lower temperatures, the experimental oil yield exceeds the model values: the model uses the equilibrium char amount (at $t = \infty$), thus overestimating char at shorter times. Practically, the reactor will operate at the optimum T, thus making this deviation unimportant in reactor design.

Particle Movement in the Riser of a CFB

The residence time τ of biomass particles in the CFB-riser needs to be short and accurately controllable, but depends on the operating regime. Particle plug flow is the required mode since all particles then have a uniform residence time. Back-mixing should be avoided as this gives a wide residence time distribution for the particles. Previous studies [e.g. 8, 9] mostly examine low values of solids circulation rates ($G \geq 100$ kg/m²s). The present research extends this range with operation from 25 to 622 kg/m²s (G) and 1 to 10 m/s for the superficial gas velocity (U). Positron Emission Particle Tracking (PEPT) [10, 11] was used to study the movement and population density of particles in the CFB-riser. The bed material was sand with an average diameter of 120 μm and a density of 2260 kg/m³. ^{18}F labelled tracers were sand (~ 120 μm) and radish seed (~ 500 μm), chosen to represent the behaviour of biomass in the riser. The PEPT results demonstrate that either back-mixing or plug flow strongly depend on combined values of U and G.

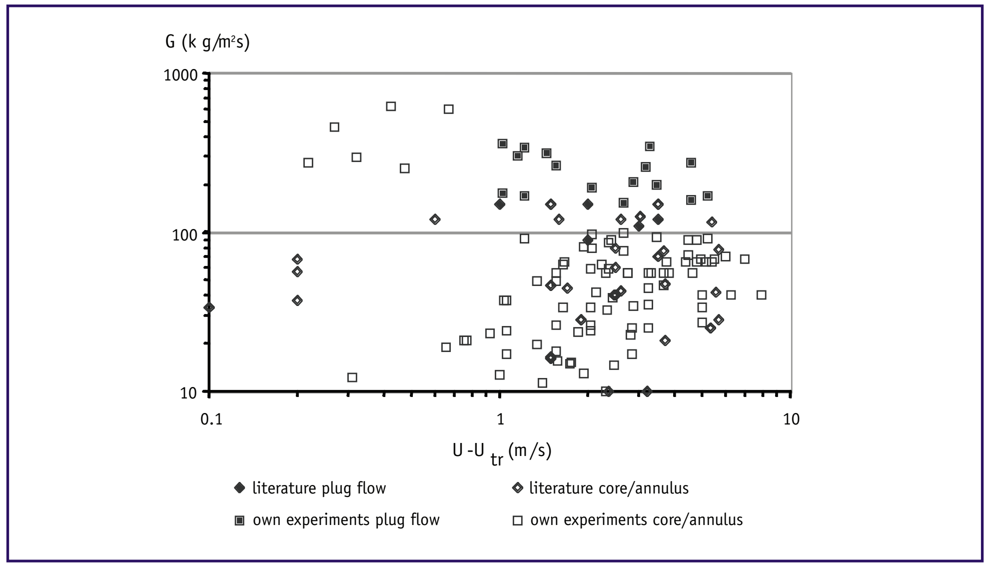

Figure 3: Plug flow and core/annulus regime in function of G and U-U_{tr}.

At various lower combined (U, G) values, no stable circulation in the riser could be obtained and the bed was still behaving in a bubbling or turbulent mode. A minimum superficial gas velocity (the transport velocity, U_{tr}) is needed to operate in the CFB-mode. This was experimentally verified [10, 11] and indicates that the equation of Bi and Grace [12] fits the experimental findings. The predicted velocity is increased by 20% as a safety measure for practical design [13].

The plots of particle movement distinguish mainly core/annulus (mixed, up and down) and plug flow (mostly up) mode. All experimental and literature data are presented in Figure 3, demonstrating that it is indicated:

(i) For operation in plug flow, as required in biomass fast pyrolysis, G needs to be greater than ~200kg/m²s and U needs to be greater than (U_{tr} + 1) m/s,

(ii) For operation in mixed mode, as required for biomass combustion for example, G needs to be less than ~150 kg/m²s, irrespective of U (> U_{tr}). The particle slip velocity, U_s, is in theory $U_s = U/\varepsilon - U_t$, where ε the voidage in the riser (≥ 0.98) and U_t is the terminal velocity of the particle. Experimental results demonstrated that this theoretical equation only holds in the plug flow mode, where $U_s \approx U - U_t$, since ε is close to 1. Particle slip velocity and residence time define the required reactor height H by $H = U_s \cdot \tau$.

Final Reactor Design

The main purpose of this work is the determination of the reactor (riser) dimensions required to ensure the desired conversion. The model and reaction kinetics determines the residence time for a required oil production at a selected operating temperature (normally close to 500°C). The short residence time (a few seconds only) implies the use of small particles, practically in the range of 100-300μm, and the conversion has to be completed in a single pass through the riser. The operation of the riser is isothermal when U and G are correctly specified.

The heat balance [3, 5, 6] determines the required heat (heating of biomass and reaction heat), which can be supplied by combustion of the non-condensable pyrolysis gas either indirectly preheating the circulating bed material, or directly heating the reactor. In both cases, the combustion gas forms the nearly oxygen-free fluidisation gas. Indirect heating of the bed material separates the heat transfer and fluidisation, which simplifies the process. The char can be recovered. Operation in plug flow guarantees a constant, controllable residence time. Together with the heat balance, U and G determine the diameter of the reactor. In the plug flow mode, the slip velocity, U_s, equals $U - U_t$, with U_t the terminal velocity of particles used as bulk bed material. The required bed height (H) is hence defined.

This design strategy is applied to a 10 MW (bio-oil) reactor, which consumes 3.4 t/hr of biomass and produces 2 t/hr of bio-oil. The riser has a diameter of 0.4 m and is 12.5 m high. The circulation rate of bed material (sand) needs to be 115 t/hr. The gas velocity should be 5.6 m/s for operation in plug flow with a residence time of 2.5 s.

An outline diagram of the complete process is given in Figure 4 (see overleaf) where different oil recovery techniques are proposed including indirect condensation, electrostatic precipitation, and combined scrubbing-condensation. The latter is recommended because of the high cost of electrostatic precipitation and the problem of preferential deposition of lignin during indirect condensation, leading to fouling of the heat exchanger surfaces.

An indicative economic evaluation of the process was made, comparing the price per GJ of bio-oil (heating value of the product) and heavy fuel oil, respectively 16 to 19 MJ/kg and around 41 MJ/kg. The required investment was estimated at 4.6 million . The average annual operating costs were 2.6 million /year for an annual production of 16320 tons of bio-oil, i.e. 158 /ton bio-oil, corresponding to 9 /GJ. If the char is sold at 46 /ton (despite its calorific advantage over coal), a reduction of 1 /GJ is achieved. The current price of heavy fuel oil is 460 /ton or 11.2 /GJ. The pyrolytic production of bio-oil is hence economically viable, even with a profit margin of 20 to 30%.

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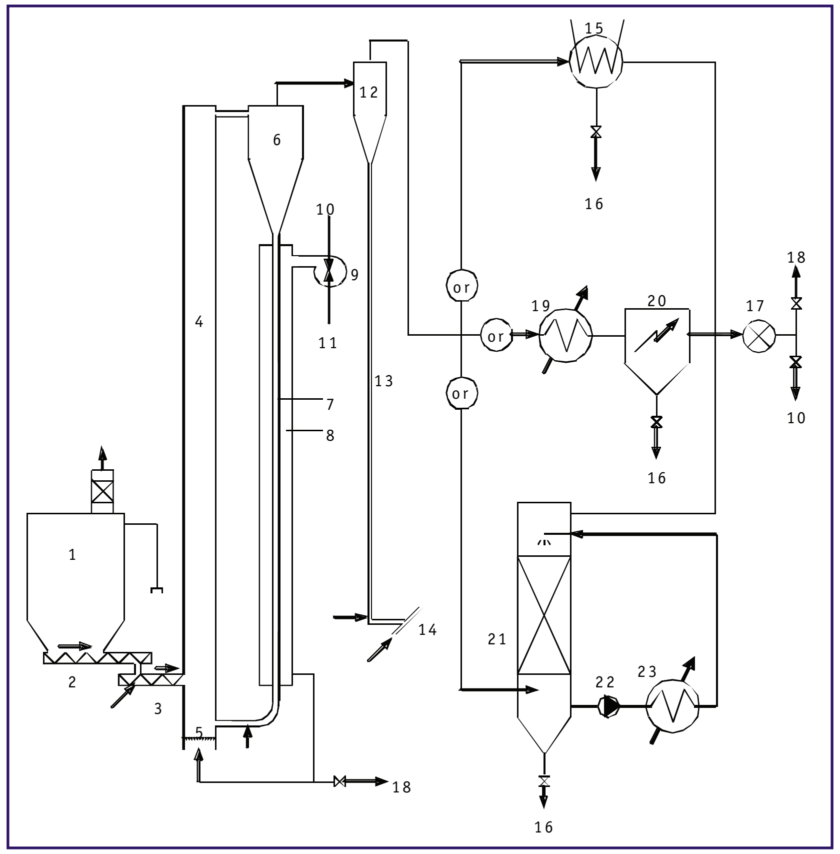

Figure 4: Schematic diagram of the pyrolysis installation

Key:

1) biomass hopper, pneumatic feeding, baghouse filter
2) screw conveyor (variable rpm)
3) screw conveyor (high rpm)
4) riser
5) tubular distributor for combustion gas
6) low-efficiency (LE) cyclone for removing circulating bed material (sand), with cut-size 100 µm
7) downcomer and L-valve
8) radiation heater
9) burner
10) non-condensable gas
11) combustion air
12) high-efficiency (HE) cyclone for char
13) downcomer with L-valve
14) pneumatic conveying of char to silo and densification
15) condenser
16) evacuation of bio-oil
17) suction fan for non-condensable gas
18) post-combustion or flare
19) cooler
20) electrostatic precipitator
21) scrubber - condenser
22) circulation pump of bio-oil
23) cooler – heat exchanger

Conclusions

TGA experiments determined the reaction rate of pyrolysis and its Arrhenius dependency. Batch and CFB experiments yielded between 60 and 65 wt% of bio-oil at around 500°C and very short residence times of the biomass particles. A model has been developed to predict the yield of oil, gas and char as a function of operating parameters. The residence time of the biomass particles in the riser depends on the fluidisation regime. In plug flow, all particles have the required, nearly constant, residence time. Plug flow is achieved when $U \geq (U_{tr} + 1)$ m/s and $G \geq 200$ kg/m^{2}s. A plug flow CFB of 10 MW (bio-oil) capacity requires a riser of 0.4 m I.D. and 12.5 m height. A CFB biomass pyrolysis process appears economically viable.

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Progress in the Biorefineries Task in PyNe

By Doug Elliott and Tony Bridgwater.

Definition

Consideration was given to the definition of a biorefinery, and this was defined by the PyNe group at their most recent meeting as:

A biorefinery processes and upgrades a renewable raw material (i.e. biomass) into several marketable products, emphasising fuels and chemicals.

- Marketable includes value, standards, usefulness, environmental acceptability, economics, sustainability, legislation.
- Important to consider complete use of raw material, optimisation, efficiency, effectiveness, economics, environment.

Case studies

The key contribution of PyNe will be consideration of how pyrolysis can be or should be integrated into a biorefinery. To this end, one of the outputs of the Task will be a set of case studies as summarised below:

Chemicals as primary product
- Speciality chemicals and separation.

Transport fuels as primary product
- Bio-oil for transport fuels via gasification and FT and/or methanol.
- Bio-oil (hydro)de-oxygenation for transport fuels.

Reference case
- Power and heat.

Some of the concepts that can include pyrolysis are exemplified in Figures 2 to 5 overleaf to show the diversity of biorefinery systems being considered.

Round Robin

In order to address a commonly recognized issue, a Round Robin on lignin pyrolysis has been agreed in order to consider concepts such as those illustrated in Figures 2, 3, 4 and 5 overleaf. This will be based on those laboratories who wish to participate who will be provided with a standard sample of lignin, possibly several samples if these can be resourced. Each laboratory will carry out analytical and/or laboratory scale tests and will provide full details for review and comparison. It is planned that this will result in at least one journal paper as well as a report.
Lignin has been procured from several sources.

Continued overleaf.

Objective
- Compare process, methods, analyses and products to share experiences, methodologies and results.
- Publish results in a journal as a Task output.

Organisations participating

Aston	Fundamental and Applied
FZK	Fundamental and Applied
ECN	Applied
Naples	Fundamental
Twente	Applied
USDA	Applied
BFH	Fundamental and Applied
NREL	Applied
PNNL	Applied
VTT	Fundamental
CIRAD	Fundamental and Applied
IFP	Fundamental

Figure 1: PyNe Workshop

Recommendations

The last PyNe meeting also discussed and reviewed RD&D recommendations for development of biorefineries, for laboratory research, assessments and general considerations as below:

Laboratory

1. Characterisation of byproducts and wastes from current and planned biomass conversion processes
2. Find (new) uses for all byproducts and wastes from biomass conversion processes. Lignin is a good example from fermentation
3. Research into processes for production of more interesting chemical products
4. Consider appropriate separation processes, including development of new methods if necessary
5. Can new and/or modified pyrolysis or thermal decomposition technologies be developed? If so, what?
6. What upgrading and/or refining technologies need to be developed?
7. How can biomass be pretreated or modified to improve yields?
8. Use of less clean and contaminated biomass will become important, which affects process and products
9. Feed flexible processing needed

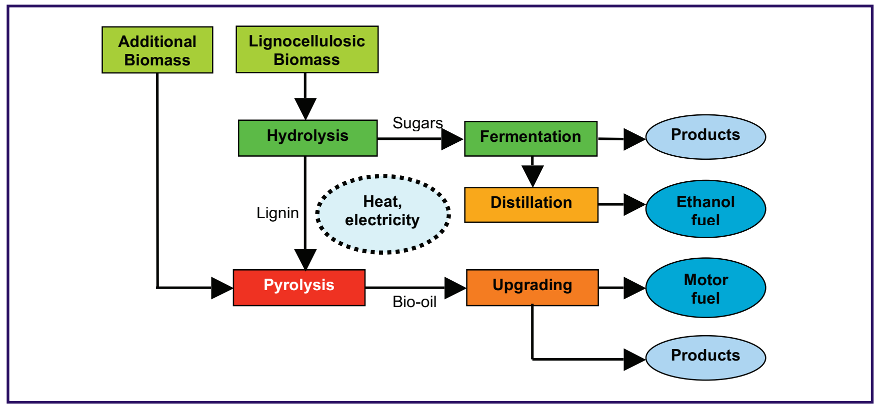

Figure 3: Possible future biorefinery based on bio-chemical and thermochemical conversion (from 1).

