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Wellman Process Engineering Limited
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PyNe Subject Group Workshop Netherlands

Implementation

As fast pyrolysis nears full commercialisation, it is important to recognise the opportunities for implementation and overcome the barriers that could inhibit more rapid industrialisation. This PyNe Subject Group met in the Netherlands at the end of November 1998 to review how the technology can be developed and implemented. Max Lauer, the Convenor, provides a summary from this Group on page 9.

Environmental Health and Safety

As more organisations become involved in the production, processing and handling of this liquid, it is important that all necessary procedures and protocols are followed. The Subject Group will review the requirements for bio-oil to be handled and transported safely and will provide guidelines and make recommendations on procedures. Philippe Girard, the Convenor, provides a summary of the outcome from this Workshop on page 8.

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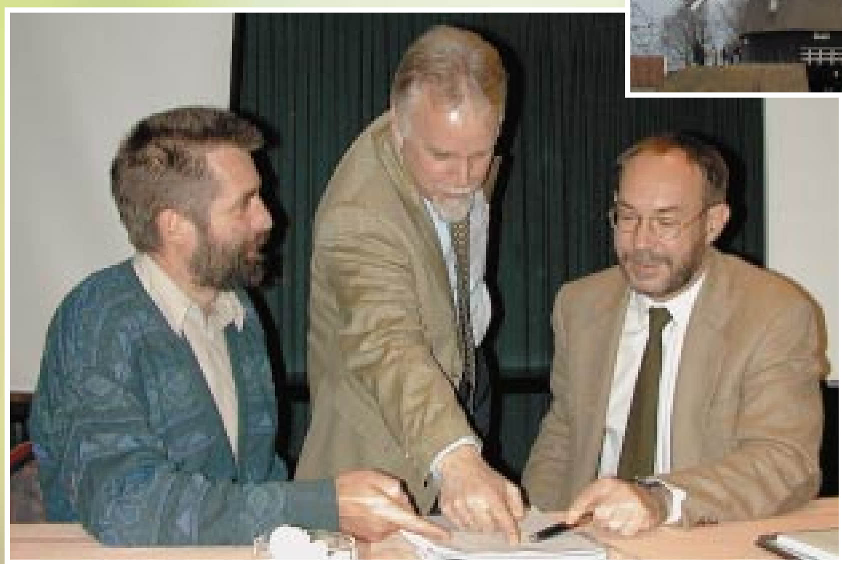
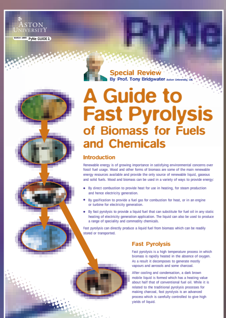
Pyrolysis Network.



Max Lauer (right) with fellow Convenor Philippe Girard (left) and Wolter Prins (centre) from BTG at the Workshop in November 1998 in the Netherlands


PyNe
Special Review
A Guide to Fast Pyrolysis of Biomass for Fuels and Chemicals
Introduction
Fast Pyrolysis

The PyNe Guide to Fast Pyrolysis of Biomass

A 6 page pull out guide to biomass fast pyrolysis is included in the centre of this newsletter. Additional copies are available from the Co-ordinator, details on page 2.

Brazil

Brazil has recently joined IEA Bioenergy and has elected to participate in the Pyrolysis Task represented by PyNe. There are now 18 countries represented in PyNe. More news will be published when it is available.

5th Framework Programme

By the time this Newsletter is delivered, the 5th Framework Programme should have been launched. A review of the basic structure and key points of the Programme is given on page 3.

ASTON UNIVERSITY

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

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Optimisation of Biomass Pyrolysis for Fluid Fuel Production

Bergen, Norway

26th–27th November 1998

By Karsten Pedersen, DTI, Denmark

The workshop covered the most common processes for making liquid fuels from biomass with presentations from chemists, geo-chemists and engineers on a wide range of topics from fundamentals to applications for pyrolysis products. There were 25 participants from industry and academia.