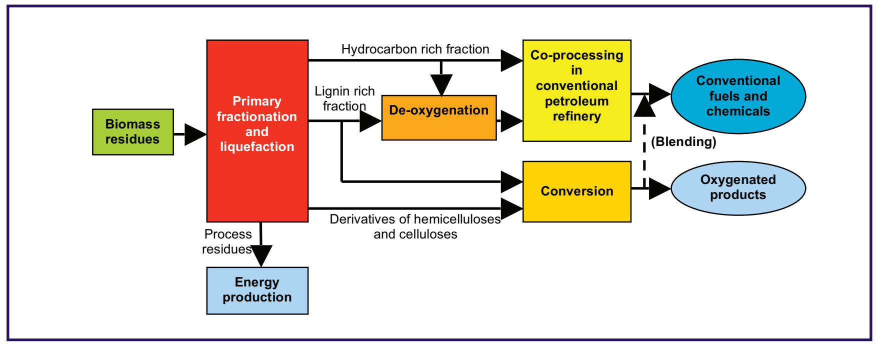

Figure 4: Overall biorefining concept (from 2).

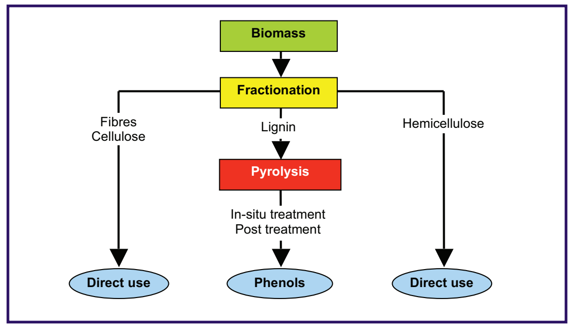

Figure 5: Biomass fractionation to support biorefining (from 3).

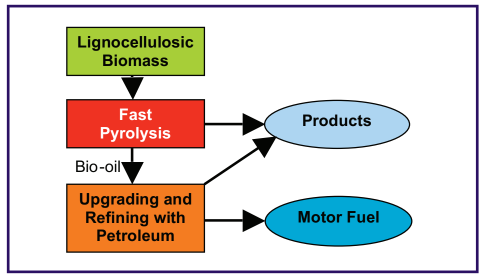

Figure 2: Pyrolysis/petroleum biorefinery.

Assessment or Studies

1. Find (new) uses for all byproducts and wastes from biomass conversion processes. Lignin is a good example from fermentation.
2. Develop strategy of deciding what to produce
3. Need to match raw material, technology, product and market
4. Review products that can be produced, how they are synthesised, what they cost and compare to market opportunity
5. Evaluate raw material availability for conversion
6. Identify opportunities for specific products and groups of products
7. Build set of case studies to improve understanding of opportunities
8. How to define optimum biorefinery
9. How to identify optimum products

Considerations

1. Do not generalise too much
2. Develop feed flexible processes, including contaminated feed materials
3. Understand special limitations of a biomass economy in different locations
4. Technology transfer chemically, geographically, economically
5. There is no limitation on what can be made from biomass, only what can be made economically or competitively – so need some strategies, and need to consider time needed to become available

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References 1 Stevens DJ, PyNe workshop, Heidelberg, Germany, May 2005, 2 Solantausta, YO, Private communication, 3 Meier, D, Private communication.

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GasNet contents

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CHRISGAS fuels from biomass

CHRISGAS Clean Hydrogen-Rich Synthesis Gas

By Dr Sune Bengtsson, Växjö University, Sweden

The primary aim of the EC and Swedish Energy Agency sponsored CHRISGAS Project is to demonstrate within a 5-year period an energy-efficient and cost effective method to produce hydrogen-rich gases from biomass, which can be transformed into renewable automotive fuels such as FT-diesel, DME and hydrogen.

This syngas process is based on steam/oxygen-blown gasification of biomass, followed by hot gas cleaning to remove particulates, and steam reforming of tar and light hydrocarbons to further enhance the hydrogen yield. The process is planned for demonstration at the Växjö Värnamo Biomass Gasification Centre (VVBGC) in Värnamo, Sweden. Following rebuild and modification, it will be the world's first complete IGCC demonstration plant for biomass (See Figure 1).

Continued overleaf.

Figure 1: The Värnamo Plant, Sweden.

The key work areas of the project therefore centre round the activities at the Värnamo IGCC pilot plant and the most significant challenge faced in the project is rebuilding and putting back into operation the large complex pilot unit, which has been mothballed under a conservation program for more than five years. Once this challenge has been met, the Centre can be used as a platform for advanced research, development and demonstration and testing of biomass gasification.

During the first 24 months a study providing Conceptual Engineering Design Alternatives has been performed, as well as an initial Risk Assessment. The process is being designed to include hot gas cleaning and upgrading. Future conversion of gases to gaseous and/or liquid energy carriers at semi-industrial level is planned for the second stage. A Basic Engineering study of the planned rebuild using an external engineering consultant has also been completed. Furthermore a thorough Status Review of the existing pilot plant at Värnamo has been conducted wherein the gasifier, feed system, ash system, gas cooling as well as auxiliary systems have been checked for function and/or quality. Maintenance and modification requirements have been identified, and work related to the upgrade is currently ongoing at the plant. Another significant technical challenge is to find a solution to reduce the inert gas consumption and its presence in the syngas. An innovative piston feeding system for biomass to the gasifier is being developed within the project to tackle this. Other parallel R&D activities covering the whole value chain from biomass to syngas include: feedstock biomass logistics; biomass drying integration; pressurised fuel-feeding, gasification, hot synthesis gas characterisation; high temperature filtration/cleaning; catalytic steam reforming and shift gas catalyst characterisation are also well under progress.

The CHRISGAS project has made a very promising start and has been described as an EC Flagship Project. In April 2006 two major Swedish organisations, Södra and Perstorp Oxo joined the Project at their own cost. Further funding for VVBGC is currently being sought from the Swedish Energy Agency.

For further information please do not hesitate to contact Sune Bengtsson, Coordinator of the CHRISGAS project and Managing Director at VVBGC (see below).

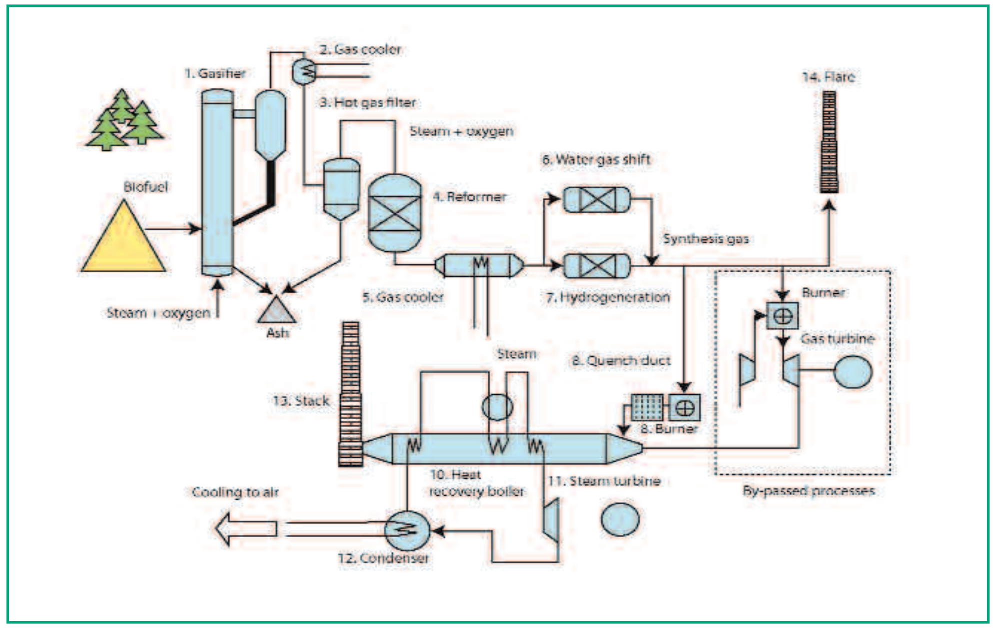

Figure 2: Schematic of the IGCC demonstration plant.

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Project Information

Acronym: CHRISGAS
Full Title: Clean Hydrogen-rich Synthesis Gas
Contract Number: SES6-CT-2004-502587
Duration: 5 Years (60 months)
Contact Person: Dr Sune Bengtsson

List of Partners:
Växjö University (Co-ordinator), AGA-Linde, Catator, CIEMAT, FZ Jülich, KS Ducente, Pall Schumacher, Perstorp, Royal Institute of Technology (KTH), S.E.P. Scandinavian Energy Project, Södra, Technical University Delft, TK Energi, TPS Termiska Processer, University of Bologna, Valutec, Växjö Energi, Växjö Värnamo Biomass Gasification Centre (VVBGC)

Website: http://www.chrisgas.com

Renewable Fuels for Advanced Powertrains – RENEW

By Juliane Muth, Volkswagen AG and Klaus Lenz, SYNCOM

The Integrated European Project "Renewable Fuels for Advanced Powertrains (RENEW)" has brought together 32 European partners, among them automotive manufacturers, mineral oil industry, plant builders and R&D institutes to cooperate in a four-year project to undertake a technical, economic and environmental assessment of production routes for renewable biomass-to-liquid (BTL) fuels. The whole chain from biomass production up to fuel application in today's and future combustion engines will be investigated (Figure 1).

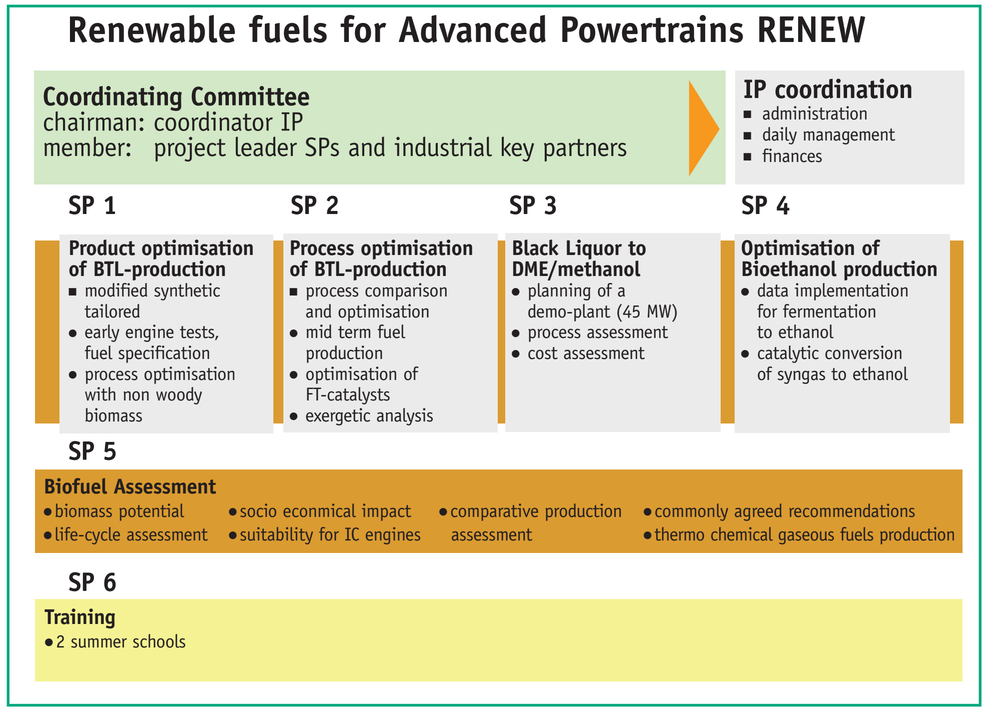

Figure 1: Structure of RENEW

The focus is on the gasification of lignocellulosic biomass, the subsequent gas cleaning/ treatment, the determination of suitable gas compositions and the required purity levels of the synthesis gas for fuel production. From the synthesis gas, several fuel types will be produced in adequate synthesis reactors: Fischer Tropsch Diesel (FT-Diesel), Homogenous Charged Compression Ignition fuels (HCCI-fuel), Dimethylether/Methanol (DME) and Ethanol. See figure 2 overleaf.

After 30 months duration, production of BTL fuels has been completed and engine tests proved the suitability of such motor fuels. Activities are now concentrated on further optimisation of processes and fuel specifications. Investigations of the biomass potential in EU-25 revealed a considerable substitution potential of fossil fuels. The methodology for an environmental, technological and economic assessment of BTL production routes has been defined and agreed amongst the consortium, the data acquisition has been completed and evaluation of results started

Continued overleaf.

BTL Tests in Engines

The objective was to perform engine tests to determine specifications for BTL in order to fulfil the requirements of the forth-coming EURO V norm. The properties of the fuels used were defined according to table 3.

Engine tests in the RENEW project have been performed with BTL, blends of BTL, GTL and DME at four vehicle manufacturers. Whereas Daimler Chrysler and Volkswagen tested BTL-FT and blends thereof in today's engines, Regienov/Renault investigated the effect of BTL-kerosene on new combustion processes (HCCI) and Volvo tested BTL-DME in truck diesel engines. Results of the engine tests performed at Volkswagen are shown in Figure 4: Synthetic GTL diesel, BTL light diesel and BTL kerosene were tested in a Golf V, 2.0 TDI 4V 103kW engine using the New European Driving Cycle (NEDC). Substantial reductions of NOx and particulates emissions have been achieved.

Final Project Results

In the remaining 18 months RENEW will focus on assessing the environmental, economic and technology performance of BTL production, complete the optimisation of production processes and prepare the dissemination of results. The outcome of the project Renew will be the generation of a comprehensive knowledge-base on different BTL-production pathways, open to relevant stakeholders in the EU and commonly agreed strategic recommendations on future technology options.

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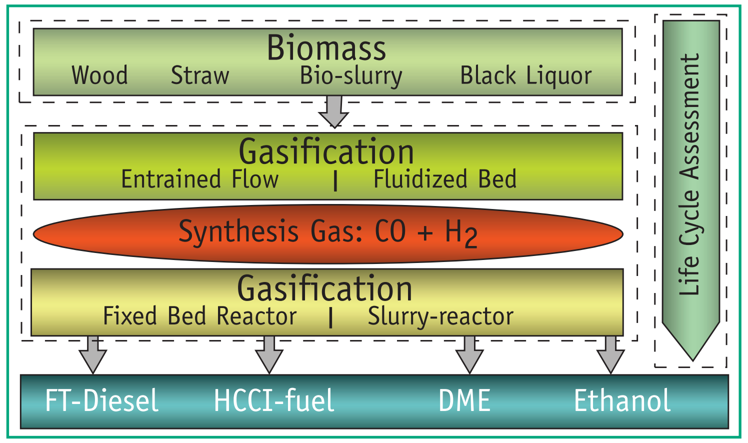

Figure 2: Production pathways for BTL.

Table 3: Preliminary fuel specifications.

properties	test method ASTM	unit	Diesel EN 590*	BTL kerosene	BTL light diesel	GTL diesel
density @ 15°C	D4052	g/ml	0.82 - 0.845	0.76	0.77	0.783
LHV (Vol)		MJ/l	35 - 36	33	34	34
Distillation - IBP	D86	°C	180	180	212	241
Distillation - FBP	D86	°C	360	275	326	355
cetane number	D613		> 52	79	94	73
kin. viscosity, 40°C	D445	cSt	2 - 4.5	1.5	1.3	2.5
CFPP, class F	EN 1 16	°C	-20	< -18.5	0	-
lubricity at 60°C	ISO 12156-1	µm	< 460	536	484	608
Polyaromatic content	IP 391	g/g (%)	< 11	< 0.1	< 0.1	< 0.1
Sulfur content	EN 14596	mg/kg	<10 (50)	< 10	< 10	< 10
n-Paraffin content	-	g/g (%)	-	89	94.5	50

* typical diesel properties for LHV, IBP

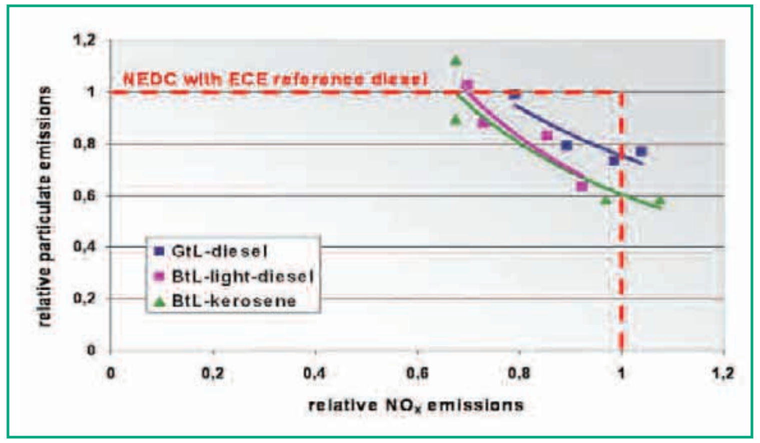

Figure 4: Reduction potential of NOx and particulates for two BTL and one GTL-fuel.

Improvement of the S&T Research Capacity of TUBITAK-MRC EI in the Fields of Integrated Biomass Gasification with Power Technologies

By Professor Hayat Olgun, TUBITAK Marmara Research Center, Turkey

Within the sixth framework programme, a Specific Support Action was awarded to TUBITAK-Marmara Research Center (MRC) of Turkey with the acronym "Bigpower". The objective of the three-year Bigpower project is to improve the research capacity to that of a centre of excellence on biomass gasification and integrated power technologies at TUBITAK-MRC Energy Institute (EI) (See figure 1). TUBITAK-MRC was founded in 1972 with a campus-type research center that currently accommodates seven research institutes (www.mam.gov.tr). MRC's location in the industrial heart of the country is very appropriate considering its mission of contributing to the competitiveness of Turkish industry through research and technological development. The institute develops, provides, and applies technological knowledge for practical applications in energy and environment technologies. EI aspires to improve its research capacity in the area of biomass energy.

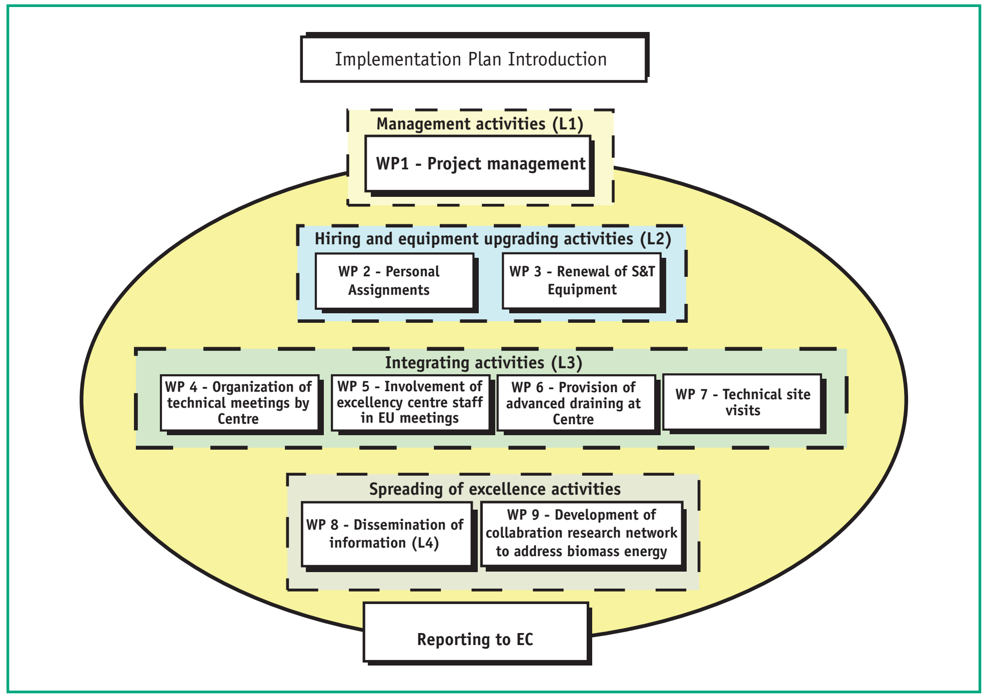

Figure 1: Methodology and approach of the Bigpower project.

Continued overleaf.

Figure 2: Participants of kick-off meeting

- The kick off meeting held at the EI on the 9th September 2005 enabled closer cooperation with similar research centers and laid the project objectives on a firm ground. (See Figure 2)
- Three young graduate students have been recruited, and have already been introduced into the work program
- A pilot scale fixed bed downdraft gasifier (up to 50 kg/h feeding capacity) based on wood chips as a raw material was designed. This system is under construction. (See Figure 3)
- Two lab scale gasifiers, one fixed and one fluidised bed, have been designed and manufactured. Cold tests with these systems are ongoing
- A new laboratory building, financed by the Turkish government, is under construction. It is planned to be completed by the end of 2006
- Two international seminars were successfully organised
- Participation at several international meetings was enabled
- Graduate students were trained abroad for two to three weeks
- Two senior scientists visited several European research centers, universities and power stations

All relevant co-operations with this project are welcomed and we look forward to co-operating with other research centres in terms of site visits, exchange of researchers and seminars. An international workshop is planned in cooperation with JRC-Petten for 2007. Those interested can either consult the web-site or contact Dr. Olgun directly (see below). Some financial support will be available to those eligible.

Figure 3: Pilot scale downdraft biomass gasifier

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Wood Gasification – Technologies, Developments, Experiences

By Hendrik Reimer, Fraunhofer-Institute for Environmental, Safety, and Energy Technology UMSICHT, Germany

This is a summary of the highlights of the conference "Holzvergasung – Technologien, Entwicklungen, Praxiserfahrungen" ("Wood gasification – Technologies, Developments, Experiences"), held on 26 April 2006 in Nuernberg-Fuerth, Germany and organised by BHKW-Consult (www.bhkw-infozentrum.de).

The meeting focussed on small-scale wood chip gasifiers, combined with IC gas engines for combined heat and power production. It was attended by 120 participants from Germany, Austria, and Switzerland. Most of the participants came from potentially interested customers for example operating companies such as regional energy suppliers and there was little participation from Science and Research.

Markus Gailfuss from BHKW-Consult gave an initial introduction into gasification technology and the national conditions due to green energy legislation in Germany.

In his presentation Prof. Siegfried Rapp provided a snapshot of the present status of the technological development, summarising some lessons learned. He also covered crucial problems such as tar removal, overall plant performance and requirements to meet certain technical and legal standards.

These overviews were followed by technical presentations on gasification systems:

1. Gasification technology from Hörmann/Mastergas (Björn Kuntze, Mastergas) (www.mastergas.de)
2. Gasification technology from NRP-Pyrator (Ulrich Finger, NRP) (www.holzvergaser-nrp.de)
3. Gasification technology from Dasagren (Dr. Seitz, Dasag Renewable Energy AG) (www.dasagren.ch)
4. Gasification technology from Kuntschar & Schlüter (Walter Sailer, SW-Energietechnik) (www.kuntschar-schlueter.de)
5. Gasification technology from PYROFORCE (Herbert Gemperle, Pyroforce Energietechnologie AG) (www.pyroforce.ch)
6. Gasification technology from "Biomass Engineering Ltd." from the UK (Dr. Ralf Schramedei, Stadtwerke Düsseldorf) (www.biomass-uk.com)
7. Gasification technology from Mothermik (Jan Kramb, Mothermik) (www.mothermik.de)
8. Gasification technology from AHT Pyrogas (Paul Heymanns, AHT Pyrogas)

Most of the technologies are based upon air blown fixed bed gasifiers, typically producing 100 to 300 kWel. Apart from No. 1, who admitted to needing further development, most of the others companies are currently trying to penetrate the market. Solutions presented for the common problems such as tar are quite different within the technologies. Some claim to operate "tar-free", others use wet scrubbers or just cyclone and filters. All the companies are SMEs (small to medium size enterprises) and they sometimes appear to promise more about their technologies to customers than they actually know by proven results.

Since the audience was mostly composed of potential customers, the questions and discussions focussed on economics, particularly investment, and operational costs. Only a few technical questions were discussed. Due to the quite different technical standard of the systems, the investments differed considerably from 2,600 ... 5330 /kWe. Economic feasibility however was claimed under certain conditions for each system.

The final conclusion leaves two key questions open for each single technology:

1. Does it really work under usual clients' expectations for long-term operation?
2. Are the economic conditions realistic?

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Progress on Health, Safety and Environment in Biomass Gasification

By Harrie Knoef, BTG biomass technology group, Netherlands

At the September 2006 ThermalNet meeting in Glasgow, a workshop was dedicated to Health, Safety and Environment (HSE) issues in biomass gasification. The GasNet and IEA Task 33 networks have recognised HSE to be an important non-technical barrier for the widespread implementation of small-scale gasifiers up to about 5 MWth. Mr. Rüdi Bühler presented on overview of prior HSE work undertaken by GasNet and IEA Task 33. In both networks HSE has been on the agenda since 2002. Mr. Bühler detailed the networks' HSE activities over the last four years and explained why HSE is such an important topic. The joint workshop of GasNet and IEA in Innsbruck (September 2005) was one of the highlights in this respect.

In order to address the HSE barrier more effectively the Innsbruck meeting recommended that a Guideline for safe and eco-friendly design, construction and operation of biomass gasifier plants be developed. The Innsbruck meeting therefore prepared a dedicated proposal on this subject. It was discussed and agreed during the Glasgow workshop that future failures of biomass gasification technology due to HSE aspects would have a very detrimental effect on future technology commercialisation perspectives in general and on public opinion in particular.

In the second presentation, BTG's Harrie Knoef presented an outline of the "Gasification Guide" project proposal. In the "Gasification Guide" project case studies will play a central role. Information on HSE issues will be collected to develop a draft Guideline and a Software Tool. The draft Guideline will be used for validation at biomass gasification plants that are under construction or at the planning stage. Achievements and results of the "Gasification Guide" project will be disseminated and communicated through a dedicated project website and through the GasNet and IEA Task 33 networks. If use of the future Guideline is found to be beneficial it may be developed further into a Standard in a follow-up standardisation project.

In the third session Prof. Hermann Hofbauer presented the "Gasification Guide" project dissemination and communication activities in more detail, and subsequently led a discussion on how the HSE activities within ThermalNet on the one hand and the Gasification Guide project on the other hand could be best synchronised. Plans to establish an Advisory Board supervising the HSE topic and to organise joint workshops taking advantage of the parallel projects were warmly welcomed.

Contract negotiations with the European Commission are close to completion and it is envisaged that the three-year "Gasification Guide" project will start operation in November or December 2006.

Figure 1: ThermalNet HSE workshop, Glasgow September 2006.