The following different routes for making liquid fuels were illustrated:

- Hydrous pyrolysis: conversion of biomass with steam at high pressure 10–200 bar and 340–360°C, close to the supercritical state of steam, a residence time of 6–72 hours and an homogeneous catalyst like sodium hydroxide. The process of hydrous pyrolysis (i.e. with water) should not be confused with hydro-pyrolysis (with hydrogen) discussed below. The liquid fuel produced in this way has a low oxygen content. The hydrous pyrolysis process is mainly suited for biomass and sludge with a moisture content higher than 50%.
- Flash pyrolysis of biomass normally takes place at 500–540°C with an extremely short residence time, preferably below 1 second. The product has an oxygen content around 35% and is not miscible with conventional fuels. The product has the highest stability when made from hardwood. The yield is around 75 w% bio-oil from dry ash free biomass. The product is mainly used for chemicals, but some commercial considerations have been made for fuels in countries with a high tax on crude oil products and low tax on biomass derived products like in the Nordic countries. Bio-oil from flash pyrolysis is unsuited for normal oil refineries, since the highest oxygen content in crude oil is around 1% and higher levels of 30% or more would cause problems. It was recommended that bio-oil should find its own market opportunities.
- Hydro-pyrolysis converts dry biomass in a hydrogen rich atmosphere at pressures around 100 bar with a residence time in the range of 1–30 seconds. The yield is not so dependent on the space-time relationship as for flash pyrolysis. The product has low oxygen content and is miscible with petroleum products.
- The indirect route for production of liquid products could take place via biomass gasification, gas conditioning and liquid synthesis with a Fischer Tropsch catalyst. At present, no plant exists for converting biomass into petroleum products, but it should be feasible to establish such a process on short notice since both the biomass gasification and the Fischer Tropsch plants are in operation today in South Africa.

Geochemists have made considerable efforts in modelling the reaction condition and pathways for the formation of oil reservoirs which are derived from marine biomass. Research efforts today concern the possibilities for converting terrestrial biomass into liquid fuels by increasing the conversion rate by more than five orders of magnitude. The challenge is to minimise coke formation and theoretically, it is possible to obtain 40 w% hydrocarbon products from dry ash free biomass.

The workshop was organised by Dr. Tanja Barth from the University of Bergen, Dr. Geoffrey Abbott from the University of Newcastle and Dr Karsten Pedersen from the Danish Technological Institute with support from JOULE. Proceedings are planned and enquiries should be sent to:

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5th Framework Programme

The 5th Framework RTD Programme will be launched by the European Commission just before publication of this issue of the PyNe Newsletter. The total budget of the programme is 15,000 MECU.

The 5th Framework Programme is divided into four different **Themes:**

1. Quality of life.
2. Information society.
3. Competitive and sustainable growth.
4. Energy, environment and sustainable development.

The themes are all divided into Key Actions where the actual RTD programme is placed.

Themes 1 and 4 deal with renewable and bio–energy and the area is found in different places in the work programme:

Theme 1, Key Action 5 'Sustainable Agriculture, Fisheries and Forestry.' Renewable energy will be found both in section 5.2 'The integrated production of biological materials for non-food uses' where the RTD emphasis is on liquid biofuels; and also in section 5.3 'Sustainable and multi-purpose utilisation of forest resources' where renewable energy production on a farm-scale is interesting.
Theme 4, Key Action 5 'Cleaner energy system including renewable energies' and also in Key Action 6 'Economical and efficient energy for a competitive Europe'.

Relevant extracts pertaining to biomass and pyrolysis from the official documentation are given below.

Theme 1, Key Action 5 – Sustainable Agriculture, Fisheries and Forestry:

- Integrated production and exploitation of biological materials for non-food uses.
- Technologies for the production and exploitation of natural resources, including forests.
- Sustainable and multi-purpose utilisation of forest resources.
- Efficient, environment-friendly processes and recycling technologies.
- High value added and diversified products.

Theme 4, Key Action 5 – Cleaner energy systems:

- Large-scale generation of electricity and/or heat from biomass or other fuels to improve efficiency and reduce cost and environmental impact.
- Development and demonstration of conversion technologies for biomass.
- Integration of renewable energy sources into energy systems, develop new applications and overcome barriers to the greater uptake of renewable energies.

Theme 4, Key Action 6 – Economic and efficient energy for a competitive Europe:

- Make more effective, sustainable use of energy with new technologies and improved existing technologies.
- Improving the efficiency and cost of new and renewable energy sources.
- Analysis of the cost effectiveness and efficiency to develop strategies for the introduction of new energy technologies.