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Siemens Acquires Coal Gasification Business of the Swiss Sustec-Group

Press Release by Siemens, May 16th, 2006

The Siemens Power Generation Group (PG) is expanding its power plant business with products and solutions for conversion of coal to electricity by acquiring the technology and engineering activities of the Sustec-Group. This acquisition comprises, inter alia, the German firm Future Energy GmbH as well as a 50 percent stake in the Chinese joint venture with the Shenhua Ningxia Coal Group. By this acquisition, Siemens is securing a key technology for environment-friendly power generation. To accelerate development and testing of the next gasifier generation, Siemens also plans to build a large-scale coal gasification plant with an overall thermal capacity of more than 1000 MW at the location Spreetal in Saxony. Approval from the anti-trust authorities for the acquisition of the Sustec-Group is still pending. The price of the transaction will remain undisclosed.

In addition to a wide range of coal grades, the Sustec-Group process known as GSP entrained flow gasification can also utilise biomass as well as petroleum coke and refinery residues as feedstocks. In line with the globally increasing demand for energy and raw materials, an attractive growth potential is now emerging for advanced coal gasification technology. In recent months, several contracts for large-scale coal gasification projects were already awarded to the Sustec-Group, three of which are located in China.

With the planned coal gasification plant in Spreetal which is to have an overall thermal capacity in excess of 1000 MW, Siemens intends to enter a new output class. After completion of construction and the subsequent test phase, the plant is scheduled to start commercial production about three years from now. The syngas produced will be used for power generation and production of roughly 600,000 tons of methanol per year.

In recent years, the demand for steam power plants has risen considerably. The primary driver of this development is China's immense market with its vast coal reserves. Furthermore, other important markets such as the U.S. are also showing increased interest in coal based power generation including application of clean coal technologies, as an environmentally compatible solution for their future electricity requirements. "The share of electric power generated by coal-fired power plants will remain significant," stated Klaus Voges, chairman of the Siemens Power Generation group managing board. In response to persistently high natural gas prices as well as more and more stringent demands in terms of climate protection and supply reliability, the interest in solutions for clean conversion of coal to electricity is also on the rise. "Against this backdrop, innovative power plant concepts for environmentally compatible conversion of coal to electricity such as IGCC plants gain decisive importance," Voges stated.

An IGCC plant (integrated gasification combined cycle) is a combined cycle plant that is supplemented by a front-end coal gasification plant for generation of syngas. A gas turbine is fired with this syngas, with the hot exhaust fed to a heat recovery steam generator. The steam produced in the latter is utilized to drive a steam turbine, thereby maximizing the amount of power generated. The emissions from IGCC plants are clearly below those of even the most advanced "conventional" coal power plants. In a second step, plans call for complete capture of CO_2 contained in the syngas and sequestration of the former in caverns. This technology can therefore make a significant contribution to the supply of electric power which is both secure and highly compatible with the environment and climate.

The Power Generation Group (PG) of Siemens AG is one of the premier companies in the international power generation sector. In fiscal 2005 (which ended September 30), Siemens PG posted sales amounting to approximately EUR8.1 billion and received new orders totaling EUR11 billion. Group profit amounted to EUR951 million. On September 30, 2005, PG had a work force of approximately 33,500 worldwide.

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Latest News in Biomass Gasification

By Harrie Knoef, BTG biomass technology group, Netherlands

Co-firing biomass at the coal gasification power plant of Nuon, Buggenum, Netherlands. Earlier this year, Dutch power utility Nuon announced the official start of large-scale co-firing biomass at its 250 MWe IGCC coal gasification plant in Buggenum in the province of Limburg in the south of the Netherlands. The plant in Buggenum is ideal for co-firing biomass as it applies advanced 'clean coal' IGCC gasification technology, and an extensive gas cleaning section is already in place. In its press release, Nuon (www.nuon.com) reports that the Buggenum plant is the first in the world to gasify biomass and coal together for the production of power.

Substituting part of the coal used by biomass will lead to 22% CO_2 emission reduction, or 300,000 tonnes of CO_2 per year. A further reduction in CO_2 emissions can be achieved by applying CO_2-capturing measures. Working together with stakeholders such as the government, the research community and environmental NGO's, Nuon wants to investigate the possibilities and desirability of large scale CO_2 capture, recycling and sequestration.

In July 2006 Nuon announced that it had selected the Eemshaven port in the province of Groningen in the very north of the Netherlands as the location for its new large-scale power plant (1200 MWe). Nuon has acquired a license from Royal Dutch Shell plc to apply its modern 'clean coal' IGCC gasification technology. NUON plans gasifying both coal and biomass at the future "Magnum" IGCC power plant. To maximise fuel flexibility the plant will also be capable to fire natural gas. Nuon hopes to secure environmental permits in early 2007 and plans to take a formal investment decision in mid 2007. If all goes according to plan, the new Eemshaven power plant can start supplying electric power in 2011. The power plant can provide electricity for an equivalent of two million households. More information will be presented on this ambitious project in a future edition of this newsletter.

Tar Standard is a Fact

In the previous issue of this newsletter, the development of the European standard for measuring tar and particulates in producer gas was reported. Early this year voting on the standard showed unanimous support. As a result, Tar Standard TS 15439 is a fact. The Standard is a CEN Technical Specification, valid for three years. After three years it needs to be determined whether the Technical Specification will be continued. Print copies of Tar Standard TS 15439 can be obtained from the national standardisation institutes in the EU Member State.

English summary of the standard: Technical Specification TS 15439 gives methods for sampling and analysis of tars and particles in order to determine the load of these contaminants in flowing biomass gasification product gases. The Technical Specification is applicable to sampling and analysis of tars and particles in the concentration range typically from 1 mg/mn^3 to 300 g/mn^3 (tars) and from 20 mg/mn^3 to 30 g/mn^3 (particles) at all relevant sampling point conditions (0°C to 900°C and 60 kPa to 6000 kPa (0,6 bar to 60 bar). Particle concentrations lower than 20 mg/mn^3 are outside the scope of this Technical Specification and can be measured according to EN 13284-1. Application of this Technical Specification allows determination of five different parameters: A. The concentration of gravimetric tar in mg/mn^3; B. The concentration of individual organic compounds in mg/mn^3. This Technical Specification gives data on repeatability and reproducibility for the compounds listed in Annex B. The Technical Specification is also applicable for other organic compounds (e.g. those mentioned in Annex A), but repeatability and reproducibility have not been assessed for compounds other than those in Annex B; C. The sum of concentrations of identified GC-detectable compounds listed in Annex B; D. The sum of concentrations of all GC-detectable compounds with retention times in the range of benzene to cororene calculated as naphthalene (benzene excluded), given that this sum of concentrations can be determined. E. The concentration of particles in mg/mn^3.

Fluidyne Gasification 30 Years

The year 2006 marks the 30th year of involvement of Fluidyne Gasification (Auckland, New Zealand) with biomass gasifiers for engine-based power generation. Company owner-director Mr. Doug Williams reported this remarkable fact on the gasification mailing list Gasification@listserv.repp.org on 22 September 2006. Doug's involvement in biomass gasification encompasses the supervision of licensees of Fluidyne's gasification technology in Northern Ireland, Canada and recently Australia. The range of Fluidyne gasifiers cover 4 classes (Laboratory, Pacific, Atlantic and Mega), with capacities as follows:

Table 1: Fluidyne gasifier capacities.

Gasifier Class	Electricity Output in kWe	Heat Output in kWth
Laboratory Class	15	30
Pacific Class	35	70
Atlantic Class	70	140
Mega Class	550	1100

The Atlantic Class gasifier/generator demonstration unit in Northern Ireland has been completed to its final commercial design requirement, and engine performance is above expectations, producing almost 90 kWe. The engine starts and runs on wood gas only, there is no fossil fuel used whatsoever. The staff at Innovation Technologies Ireland Ltd. (Ballycarry, Carrickfergus) www.innovation-tech.co.uk intends developing commencing commercial projects shortly.

The 300 kWe Mega Class gasifier demonstration unit in Winnipeg (Manitoba, Canada) was subject to EPA emission testing. The EPA test results will be posted shortly on the Fluidyne Archive www.fluidynenz.250x.com. W2e Technologies Inc. plan to open its production facility for these biomass gasifiers in March 2007.

In Australia, a small 15 kWe gasifier was tested with the Tasman Class gasifier being specifically developed for tropical conditions. A new company "Gasification Australia" planned to begin production of the Tasman Class gasifier in early 2007.

More details and progress on all these developments reaching commercial status will be provided in due course.

Figure 1: Fluidyne Atlantic class.

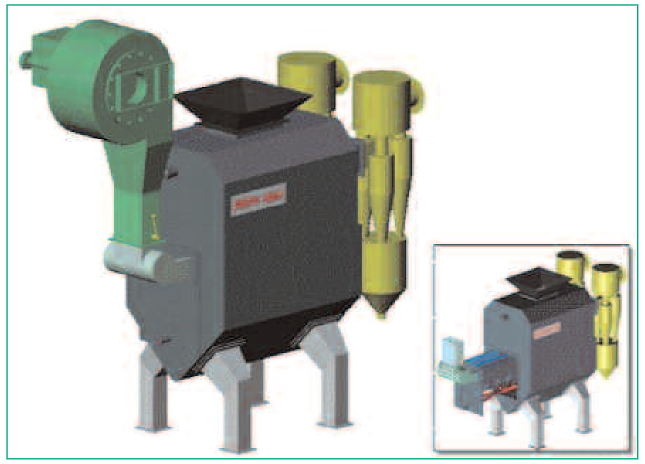

Figure 2: Fluidyne Mega class.

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CombNet contents

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Operating Experience from a New Biomass Fired FBC-Plant



By M.Bolhàr-Nordenkampf, I. Tschanun, S.Kaiser: Austrian Energy & Environment AG, Vienna

The technical concept of the plant in Timelkam/Austria comprises a biomass combined heat and power plant (CHP) with a new bubbling fluidised bed boiler. For electricity production, an existing steam turbine is used. With an estimated operation of 8000 h/year 95 GWh of electricity and 88 GWh of district heat can be produced, which corresponds to a supply of 26,000 and 5,800 private households with electricity and heat, respectively. (Table 1, Table 2, Fig. 1, Fig. 2).

The plant is approved according to the § 29 Abs. 1 Z3 Abfallwirtschaftsgesetz (AWG), which sets emission limits for renewable fuels. The emissions are related to 12% O_2 content in dry flue gas.

Figure 1: Outside view of the Timelkam plant with biomass fuel.

Figure 2: Outside view of the Timelkam plant with fuel bunkers.

Table 1: Design values of the plant Timelkam.

Design Values	
Max. fuel heat rate	50.0 MW
Lower heating Value	5.000 ÷ 16.000
Moisture	12 ÷ 60 %
Ash content	max. 6 %
Fuel flow	max. 26 t/h
Control range	60 ÷ 100 %
Combustion temperatures	700 ÷ 900 °C

Table 2: Emission limits for the Timelkam plant.

Pollutants according decree	Emission limit
Carbon monoxide CO	90 mg/Nm³
Sulphur dioxide SO_2	45 mg/Nm³
Nitrogen oxides NOx as NO_2	210 mg/Nm³
Unburnt organic carbon Corg	25 mg/Nm³
Dust	25 mg/Nm³
Hydro chloride HCl	9 mg/Nm³
Hydro fluoride HF	0.63 mg/Nm³
Mercury Hg	0.04 mg/Nm³
Dioxins and Furans PCDD/F	0.1 ng/Nm³

The plant is approved according to the § 29 Abs. 1 Z3 Abfallwirtschaftsgesetz (AWG), which sets emission limits for renewable fuels. The emissions are related to 12% O_2 content in dry flue gas. The emission values for CO, NOX and organic matter have to be obtained with the fluidised bed combustion respectively with the SNCR.

Wood chips and wood residues from forest industry, as well as from paper industry (bark, saw dust, grinding dust) and waste wood are used as fuel.

The permit was granted in 2002, the construction was started at the end of 2004 and the boiler reached the PAC in February 2006. Green power feed in tariffs were granted for ten years according to the Federal Green Power Regulation.

The applied combustion technology is the "ECOFLUID" bubbling fluidised bed. The main feature of this technology is the principle of staged combustion of the fuel.

Figure 3: View of the boiler top

The oxygen level in the fluidised bed is limited and hence only a part of the fuel is combusted, whereas the rest of the fuel is gasified. This can be achieved by adding a substoichiometric amount of oxygen (lambda approx. 0.35) to the fuel. However, in order to keep a constant lambda and temperature in the bed, this would result in a fluctuation of the fluidisation air volume flow and hence in fluidisation of the bed in accordance to the heating value of the fuel. Since this effect is not desired, the primary air is mixed with recirculated flue gas. This allows the control of lambda and the bed temperature as well as keeping the fluidisation of the bed at a constant level.

This substoichiometric bed operation allows the control of the bed temperature in the range between 650°C-820°C. Therefore, also fuel with low ash melting temperature can be burned without any sintering problems in the bed. The standard operation temperature of the fluidised bed is approximately 760°C.

The gasification gases rising from the bed are fully combusted by adding secondary air to the boiler. This causes a rise in temperature and oxygen content, as seen in Fig. 4. The turbulence in this area of the first pass results in very low CO-values in the fuel gas.

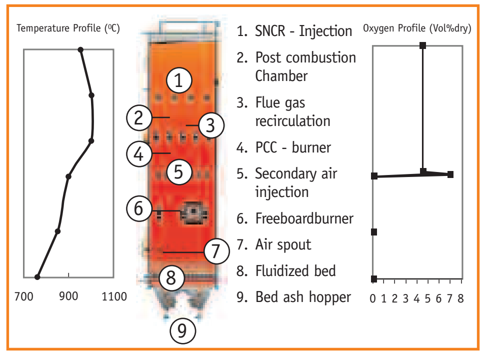

Figure 4: Temperature and oxygen profile in the combustion chamber of the fluidised bed boiler

For high calorific fuels recirculation gas is injected above the secondary air to "cool" the flue gases in the post combustion chamber. This staged combustion concept results in a homogenous and moderate temperature profile in the furnace and first pass of the boiler and thus low NOx emission. If needed, NOx emissions can be easily controlled by installing a SNCR at the appropriate temperature level in the boiler.
By using refractory lined superheaters in the second pass corrosion problems can be minimised although high steam parameters can be obtained. These properties enable the ECOFLUID bubbling fluidised bed to handle a broad fuel range with different heating values as well as corrosive fuels (e.g. net calorific values in a range of 3 to 20 MJ/kg) (Tschanun, 2001; BolhàrNordenkampf, 2005; Tschanun, 2003; Tschanun, 1998).

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The ChlorOut Concept – Measurement and Reduction of Corrosive Alkali Chlorides

By Håkan Kassman and Magnus Berg, Vattenfall AB, Sweden

VATTENFALL

The ChlorOut concept has been developed by Vattenfall to minimise deposit formation and corrosion during combustion of biomass fuels. It consists of IACM, an instrument for on-line measurements of gaseous alkali chlorides, and a sulphate-containing additive that converts alkali chlorides to less corrosive alkali sulphates. This article presents results from an installation of the ChlorOut concept in a CFB boiler.

Background

Biomass and waste derived fuels contain relatively high amounts of alkali (Na + K) and chlorine (Cl), but contain very little sulphur (S). Combustion of such fuels can result in increased deposit formation and superheater corrosion. These effects can however be reduced, by co-combustion with for instance coal or peat, or by using additives. The additives can either prevent the release of gaseous alkali chlorides or react with them to form less corrosive alkali sulphates.

IACM

Vattenfall has developed and patented an instrument, IACM (In-situ Alkali Chloride Monitor), that measures the concentration of gaseous alkali chlorides (NaCl + KCl) and sulphur dioxide (SO_2) at superheater temperatures.
The result is expressed as KCl for biomass fuels. IACM is based on the principle of optical absorption at characteristic wavelengths and it normally measures cross-stack. The detection limit at a 5 meters measurement length is 1 ppm for KCl and NaCl, and 4 ppm for SO_2.

IACM is a powerful tool for on-line fuel quality control with respect to release of corrosive KCl in the flue gas. Figure 1 shows an IACM measurement at a pulverised fuel burner during a fuel change from combustion of 100% biomass to co-combustion of biomass and coal.

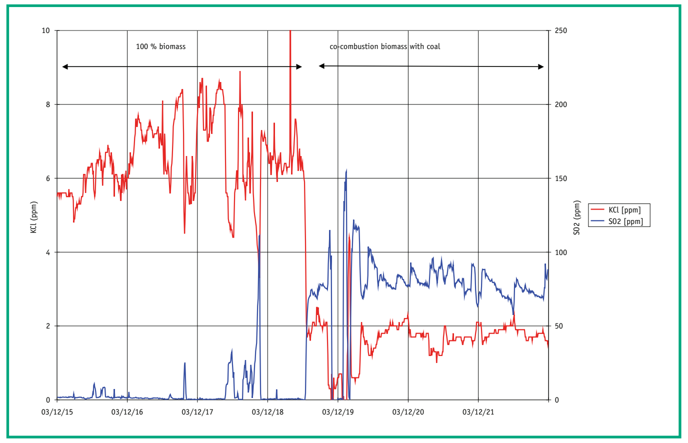

Figure 1: IACM measurements during a fuel change.

The ChlorOut Concept

Vattenfall has also developed and patented the so-called ChlorOut additive. It effectively converts alkali chlorides into alkali sulphates, which are much less harmful from a deposit and corrosion point of view. The ChlorOut additive is sprayed into the flue gas after the combustion zone but before the superheaters. The ChlorOut additive is usually ammonium sulphate, and therefore a significant NOx reduction is also expected.

The ChlorOut concept combines IACM, for measurement of KCl, with an additive for reduction of KCl. The ChlorOut concept reduces deposit formation and superheater corrosion during combustion of fuels rich in alkali and chlorine.

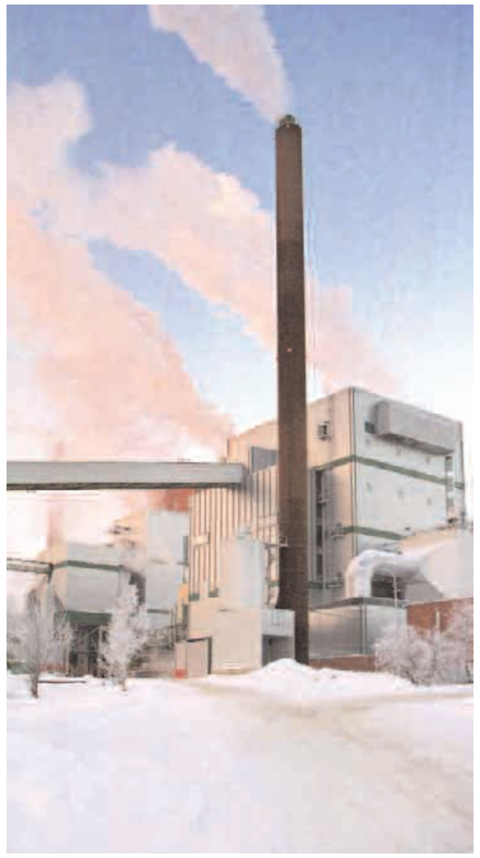

Figure 2: The CFB plant in Munksund, Sweden.

The ChlorOut Concept in Munksund

The ChlorOut concept is installed in several boilers including a 96MWth/25MWe CFB boiler in Munksund, in the northern part of Sweden (see Figure 2). The boiler is mainly fired with bark and a chlorine containing waste. In Figure 3, a significant reduction of KCl was achieved during addition of ChlorOut.

A number of measurement techniques including IACM, deposit and corrosion probes have been used to study the effect of ChlorOut. Three different operating cases were evaluated; normal fuel mix, normal fuel mix with ChlorOut, and co-combustion of peat. Figure 4 shows results obtained from IACM for the three cases. Figure 5, a significantly lower chlorine content was found in deposits collected at 500°C, during co-combustion of peat as well as with ChlorOut.

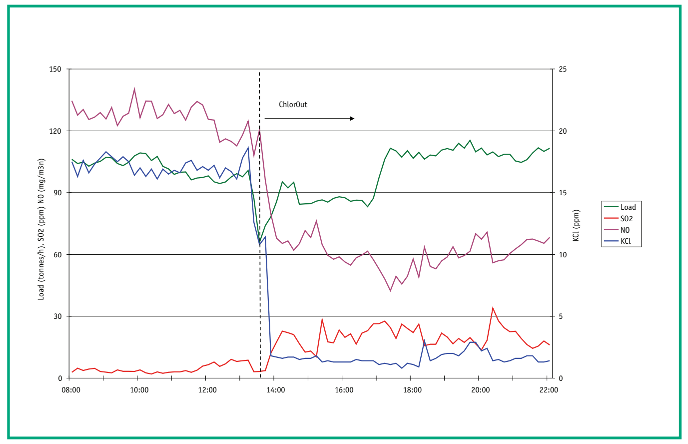

Figure 3: IACM and emission measurements with and without ChlorOut.

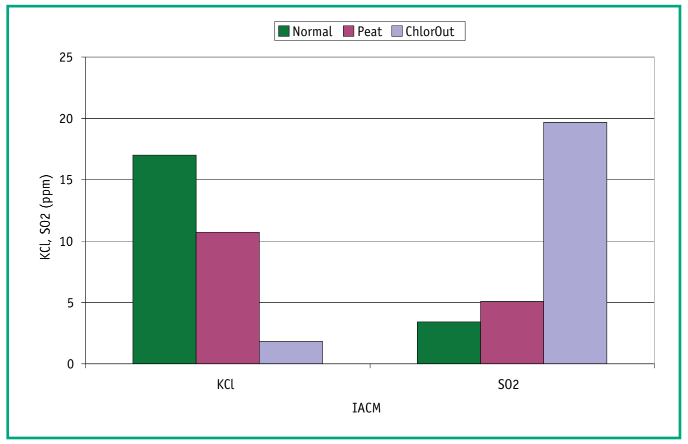

Figure 4: IACM measurements during the three operating cases.

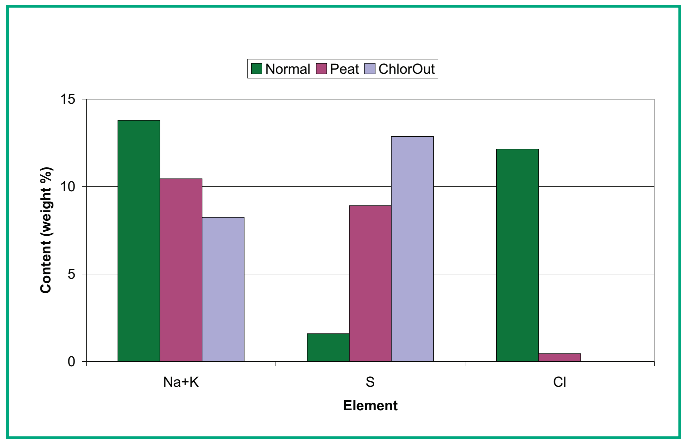

Figure 5: Deposit analysis during the three operating cases.

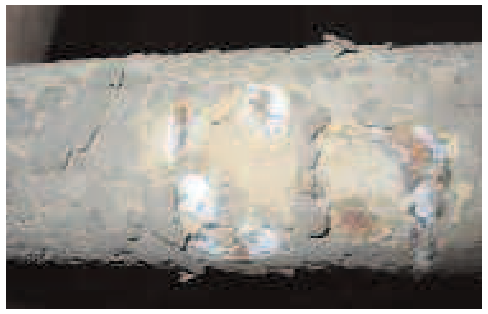

Figure 6a: Corrosion probes - Normal fuel mix.

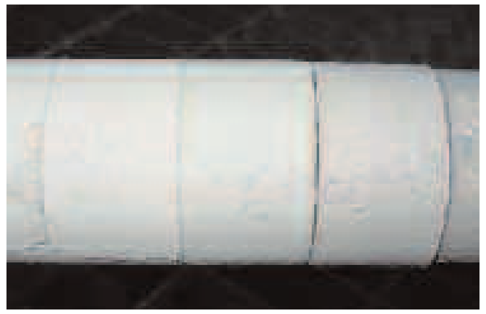

Figure 6b: Corrosion probes - ChlorOut.

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The First Demolition Wood Fired Biomass Plant in the Netherlands includes a Fire Tube Boiler Cleaning Apparatus

By Enno Nuy, OPTIMUM Environmental & Energy Technologies, Netherlands

BioEnergy Twente, a joint venture of Bruins & Kwast (biomass trading), Cogas Energie (energy company) and PPM Oost (venture capitalist), is operating the first biomass plant in the Netherlands, fired with demolition wood. Some 17.000 tonnes per annum are converted in a Polytechnik furnace (based in Austria) into 1,7 MW electrical and 6,7 MW thermal energy. One of the main consequences of using demolition wood as fuel is the stronger regime for the flue gas cleaning section.

In spite of the fact that demolition wood is considered to be clean biomass, with a maximum of 3% impurities such as plastics, as far as the flue gases are concerned the plant is considered to be a waste incineration plant. Not only were the strongest emission levels imposed, but the flue gases also have to be monitored continuously 24 hours per day. One of the biggest challenges is realising the 130 mg NOx emission level. This level came within reach by combining the adiabatic furnace of Polytechnik with a selective non-catalytic reduction. With primary measures, the Polytechnik furnace performs a NOx level below 200 mg/Nm3 at 11% O_2.

One of the main features of a demolition wood-fired biomass plant concerns the ash deposition. Ash weakening occurs at a temperature around 1100 °C. By controlling (amongst others) flue gas recirculation, fouling consequences can be diminished, however not prevented. In order to cope with this problem of boiler fouling, OPTIMUM developed a world wide patented system for automatic in line cleaning of fire tube boilers. With this automatic pipe cleaning system APCS, fire tube boilers no longer have to be taken out of operation for cleaning purposes.

The APCS functions as follows: a positioning system moves a lance with a brush containing cable to an opener/shutter in the back plate of the boiler. A laser device opens the valve, the lance is moved forward into the smoke box just in front of the opposite boiler tube. The cable unwinds and brings the brush into the tube, through to the other side; then the cable is withdrawn, brushing the dust out of the tube. The dust is taken with the flue gases to the gas cleaning section while the lance with the cable with the brush is withdrawn from the smoke box. The valve is closed and the positioning system brings the lance to the next position.

By continuously repeating the cleaning cycles, ash deposition inside the tubes can be prevented or restricted. The fouling characteristics and boiler conditions determine the type of brush being applied and the number of cleaning cycles per day.

Table 1: BioEnergy Twente features.

Main features of the BioEnergy Twente biomass plant	
Input	17.000 T/a demolition wood
Heating value	14,7 MJ/kg
Output electrical	1,7 MWe
Output thermal	6,7 MWth

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Figure 1: Boiler house.

Figure 2: Flue gas cleaning.

Figure 3: Typical fouling.

Figure 4: APCS.

Figure 5: Lance with brush in front of opener/shutter.

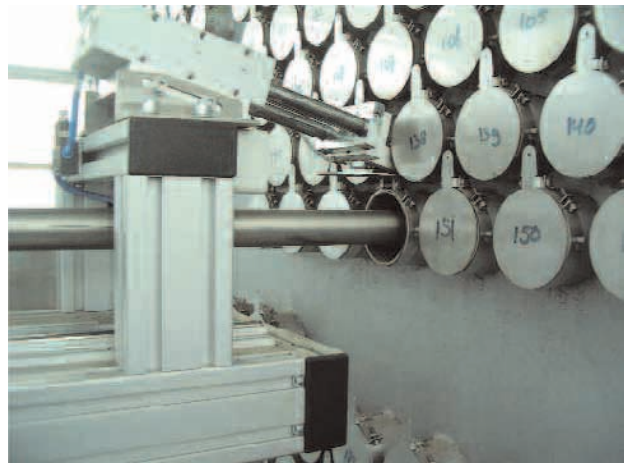

Figure 6: Brush moved into smokebox and fire tube.