Particular points
Particular points to note are:

- International co-operation will be re-inforced.
- Multi-disciplinarity will be encouraged.
- SMEs will be given greater encouragement.
- Wastes are now included with biomass for both R&D and Demonstration.
- Pyrolysis may not be applicable to all of the areas e.g. large scale applications.
- Training and mobility will continue to be encouraged.
- Electronic submission of proposals is being considered.
- Emphasis should be put on the convincing presentation of the socio-economic impact and EU-added value of the proposals.
- Updated information will be regularly provided through the Internet (www.cordis.lu) and its consultation is therefore strongly recommended.

How can PyNe help you?
PyNe provides key contacts (on the back page of the newsletter) across Europe and North America who will help find a partner or comment on your ideas. The EC officials are also very willing to review outline proposals in the framework of the pre-proposal check to ensure that they fit into the 5th Framework Programme Terms of Reference. Contact officials are:

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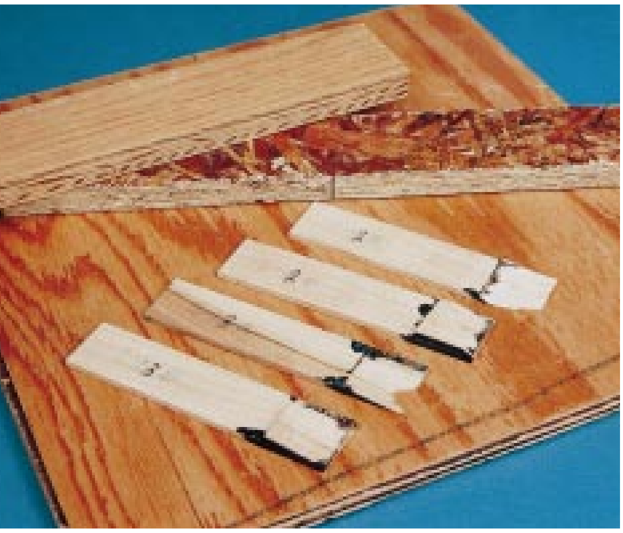
Adhesives from Biomass Pyrolysis Oil

By Stephen Kelley, National Renewable Energy Laboratory, USA



Wood products made from phenol-formaldehyde resins derived from bio-oil at NREL, USA

Producing phenol formaldehyde (PF) adhesives from biomass pyrolysis oil is the focus of a number of research groups around the world. The National Renewable Energy Laboratory in the USA (NREL) has successfully developed pyrolysis oil modified PF resins, that contain 35-45% pyrolysis oils, whose performance has been validated by an independent plywood testing laboratory. These formulations are based on an inexpensive, refined pyrolysis oil that does not require the use of an organic solvent in the upgrading process. Several different pyrolysis oil/PF resin formulations were successfully demonstrated and NREL is now discussing larger scale demonstrations with an industrial partner.

To be a commercially viable alternative to synthetic phenol, pyrolysis oils must meet a number of performance criteria. These criteria include the obvious requirements of cost and adhesive quality, and the less obvious criteria of batch to batch reproducibility and acceptable odour. Chemists and engineers at NREL are working to meet all of these criteria.

Pyrolysis liquid refining

Using standard fast pyrolysis conditions the production cost of pyrolysis oils is much lower than that of synthetic phenol. Alternative pyrolysis techniques, e.g. slow pyrolysis or partial oxidation/pyrolysis, suffer from lower yields and therefore have increased production costs relative to the standard fast pyrolysis processes. Unrefined fast pyrolysis oils are difficult to formulate directly into PF resins. This is due to the acidic character of the unrefined oils and the relatively large amount of unreactive materials contained within the unrefined pyrolysis oils. Both of these features diminish the performance of PF resins containing high levels of unrefined pyrolysis oils.

NREL has demonstrated the effectiveness of an organic solvent based extraction process for upgrading the unrefined oils. More recently this process has been improved to increase the yield of the isolated oils and lower the production costs of the refined pyrolysis oils.