Conversion of a Pulverized Coal Power Plant to 100% Wood Pellets in Belgium

By Yves Ryckmans, Electrabel/Laborelec, Belgium

In the light of Belgium's targets for CO_2 reduction (7,5% by 2012) and renewable electricity production (6%), Electrabel recently implemented a full retrofit of an existing pulverised coal power plant to fire 100% wood pellets. This full conversion from coal to wood is thought to be a world first, as the use of fossil fuel in the plant has been totally abandoned. Every day, about 1000 metric tons of wood pellets are delivered via "just-in-time" mode by flat boats navigating from the port of Antwerp. The plant has a yearly production capacity of 570 GWhe from 350,000 tons of wood pellets. The power plant has become the largest source of green electricity in Belgium (400,000 green certificates per year). Everything has been designed such that the layout is fully reversible to coal in three weeks time in case present legislation is changed.

Figure 1: Liège Unit 4 of Les Awirs power plant (near Liège).

The Les Awirs plant was commissioned in 1967 for generating 125 MW of electricity firing heavy oil and natural gas. In 1982 the plant was re-powered to fire pulverised coal in tangential manner. A second retrofit was realised in 2005 for firing 100% wood pellets. The capacity of the renewed plant is 350,000 metric tons of wood pellets, originating from all over the world. Approximately one third is shipped from overseas to Antwerp harbour, where it is discharged on flat boats navigating along the river Maas up to the plant. The second third is transported by boat from North-Eastern Europe to Antwerp, and then in the same way to the power plant. The last third originates from closer proximity areas in Southern Belgium and is transported by truck up to the power plant.

Design

The whole fuel supply system has been modified. Unloading of the flat boats into the receiving hopper is carried out by use of a mobile crane. Belt and conveyor chains have been fully covered and equipped with dust suction and filtering at any transition level. Some of the conveyors are new, but some of the coal conveyors were re-used.

Figure 2: Bio-fuel hopper including dust suction and filtering systems.

The existing coal bins - for intermediate storage of the raw fuel before milling - have been re-used as well and equipped with extended anti-explosion systems (See Figure 2). The former roller mills for coal were replaced with two hammer mills of 30 tph each to pulverise wood pellets to particles under 3 mm, with 75% under 1,5 mm.

The existing coal boiler remained unchanged with the exception of new dedicated burners for pulverised wood. A mixture of wood dust and cold primary air (less than 60°C to cope with fire and explosion risks) is injected in the centre tube, while hot secondary air is injected along the periphery. The steam temperature has been reduced from 545°C to 510°C, steam pressure being 145 bar.

Safety Measures

Since wood dust can be released all along the fuel handling system, which may be very explosive under certain mixtures with air, several safety measures have been implemented and have been included in the new design to prevent explosions and protect workers likely to be exposed to the risks:

- metal and spark detection
- earthing of equipment
- micro-pulverisation of water in the critical places, sprinklers along the conveyors
- anti-explosion bottles injecting sodium bicarbonate into the bins, etc.

Continued overleaf.

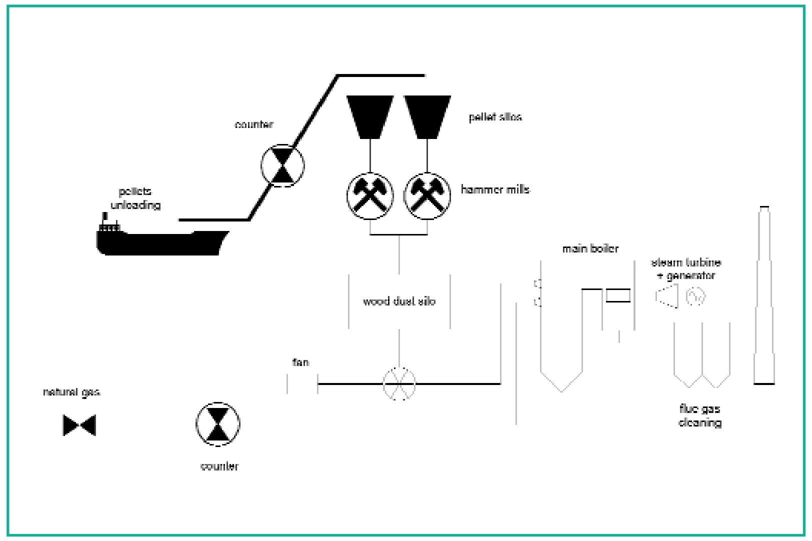

Figure 3: Schematic of the retrofitted power plant.

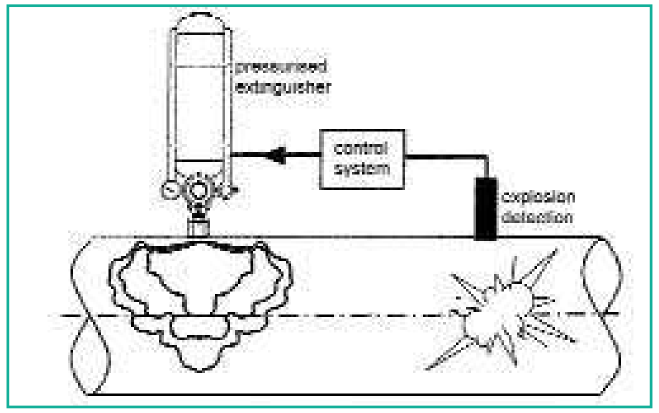

Figure 4 a & b: Anti-explosion bottles for protecting the fuel bins and pipes conveying air and wood dust mixtures.

Wood Pellet Certification

The Belgian authorities required a certification for the origin of the imported wood fuel delivered to the power plant from all parts of the world: Canada, Asia, South Africa, Latin America and Eastern Europe. The number of green certificates granted is directly related to the energetic efficiency of the supply chain on the base of a life-cycle analysis taking into account fossil equivalent CO_2 emissions at each step in the supply chain. This results on average in about 0,7 certificate per MWh of net green electricity. Other requirements are the provision of a guarantee that the forest resources are managed on a sustainable basis, and the acceptance of extended audits at individual fuel suppliers by an independent body. In order to cope with technical issues as well as all environmental limitations when firing wood pellets, Electrabel has designed its own fuel specifications, adapted from already existing European standards like:

- Swedish Sweden SS 18 71 20
- German DIN 51731
- Austrian Önorm M7135

Operating Results

Within 8 months of initiating the necessary studies, the conversion of the Unit 4 of Les Awirs coal power plant into a biomass plant was completed. Since August 2005, the power plant has been extensively tested for optimising every component of the new fuel handling system from the unloading hopper up to the new pulverised fuel burners of the former coal boiler. A deep chemical and physical analysis of the wood pellets was made in order to ensure complete burnout of the wood into the existing boiler. Today, the renewed plant is operated at nominal load and generates both electricity and green certificates as expected.

Table 1: Key performance data of the Awirs plant.

Net electrical efficiency	34%
Net output	80.3 MWe
Wood pellet LHV	17 MJ/kg
Fuel consumption	350 kton/year
Energy production	562 MWhe/year
Green certificates	0.70 certificate/MWhe

The emissions of dust, NOx and SOx remain well below the limits imposed from 2008 on by the LCP-Directive 2001/80/EC.

Table 2: Gaseous emissions firing wood pellets (all figures at 6% O_2, dry flue gas).

	dust	SOx	NOx
Measured	19	30	120
LCP before 2008	350	1700	1100
LCP after 2008	100	1200	600

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ThermalNet contents

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Interests:
- Combustion and gasification of biomass
- Quality Management system for biomass combustion plants
- Health and Safety aspects of gasification

Current and recent projects:
- Quality Management of biomass combustion systems. Several projects in development and application of QM
- Evaluation of biomass gasification projects
- Combustion tests with agricultural waste

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Interests:
- Liquid Biofuels (incl. pyrolysis oil)
- Small scale biomass power generation systems

Facilities:
- Engines and microturbines fed with solid biomass and vegetable oils
- Emulsification system and equipment for emulsion analysis

Current and recent projects:
- VOICE: Vegetable Oil Initiative for a Cleaner Environment
- BIO MGT: Innovative small scale polygeneration system combining biomass and natural gas in a Micro Gas Turbine
- BIOSOUTH: Techno-economical assessment of the production and use of biofuels for heating and cooling applications in South Europe
- COMBIO: A new competitive Liquid Biofuel for Heating
- BIOSIT: GIS-based planning tool for greenhouse gases emission reduction through biomass exploitation
- Progetto Olio Vegetale Puro (pure vegetable oil for tractors)

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Interests:
- Biomass resources
- Thermochemical conversion processes
- Economics

Facilities:
- Biomass fuel analysis laboratory
- Pyrolysis unit (under construction)
- Gasification unit (to be commissioned)

Current and recent projects:
- Bioenergy chains from perennial crops in South Europe
- BIOKENAF: Biomass production chain and growth model for kenaf
- EUBIONET
- SOLLET: European network strategy for combined solar and wood pellet heating systems for decentralised applications
- Establishing local value chains for RES-heat in local communities

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Interests:
- Bio-oil analysis
- Upgrading

Facilities:
- Bench-scale hydrotreater
- Chemical analytical.

Current and recent projects:
- Pyrolysis oil to gasoline
- Upgrading of pyrolysis oil to fuels and chemicals

Continued overleaf.

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Interests:
- Pyrolysis
- Gasification

Facilities:
- Lab-scale slow (batch and continuous) and flash pyrolysis reactors
- Lab-scale and pilot stage gasification unit
- GC, GCMS, HPLC

Current and recent projects:
- An assessment of bio-oil toxicity for safe handling and transportation (BIOTOX)
- Multi agricultural fuelled staged gasification with dry gas cleaning (Liftoff)
- SOFC Fuel cell fuelled by biomass gasification gas (Green Fuel Cell)
- Biomass conditioning for large scale transport fuel implementation (PRECOND)

Claus Greil

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Interests:
- Gasification (fixed, fluidised, entrained)
- Combustion (fb, cfb)
- Power & synthesis gas production
- Feedstock (coal, biomass, sewage sludge, other secondary fuels)
- Process engineering
- Project management, costing & economics

Facilities:
- Analytical laboratory
- Pilot plants for combustion and flue gas treatment
- Depending on the type of project test facilities may be installed at commercial plants in collaboration with clients

Current and recent projects:
- Large industrial projects: Improvement of existing combustion systems, gas cleaning, utilisation of secondary fuels. Upgrading of commercially proven technologies for new application purposes

Janina Ilmurzynska

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Interests:
- Biomass gasification
- Product gas analysis
- Modelling
- Co-firing

Facilities:
- Laboratory 2-stage gasifier, updraft, 150 kWth pyrolysis reactors
- Macro TGA
- Combustion investigation stand 0.5MWth
- Stand for solid fuels quality investigation
- Slagging intensity investigation stand
- Fuel cells (SOFC) manufacturing and testing
- Instruments for optimisation of industrial boilers (on-line measurement, diagnosis, mathematical modelling, laboratory investigation of combustion and co-firing processes)
- Solid fuels analysis laboratory
- FLUENT software

Current and recent projects:
- Studies of fuel blend properties in boilers and simulation rigs to increase biomass and bio-waste materials used for co-firing in pulverised fired boilers
- Integration centre for Central Europe for research in energy supply from fossil fuels and renewable sources
- Development of the method for investigation of biomass and wastes pyrolysis in laboratory scale
- New burner technologies for low grade biofuels to supply clean energy for processes in biorefineries
- Development of solid oxide fuel cells technology for stationary applications based on biomass gasification and natural gas

Gerfried Jungmeier

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Interests:
- Life cycle assessment
- Modelling of sustainable energy systems
- Management of recovered wood
- Biofuels and hydrogen for transportation
- Scenarios for market implementation of new transportation fuels

Facilities:
- Computer models for LCA and system analyses

Current and recent projects:
- Austrian Transportation Biofuel platform
- Feasibility Study on a Biofuel plant in Styria
- Renewable Hydrogen in Austria
- Wood products of today are the fuel of tomorrow – Design of wooden products for energy generation at their end of use
- Management of Recovered Wood – COST Action

Harrie Knoef

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Interests:
- Gasification

Facilities:
- Gasification and pyrolysis laboratory and pilot plants

Current and recent projects:
- Guideline for safe and eco-friendly biomass gasification
- Improvement of the S&T research capacity of TUBITAK – MRC EI in the fields of integrated biomass gasification with power technologies
- The integration of micro-CHP and renewable energy systems
- Large scale production of charcoal for use in coal fired power and co-generation plants
- Co-processing of upgraded bio-liquids in standard refinery units (Biocoup)
- Production of a movie to accelerate the uptake of innovative bioenergy technologies for heating and cooling

Continued overleaf.