Resin formulation

The formulation of pyrolysis oils into PF resins requires insight into the molecular level reactions that occur during a typical resin cook. The ratio of the reactive components, as described by the formaldehyde to phenol ratio (F/P) and the sodium hydroxide to phenol ratio (NaOH/P), must be adjusted to account for the differences between synthetic phenol and the refined pyrolysis oils. Specifically, synthetic phenol has three well defined reactive sites while pyrolysis oils have a distribution of reactive sites. This distribution of reactive sites includes both the number of reactive sites on each molecule and the inherent reactivity of each reactive site with formaldehyde under typical resin synthesis conditions, e.g. pH and temperature. These distributions are influenced by the source of biomass feedstock, the pyrolysis conditions and the refining process used to isolate the refined pyrolysis oil. Thus, the optimum F/P ratio needs to be determined for each new pyrolysis feedstock.

Pyrolysis oils are also more acidic than synthetic phenol and require a higher NaOH/P ratio than a standard PF resin. Again, the optimum NaOH/P ratio will depend on the conditions used to produce and isolate the pyrolysis oil, and needs to be determined for each pyrolysis oil. The optimum rations will also depend on the amount of pyrolysis oil that is added to the PF resin. Finally, the neat pyrolysis oil based resin must be formulated into a wood glue, which requires the addition of fillers, extenders and other additives. The package of additives will have to be tuned for the specific application.

National Renewable Energy Laboratory

Analysis

Batch to batch reproducibility is also a concern with any chemical feedstock derived from a natural source. The quality criteria for a pyrolysis oil feedstock must be relevant to its use as a component in PF resins. These criteria include the number and distribution of reactive sites, the molecular weight, and the acidity of the refined pyrolysis oil.

Measuring these individual characteristics can be accomplished with standard analytical techniques, but several of these standard techniques are costly and time consuming. NREL has developed rapid spectroscopic techniques that can be used to characterise pyrolysis oil and quantify its similarity to other pyrolysis oils.

Odour

Odour may be the most difficult problem for the commercial production of PF resins containing pyrolysis oils. All pyrolysis oils, regardless of their source or the process used to produce them, have a strong characteristic odour. This odour is diminished as the pyrolysis oils are formulated into PF resin but is not completely eliminated. The odour is also accentuated by the elevated temperatures used in the hot-pressing of wood composite products. Some of these odours can be diminished by the proper formulation and engineers controls around the hot press. Education for the plant personnel will also be required to minimize the concerns about odour.

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Bio-fuel System Materials Testing

By Dan Fuleki, Orenda, Canada

Orenda

OGT2500 – 2.5MW Gas turbine engine

Test procedure

Material tests were conducted to investigate the integrity of potential fuel system materials when exposed to liquid bio-fuel. The tests were conducted by exposing four different materials: aluminum, brass, mild steel and an austenitic stainless steel (material types detailed in Table 1); to bio-fuel at room temperature, 50°C and 70°C for a duration of 360 hours. The material samples were approximately 1"x 2" x 0.40" and were immersed in a covered 250 ml beaker of bio-fuel produced by Ensyn from a hardwood feedstock with a water content of 19% and a pH of 2.4.

Thin specimens were used to maximise the surface area exposed to corrosion attack for the weight of the specimen. Fuel was added to the beakers as required to ensure the specimens were fully covered at all times during the test. At specific intervals, the samples were removed from the fuel and ultrasonically cleaned in methanol for 2 minutes to remove any traces of bio-fuel and loose surface debris. The samples were then weighed and returned to the bio-fuel until the next weight measurements were made.

Results

The results of the tests are given in Table 1 and Figures 1 to 3 on the next page.

The rate of weight loss for the stainless steel and brass was undetectable. However, dramatic changes in weight were noticed for aluminum and mild steel. The rate of weight loss for aluminum was relatively constant at all temperatures, as was the case for mild steel at room temperature. However, at the elevated temperatures, the rate of weight loss for mild steel decreased with time. This may have been due to the accumulation of material on the surface that was observed during testing. This would have offset some of the weight loss as well as decrease the interaction of the fuel and the material.

Continued on next page...

Conclusions

The changes in specimen weight indicates that mild steel and aluminum are highly susceptible to corrosion at any temperature and are not acceptable materials for bio-fuel applications. In addition, the formation and adherence of deposits observed on the mild steel would also negatively affect its operating characteristics and decrease its applicability to bio-fuel.