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Interests
- Biomass combustion
- Biomass gasification
- Pollutant formation & reduction
- Particulate matter
- Tars

Facilities
- Wood stoves & boilers
- Automatic wood combustion plants
- Gas analysis
- Particle analysis

Current and recent projects
- Investigation of health effects of particles from wood stoves, automatic wood combustion, and diesel engine
- Influence of operation mode and combustion type on particle emissions from wood stoves and boilers
- Techno-economic assessment of secondary measures for removal of fine particles from biomass combustion

Anja Oasmaa

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Interests:
- Liquid biofuels

Facilities:
- Pyrolysis reactors – 20 kg/h, 1 kg/h

Current and recent projects:
- EU-BIOCOUP
- CLIMFUEL
- COMBIO

Eberhard Oettel

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Email: info@fee-ev.de

Interests:
- Management of National Task Groups "Gasification of Biomass" (since 1994 for Combined Heat and Power as well as Biomass to Liquid Fuels)
- "Biogases and Fuel Cells" (since 2001)
- Participation of FEE in several EU and national projects

Current and recent projects:
- "Integration of Micro-CHP and Renewable Energy Systems" (MicroCHeaP)
- International Networks of Renewable Energy Research: Research into the Optimization for the Coordination of Technologies for Power Generation out of Product Gases from Renewable Energy Carriers
- Research and Development Projects for the Sustainable Forestry in Germany: "Sustainable Supply of Wooden Biomass – Guidelines for the Energetic and Material Use of Forestal Energy Wood and Short Rotation Forest" (DENDROM)
- German-Colombian Public-Private-Partnership Project of Development Cooperation: "Efficient Utilization of Energy from Biomass of Banana Residues" (BananEnergy)
- Regional Project: "Introduction and Application of High Technologies into Small and Medium-Sized Companies – Specializing into Biogas Technology"

Hermann den Uil

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Interests:
- System assessments of biomass conversion

Facilities:
- Lab and pilot-scale gasifiers (up to 500 kWth)
- Variety of facilities for gas cleanup
- Reactor for catalytic synthesis
- 10 kWth pyrolysis facility
- Fluidised bed combustor
- Entrained flow gasification and combustion simulator
- Various methods for characterisation of biomass feedstock and products of biomass conversion (solids, liquids and gases)

Current and recent projects:
- TORTECH: Development of torrefaction technology
- BIOGG: Biomass to Green Gas
- Ethanol: Co-production of renewable transporation fuels, green chemicals, heat and power from biomass residues

Wieslaw Rybak

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Interests:
- Support industry and public authorities in the fuel and technology selection, development, design and operation processes in order to improve efficiency and to minimise emissions
- Gain new fundamental information on the solid fuel, biomass and waste combustion and gasification
- High temperature investigations and characterisations of different fuels: different rank coals, low-grade solid fuels, biomass
- Mathematical modelling of combustion, gasification and pyrolysis systems
- Standard and specific chemical and physical analyses of different rank coals, low-grade solid fuels, biomass and waste

Facilities:
The laboratory-scale tests;
- Fluidised bed facilities, drop tube furnace – 1.5m, staged combustion furnace – 3m, flat burner, ignition furnace – 1m
- TGA, several techniques to measure the ash formation (thermomehanical analysis, pressure drop, compressive strength)
- Solid fuel analysis laboratory (basic analysis of fuel and mineral matter, optical anisotropy, surface area and pore volume, densities, petrology) are used to obtain input parameters that reflect the differences in fuel quality

Current and recent projects:
- Low sulphur coal combustion – Optimisation of boiler tunings
- Co-firing of coal and biomass in Boiler No 2 (360 MWe) at the Opole Power Sytation S.A
- Combustion of sewage sludge and gasification of straw pellets with cyclic reactor

Patricia Thornley

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Interests:
- Technical, economic, environmental and social assessment of bioenergy systems

Current and recent projects:
- Supergen: british bioenergy consortium

Stirling Engines go Commercial

By Søren Houmøller, Director, EGJ Development, and board member, Stirling Denmark

Investment by venture capital companies has geared Stirling Denmark for the commercial market. Now, R&D will live side by side with commercial sales goals and economic growth. After years of research, development and testing of its Stirling engine based CHP-plants, Professor Henrik Carlsen, founder of Stirling Denmark, realised that it took more than his own technical expertise and other skills to make a business on his work with the Stirling engine.

In early 2006 Prof. Carlsen signed a shareholder's agreement with three Danish investors lead by EGJ Development Ltd. Professor Carlsen remains the largest shareholder. The proceeds from the investment will be used to transform a demonstrated technology into off-the-shelf products, as well as to build up skills such as business strategy, management, sales, subcontracting and business development. The technical research and development will of course continue, with an increased focus on R&D that will optimise the sales, reduce the costs and improve the cash flow for the company.

Contribution from Investors

While it is obvious to everybody that the researchers provide the technical R&D, testing, etc. of a new technology, the roles of investors are often misunderstood and misconceptions are widespread. There is, however, evidence that risk-willing capital accelerates the renewable energy industry development and growth potential.

90% of all start-ups, who are not able to attract external capital, fail within 3 years. The reason is lack of contribution from investors. There are three issues that investors consider:

1. Investors only go in if there is a business case showing that they will get their money back plus profit. With Stirling, we are certain that there is a large market and that we will be able to sell engines at a competitive price very soon.
2. Investors add capital. In contrast to funding from R&D programs, investor's money can be used for anything. In Stirling we have hired an experienced, sales and management oriented managing director to take responsibility for the commercial issues, and moved the company to better suited facilities.
3. Investors provide commercial networks and management. Stirling needed a professional board of directors and needed to handle critical business system issues, including capital management, licensing and subcontracting. The new board has both the commercial and technical skills needed, and a "ping-pong" relationship has been established between the board and the managing director and Prof. Carlsen, now serving as technical director.

As a curiosity to many researchers, who seem to have difficulty raising funding, investors focus much more on the potential future earnings rather than expenses. If an investor sees the potential, he is always able to work with his contacts to raise more capital quickly.

Figure 1: Stirling Denmark founder and developer, Professor Henrik Carlsen (left) and investor, and board member Søren Houmøller (right).

Figure 2: Factors comprising an attractive investment opportunity.

Continued overleaf.

Investor Focus

Investors look at the following issues when deciding to invest:

- The technology, including advantages and disadvantages.
- The market – size, location, trends, competition.
- Economy – expenses and income, generated cash flow, ownerships shares and capital requirements.
- Organisation, including core competences of the people behind it.

The Future for Stirling

With a sound capital base, an attractive market, a demonstrated technology and a new organisation in place, the company is on course to a promising future. Within only a few years the company is expected to break even and a significant turnover is expected soon thereafter.

However, there are still risks of a both technical and commercial nature. There may be unexpected technical issues, the oil price may drop steeply and public support schemes for green electricity may change.

But venture capital is risk willing and with the Stirling engine technology, both founder, investors and markets believe a new CO_2 neutral and environmentally friendly biomass CHP technology has found is way out of the laboratory and into the real world.

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15th European Biomass Conference & Exhibition

ICC International Congress Centre, Berlin, Germany 7 – 11 May 2007

This year's Biomass Conference & Exhibition will endeavour to highlight political debate, industrial leadership and market topics with the theme "from research to market deployment".

The five-day conference programme will include:

- Plenary lectures describing the state-of-the-art in biomass technology
- Oral and visual presentations on research, development, demonstration and commercial projects
- Exhibition of biomass products, utilisation and conversion technologies
- Political and strategic workshops
- Social programme

All accepted abstracts will feature in either oral or poster sessions and will be published in the conference proceedings.

Conference topics will include:

- Biomass resources
- Biomass conversion
- Market
- Policies

Plenary presentations will be by invitation only to leading scientists and industrial actors.

For up to date information please see the website **www.conference-biomass.com**

To be added to the Biomass mailing list, please complete the form on the website.

For any further information please contact the conference organisers:

ETA- Renewable Energies,
Piazza Savonarola, 10
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Email: biomass.conference@etaflorence.it

Energetic Utilisation of Biomass

By Markus Ising, Fraunhofer UMSICHT, Germany

The Conference "Energetische Nutzung von Biomassen – Velen VII" ("Energetic Utilisation of Biomass") was held 24-26 April 2006 in a lovely water surrounded castle in the village of Velen, Germany. The conference was organised by DGMK/Kohlenveredlung (German Society for Petroleum and Coal Science and Technology/Division for Coal Processing).

This was the seventh conference in the series of this two-year period event. In the tradition of this conference and its organising society, predominantly representing thermo-chemical conversion technologies for carbonaceous materials, the 2006 conference focussed on synthetic biofuel strategies and technologies such as BTL (biomass to liquids).

85 participants attended the conference from Germany and The Netherlands. The majority of representation was from scientists from research institutes and universities, but there were also a significant number of participants from public bodies and industries involved in BTL.

The opening session had an overview on current bioenergy activities in Germany from the government's point of view, emphasising the growing importance of bioenergy for CHP and biofuels. Germany joining the IEA bioenergy implementation agreement was also mentioned. The session ended with two presentations from FEE and FZK-ITAS both dealing with an evaluation/benchmarking of BTL paths and strategies.

The scientific-technical sessions started with two presentations by Fraunhofer UMSICHT and ECN on biomass-derived SNG (substitute natural gas), presenting technological aspects, perspectives, and process economy. Both concluded SNG to be an interesting alternative to BTL.

The embedded poster session comprised 20 presentations on a variety of different topics around gasification, pyrolysis, combustion, and auxiliary technologies such as analytical methods or quality management. The poster session also showed a focus on biofuels. The best poster award was presented to Engler-Bunte-Institute from University of Karlsruhe for their presentation on "SNG" generated by means of biomass gasification.

One session was dedicated to pyrolysis. Two oral presentations dealt with a BTL concept based on straw pyrolysis, one with a systematically analysing approach (FKZ-ITAS), and one with a technical presentation (FZK-ITC). A novel technology, known as ablative pyrolysis, was presented by BFH depicting an impressive BTL demonstration plant. The University of Kassel presented a new method for characterisation of tars.

Following up with three gasification sessions there were two presentations on the Dutch strategy for BTL implementation by co-processing of biomass and coal. While ECN had the conceptual scientific view on it, NUON Power showed the practical results with their Buggenum IGCC-plant. ZSW concluded their AER-process to be a flexible concept, yielding H-rich gases, and also suitable for SNG production.

TU Delft reported on the characterisation of product gases from steam-oxygen blown CFB-gasifier. Problems with a small-scale wood gasifier and analytical equipment were discussed by TU Dresden. TU Munich presented results on SOFC operation concepts with integrated biomass gasification. Hydrothermal gasification in supercritical water as a quite uncommon technology, is proven to be suitable for several wet biomass feedstocks. FZK-ITC showed novel results using maize as a feedstock. The gasification session ended with a presentation from Engler-Bunte-Institute, concluding that residual coke from FB-gasification is suitable for downstream tar decomposition under certain conditions.

The session on biofuels started with a study by Wuppertal-Institute & FZ Juelich evaluating technologies, potentials and both economic and ecological effects of BTL implementation in a certain region. CHOREN Industries' contribution showed an update on the basic technology for BTL and their demonstration plant currently under construction in Freiberg. A presentation from TU Freiberg concentrated on hydro-cracking of FT-waxes and fuel product characterisation as a very important aspect in downstream processing of Fischer Tropsch-based BTL concepts.

The closing session related to biomass combustion comprised two presentations. FH Münster showed (experimental) results from medium scale biomass power plants with co-feeding of different agricultural biomass feedstocks. University of Essen has developed an interesting method for combustion control based on IR-thermographical monitoring of a grate combustor.

The conference ended with a podium discussion reflecting the most outstanding impressions and results. One general conclusion was that large-scale gasification technologies have gained in progress over the last few years, perhaps also driven by a growing interest in bio-syngas and biofuel strategies. For the latter the question of biomass availability and plant site logistics is still a big issue. There was consensus that long-term, biomass is the world's only regenerative carbon material, but at the same time, there were different ideas about the best way to use the limited carbon resources for our demand in heat, power, fuels, and chemical materials.

The conference proceedings are available as printed book (ISBN 3-936418-49-7), further information is also available at www.dgmk.de/kohle.

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Success and Visions for Bioenergy

A European workshop on success and visions in thermal processing for bioenergy, biofuels and bioproducts

Renaissance Hotel and Congress Centre
Salzburg, Austria
22 – 23 March 2007

Bioenergy Success Stories
Following on from the achievements of the Expert Meeting in Strasbourg in 2002, this intensive two-day workshop will bring together European experts and industry leaders to share the secrets of success in the field of thermal processing of biomass and provide a vision for the European bioenergy industry.

Wednesday 21 March 2007	Thursday 22 March 2007	Friday 23 March 2007
	Status and vision presentations	Success stories: industry case studies
	Poster viewing	Poster viewing
	Success stories: industry case studies	Workshops
	Workshops	Workshop reporting
Reception	Workshop banquet	

Figure 1: Draft programme.

Location
Nestled along the northern Alps in the heart of Austria, Salzburg is a baroque jewel. Salzburg is accessible directly by air from a few European cities, and has excellent rail connections to Munich and Vienna.

Posters
Posters are invited from all participants and will be available for discussion and viewing throughout the meeting.

Status and Vision Presentations
Invited experts from across the bioenergy and biomass field will give an overview of state of the art and outline their vision for the future of the bioenergy industry.

Success Stories
Case studies by industry leaders will provide an overview of the latest achievements in demonstration and commercial plants.

Workshops
Workshops will be held to discuss how to accelerate both rate of implementation and the successes of bioenergy processes. Each workshop will be chaired by an authority in the relevant area supported by a rapporteur and they will present the findings of the workshop in the concluding session. The workshop report will form a key component in the proceedings.

Scope
The workshop focuses on thermal processing technologies and products. Topics include:

- biofuels
- biomass pretreatment
- biorefineries
- combustion
- environment
- gasification
- heat and power
- hydrogen
- legislation
- policy
- pyrolysis
- renewable chemicals
- system analysis
- transport fuels

Papers, Posters and Proceedings
Papers and posters are invited on any topic within the scope of the conference. Accepted papers will be published in a book of proceedings. All participants will receive a copy of the proceedings and the book will be widely available for purchase and dissemination.

Please send the proposed title and author(s) details and a short abstract (250 words maximum) for the proposed paper and poster to Robert Fenton by 31 December 2006 (contact details below). Papers must be delivered within one week of the workshop in the correct format and on agreed topics. The editor's decision will be final.

Organisers

Tony Bridgwater
ThermalNet Co-ordinator and Pyrolysis Technology Co-ordinator, SUPERGEN Bioenergy Manager, IEA Bioenergy Pyrolysis Task Leader

Hermann Hofbauer
ThermalNet Gasification Technology Co-ordinator, RENET Scientific Co-ordinator

Sjaak van Loo
ThermalNet Combustion Technology Co-ordinator, IEA Bioenergy Combustion Task Leader

Robert Fenton
Secretariat

For more information please contact the organisers:
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Assessing the Sustainability of Biomass Supply[1]

By Patricia Thornley, Tyndall Centre, Manchester University

As the contribution of bioenergy to Europe's energy demand increases it will increasingly become necessary to look beyond European shores for sources of biomass. In theory there is a vast biomass resource available from other (often developing) countries that could help to provide European energy needs and an international bio-trade with biomass feedstocks as commodities could emerge in the relatively near future.

However, with the requirement to look further afield for larger quantities of, sometimes new, raw materials comes an obligation to ensure the sustainability of the materials being imported. Biomass can only really be considered as a renewable fuel if it comes from a sustainable source that has been efficiently processed and sensitively transported to its point of end use. An emerging commodity market in bio-trade will help ensure that the fuel has been delivered at minimum economic cost, benefiting end-users, but the wider environmental and social costs associated with the material also need to be considered. The variety of possible feedstocks, locations and routes will make it increasingly difficult to be certain that a particular fuel supply is indeed sustainable.

It is widely acknowledged that internationally-traded biomass has the potential to provide employment and income for rural communities, contribute to export receipts in developing countries and diversify national fuel mixes (1). However there is already growing concern about the sustainability of biomass imports in many quarters, even among the general public (2). In general these relate to two areas:

- Sustainability of biomass production – both environmentally and socially
- Transportation – both the direct transport related to the biomass movement and the possibility that by displacing agricultural land with energy crops it may be necessary to transport food greater distances – both of these impacts affect the net greenhouse gas balance implicated in global warming.

Certification
National authorities are just beginning to realise that some sort of certification or guarantee of sustainable origin is needed. But how should sustainability be defined in this context, what parameters should be taken into account and where is the credible, independent body that could administer any certification scheme and how much would it add to the cost of the feedstock?

At present a number of different groups have recognised the problem and are looking at ways of addressing it, either through research programmes, pilot schemes or feasibility reports.

The Dutch government was the first national body to really take the issue seriously and require that imported bioenergy feedstocks be certified sustainable, but at the time of writing they had not completed the development of an appropriate certification scheme. The EU has also seriously embraced the issue. In 2005 the EU introduced a biofuels directive, requiring member states to set targets for the proportion of their transport fuel that would be biofuel-derived. However, they did so mindful of the potential sustainability impacts of large scale biomass utilisation (both indigenous and imports) and included a provision that they could review the directive in 2006 and set minimum sustainability criteria for feedstocks. This has not yet been implemented but remains a possibility. Alongside this directive, a 2006 EU strategy for biofuels has also been published which resolves to look at the sustainability of feedstock cultivation and provide an assistance package for developing countries supplying biomass to Europe.

Continued overleaf.

Figure 1: ThermalNet Barriers workshop.

Figure 2a: Harvesting Eucalyptus in Brazil.

Figure 2b: Harvesting Eucalyptus in Brazil.

1. The sustainability of different methods of producing bioenergy feedstocks was discussed at the ThermalNet meeting in Lille in April 2006. This report summarises the output from that meeting.

There are also a number of independent groups that have developed certification systems within their own sectors e.g. the WWF-led sustainable palm and soy initiatives and the FSC forest certification system, etc. However, it is difficult to establish common criteria that can be applied to the widely diverse feedstocks that can be used at bioenergy facilities and these generally do not also incorporate processing, transport and delivery of the feedstock, which can have a significant impact on greenhouse gas balances. The situation is further complicated when agricultural products have more than one possible end use – why should certification restrictions apply when the product is used for energy that are irrelevant if it is instead shipped to Europe for use as a food or chemical source?

Summary

As global trade in biofuels increases it is easy to see that an independent certification system to verify the sustainability of biomass feedstocks becomes increasingly desirable. However, there are significant issues to be overcome in developing appropriate criteria and implementing a credible system. An EU call for tenders to examine the potential implementation and merits of different schemes has recently closed and work in this area is expected to progress during the course of next year. Whether or not adequate political will and perseverance (national, European and international) exists to facilitate the introduction of such a scheme on a mandatory basis remains to be seen, but the signs are that the wider sustainability issues associated with bioenergy systems are being taken very seriously and the complexity of the task has not yet deterred the EU and others.

Figure 3: Harvested trees ready to cut.

Figure 4: Cutting the Eucalyptus trees into logs.

Figure 5: Transporting the Eucalyptus logs.

References

(1) Faaij et al (2005) "Opportunities and barriers for a sustainable international bio-energy trade: towards a strategic advice for IEA Task 40", IEA, http://www.bioenergytrade.org/downloads/parisbiomassconferencetask40strategicadvice.pdf

(2) For example: http://news.bbc.co.uk/1/hi/england/cornwall/4386958.stm, and BBC News report 29/03/2006: "Palm oil demand threatening wildlife: European countries are encouraging the use of palm oil as a clean alternative fuel for cars and lorries."

Further Information

Further information can be obtained via the following websites:

IEA Task 40 Bioenergy Trade (http://www.bioenergytrade.org/otherreportspublications/fairbiotradeproject20012004/developmentofacertificationsystem/index.html)

TSEC Biosys website (http://www.iccept.ic.ac.uk/research/bioenergygroup/Projects/tsec_biosys/biosys.html#biosys_themes)

And journal papers:

Hamelinck, C.N., Suurs, R.A.A. and Faaij, A.P.C (2005) "International bioenergy transport costs and energy balance", *Biomass and Bioenergy* 29: 114-134.

Lewandowski, I.M. and Faaij, A.P.C. (2004) "Steps towards the development of a certification system for sustainable bio-energy trade", IEA, http://www.bioenergytrade.org/otherreportspublications/fairbiotradeproject20012004/developmentofacertificationsystem/index.html

Lewandowski, I.M. and Faaij, A.P.C. (2006) "Steps towards the development of a certification system for sustainable bio-energy trade", *Biomass and Bioenergy*, 30: 83-104.

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The Biorefinery: A Rising Star of European Bioenergy RD&D

By Crystal Luxmore, Aston University, UK

Aston University
IN THE HEART OF BIRMINGHAM

On October 19th and 20th 2006, the European Commission together with the Finnish Presidency hosted the first European Conference on Biorefinery Research. Chairperson Christian Patermann of EC DG Research said he was delighted with the turnout of nearly 600 researchers, policymakers and industry representatives from across the EU.

Biorefineries are a hot topic in bioenergy R&D. The mix of industry majors like Shell and BASF, EU policymakers and national politicians, and leading scientists signalled the importance of the biorefinery in Europe's energy future.

Figure 1: The Biorefinery conference.

Speeches by EU policymakers made it clear that the biorefinery will be a key focus of bioenergy R&D in the 7th Framework Programme and is also high up on the Finnish national research agenda. Keynote speeches by Juha Korkeaoja, Finnish Minister for Agriculture and Forestry, Wilfrid Legg from the OECD, Janez Potocnik EC Commissioner for Research and Science and Mauri Pekkarinen the Finnish Minister of Trade and Industry underlined the importance of biorefineries as a "promising route" to meeting the EU's Kyoto commitments and renewable energy goals.

The morning session on 19th October emphasised policy development and R&D strategies needed to develop biorefineries, with an entire session dedicated to the role of the EC's Technology Platforms in Forestry, Biofuels, Plants for the future, Sustainable chemistry and Forest-based sector. The 20th October Session focused on industrial views and perspectives on biorefineries and closed with a Round Table Discussion and a presentation of the FP7 Research Agenda.

The Breakout Sessions held in the afternoon of 19th October contained the bulk of practical science and technology and R&D content in the Conference. Delegates chose between four different breakdown sessions that covered the entire biomass chain.

ThermalNet members will be particularly interested in the presentations from the Advances in Thermochemical Conversion Session:

Co-processing of upgraded bio-oils in standard refinery units
Yrjö Solantausta, VTT

Advances in black liquor gasification
Ingvar Landälv, Chemrec

Fluidised bed gasification and synthetic biofuels, the Güssing plant
Reinhard Rauch, TU Wien

Biomass conversion replacing petrochemicals
Anthony A.G. Tomlinson, CNR

Foams from bio-based resources – Future perspectives
Jozef Sleeckx, DOW Benelux

Figure 2: An example of a poster.

Highlights from the fourth breakout session on Techno-economic and environmental analysis included Christian Kjoeller of Bioraf Contractors presentation on "Biorefinery – a quality investment opportunity," and Josef Spitzer of Joanneum Research's presentation on "Greenhouse gas emissions of bioenergy systems."

Biorefineries are a recent concept and this was highlighted as delegates debated over the very meaning of the term biorefinery. The Conference successfully mapped the current knowledge, political and industrial outlook for biorefineries in Europe and also made it clear that there is a lot of research to be done before the concept becomes reality.

Presentations from the conference are available on the website:
http://ec.europa.eu/research/energy/gp/gp_events/biorefinery/article_3764_en.htm

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Diary of Events

Information compiled by Emily Wakefield, Aston University, UK

ManagEnergy Annual Conference and EU Sustainable Energy Week "Take a Week to Change Tomorrow"
Date: 29th January 2007 - 4th February 2007
Venue: Charlemagne Building, Brussels, Belgium
Website: http://www.managenergy.net/conference/2007.html

National Biodiesel Conference & Expo 2007
Date: 4th-7th February 2007
Venue: San Antonio, Texas, USA
Website: www.biodieselconference.org/2007/

3rd International Hydrogen & Fuel Cell Expo: FC EXPO 2007
Date: 7th-9th February 2007
Venue: Tokyo Big Sight, Japan
Fax: +81-3-3349-4900
Email: fc@reedexpo.co.jp
Website: www.fcexpo.jp

European Pellets Conference
Date: 28th February 2007
Venue: Wels, Austria
Website: www.wsed.at.

World Sustainable Energy Days 2007
Date: 28th February 2007 - 2nd March 2007
Venue: Wels, Austrian
Website: http://www.energiesparverband.com/esv/index.php?id=217&L=1

Bioenergia 2007: Technology & Business Opportunities
Date: 1st-2nd March 2007
Venue: Madrid, Spain
Website: http://www.ategrus.org/

World Biofuels Markets Congress & Exhibition
Date: 6th-9th March 2007
Venue: Brussels, Belgium
Website: http://www.greenpowerconferences.com/wbm/index.html

8th Annual European Fuels Meeting
Date: 14th-15th March 2007
Venue: Paris, France
Website: http://www.wraconferences.com/wra114overview.html

NHA Annual Hydrogen Conference 2007
Date: 19th-22nd March 2007
Venue: San Antonio, USA
Website: http://www.hydrogenconference.org/

Success and Visions in Bioenergy
Date: 21st-23rd March 2007
Venue: Renaissance Hotel & Congress Centre, Salzburg, Austria
Contact: Rob Fenton
Tel: +44 (0)121 2043398
Email: r.b.fenton@aston.ac.uk
Website: www.thermalnet.co.uk

ECO Expo
Date: 4th-6th April 2007
Venue: Beijing International Convention Centre, Beijing
Contact: Rob Fenton
Tel: 866-675-2700 (US & Canada) or (01)818-906-2700 (International)
Website: http://www.ecoexpo.com/

Zero Emission Power Generation Workshop
Date: 16th-18th April 2007
Venue: Gebze, Turkey
Contact(s): Ms. Elif Caglayan or Mr. David Baxter
Email: elif.caglayan@mam.gov.tr david.baxter@jrc.nl

Bois Energie 2007
Date: 19th-22nd April 2007
Venue: Orleans, France
Website: www.boisenergie.com/

25th International Power Sources Symposium & Exhibition
Date: 23rd-25th April 2007
Venue: Assembly Rooms, Bath, UK
Tel: +44 (0)1527 518777
Email: association@sovereignconference.co.uk

GPE 2007 - 1st International Congress on Green Process Engineering
Date: 24th-26th April 2007
Venue: Toulouse, France
Tel: +33 (0)5 62242112
Fax: +33 (0)5 62242113
Email: 1stGPE@inp-toulouse.fr

3rd International Congress on Energy Efficiency and Renewable Energy Sources
Date: 25th-28th April 2007
Venue: National Palace of Culture, Sofia, Bulgaria
Website: viaexpo.com/congress-ee-vei/eng/congress.php

International Agrichar Initiative (IAI)
Date: April 29 - May 2 2007
Venue: Terrigal, New South Wales, Australia
Contact: Debbie Reed (US) or Adriana Downie (Australia)
Tel: 571-431-6626 (US) or +61 2 43404911 (AUS)
Email: dcdebbiereed@yahoo.com (US) or adriana@biomass.com.au (AUS)
Website: www.IAIconference.org (abstract submission deadline 29/12/06)

29th Symposium on Biotechnology for Fuels and Chemicals
Date: 29th April 2007 - 2nd May 2007
Venue: Denver, USA
Website: http://www.simhq.org/meetings/meetings.aspx

3rd COST E31 Conference Management of Recycled Wood: Reaching a Higher Technical, Economic and Environmental Standard in Europe
Date: 2nd May 2007 - 4th May 2007
Venue: Klagenfurt, Austria
Website: http://www.ctib-tchn.be/coste31/frames/f_e31.htm

BATIL Meeting (Biodegradability and Toxicity of Ionic Liquids)
Date: 5th May 2007 - 9th May 2007
Venue: Berlin, Germany
Website: http://events.dechema.de/BATIL_Meeting.html

Bio International Convention
Date: 6th May 2007 - 9th May 2007
Venue: Boston Convention & Exhibition Centre, Boston MA, USA
Website: www.bio2007.org

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