The weight change of brass and stainless steel in bio-fuel was relatively unaffected at any temperature. These results indicate that both brass and austenitic stainless steel materials are acceptable for bio-fuel applications. However, it is important to realise that these tests were performed under static conditions over a duration of 360 hours. In commercial fuel systems, the materials would be exposed to bio-fuel under high pressure and flow conditions for longer durations. This will probably increase the rate of degradation and possibly result in additional damage modes. For example, the softness of brass may be a concern due to the potential erosion from the particulate matter within the fuel that would only occur under flowing conditions. These laboratory scale tests are relatively simple to conduct and are useful in screening potential materials for bio-fuel applications. However, it is necessary to conduct full-scale testing under service conditions to accurately determine durability issues for a full-scale, commercial level system.

Table 1: Material weight losses

Aluminium		***Brass***		***Mild Steel***		***Stainless Steel***	
AN-A-13 Alclad 24S-T		Shim stock #603-510 R30T cold-rolled		1008-1010		Shim stock #603-812 T302 cold-rolled	
Exposure Time (Hours)	Weight Loss (%)	Exposure Time (Hours)	Weight Loss (%)	Exposure Time (Hours)	Weight Loss (%)	Exposure Time (Hours)	Weight Loss (%)
At Room Temperature							
24	0.1078	24	0.0394	24	0.3623	24	0
48	0.1685	48	0.0215	48	1.2012	48	0
72	0.2493	72	0.0251	72	2.2222	72	0
168	0.5257	168	0.0215	168	5.1651	168	0
360	1.4684	360	0.0251	360	9.4292	360	0.0075
At T=50°C							
12	0.093	12	0.0249	12	2.0575	12	0.0073
24	0.392	24	0.0214	24	5.1795	24	0.0037
48	0.6118	48	0.0143	48	8.5517	48	-0.0036
72	1.0032	72	0.025	72	11.7815	72	0
168	2.3786	168	0.0178	168	19.3544	168	-0.0036
360	3.1825	360	0.0178	360	19.7899 /22.4825*	360	0.0036
At T=70°C							
12	0.2526	12	0.0284	12	6.9526	12	0.0075
24	0.9109	24	0.0213	24	16.6783	24	0.0037
48	0.8843	48	0.0035	48	15.9169	48	-0.0263
72	2.5066	72	0.0107	72	15.8228	72	-0.0037
168	8.9096	168	0.0213	168	15.8008	168	0.0113
360	17.8125	360	0.0213	360	15.8007 /19.6057*	360	0

*Mild steel surface deposits removed

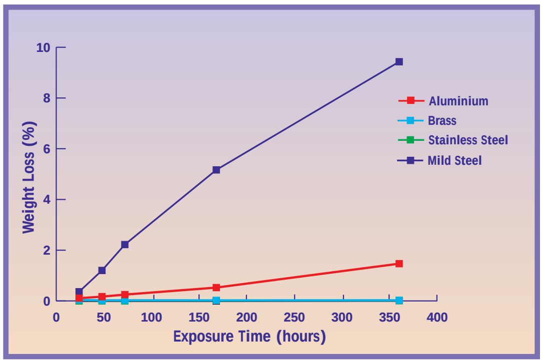

Figure 1: Material weight loss due to exposure to bio-fuel at room temperature

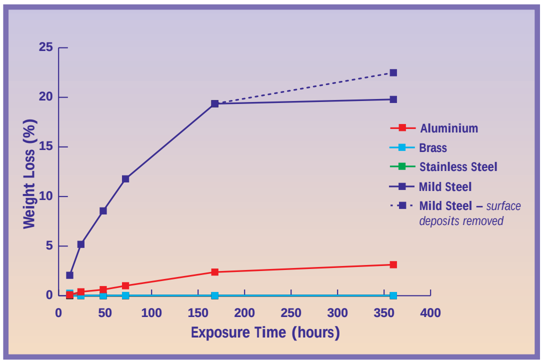

Figure 2: Material weight loss due to exposure to bio-fuel at 50°C

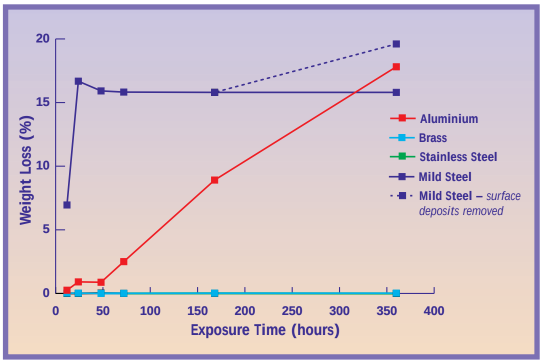

Figure 3: Material weight loss due to exposure to bio-fuel at 70°C

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UPDATE on the Analysis and Characterisation Subject Group

By the Convenors Dietrich Meier, IWC, Germany and Anja Oasmaa, VTT, Finland

Pyrolysis of biomass means the thermal degradation of their polymeric constituents cellulose, hemicelluloses and lignin. The unspecific breakdown of the biopolymers leads to the formation of a huge number of compounds ranging from low molecular simple gaseous products to condensable monomeric and oligomeric chemicals with different functional groups, molecular sizes and weights. Thus, the analysis of the liquid products is a challenge due to the complexicity of the composition which depends not only on the pyrolysis conditions but also on the type of feedstock and pretreatment procedures. For a comprehensive analysis, many physical and chemical methods have to be applied. Therefore, an ambitious task list for the subject group was established to provide information on feedstocks, standard and novel methods and results of Round Robin tests. After thorough discussions within PyNe the following objectives were agreed:

Objectives

- Provide data on feedstock analyses and methods of analysis. Include a few different examples (untreated hardwood and softwood, one agricultural feedstock e.g. straw) including analyses of feedstock and pyrolysis products, and including process type, conditions (pyrolysis temperature, residence time) and char removal method.
- Collect data on the effect of pretreatment (e.g. washings) of the feedstock on pyrolysis products.
- Collect feedback from pyrolysis liquid end-users (such as Ormrod, Neste, and Orenda) for identifying important properties and evaluating and/or developing suitable test methods.
- Evaluate alternative standard methods and new methods for measuring physical properties.
- Evaluate new methods for chemical characterisation (HPLC, SPE, i.e. solid phase extraction, 13C-NMR, FTIR, HS, i.e. head space analysis, GPC).
- Conduct a new Round Robin on physical (water, solids, particles, viscosity etc.) and chemical characterisation (pyrolytic lignin, water solubles). Suggested samples: fast, slow, and vacuum pyrolysis liquids produced under well-defined and documented conditions.
- Study and evaluate methods for measuring pyrolysis liquid quality.
- Organise a workshop to review progress and present developments in these areas.

Karl Fischer water analyser

Status of the activity

The first subject group workshop is going to be organised as a combined meeting with the Stabilisation and Upgrading Subject Group in Montpellier from 23rd to 26th April 1999. The Analysis and Characterisation Workshop will take place on 23rd and 24th April and the Upgrading and Stabilisation Workshop on 25th and 26th April 1999.

A state of the art review of analysis and characterisation is going to be presented at the 4th Biomass Conference of the Americas in Oakland, USA, on 29th August to 2nd September 1999. (For details see the Diary of Events on page 18).

Contact details for the Convenors are on the back page.

UPDATE on the Health, Safety and Environmental Subject Group

By the Convenor Philippe Girard, CIRAD, France

Fast pyrolysis bio-oils are complex, dark brown coloured, viscous, highly polar and acid substances. The amount of aromatic hydrocarbons in these products is mainly related to process parameters during production and feedstock. It is obvious that conversion of solid biomass to a liquid fuel can potentially achieve a large reduction in both CO_2 and SO_2 emissions. However, the bio-oil contains several hundreds of different chemicals in widely, varying proportions. Therefore, health, safety and environmental (HSE) issues need to be considered to assess the impact fast pyrolysis activities have on health, safety and the environment.

All aspects related to HSE issues can be divided into three sections to assess the consequences of fast pyrolysis activities:

1. Health and safety in the work place.
2. Environmental protection.
3. Incidents occurring during distribution and use.

Fast pyrolysis activities in Europe are increasing due to the development of knowledge and construction of pilot and demonstration plant. According to National and European regulations, producers of any potentially toxic chemicals have a duty to assess and declare the hazards related to the chemicals and risks of exposure (acute or chronic effects).

The main results of the last HSE Subject Group meeting held in the Netherlands included:

- The need to define fast pyrolysis oils as a substance (with the composition and a range of possible concentrations for each component).
- To investigate how to notify this new substance in terms of hazards and risks during manufacture, transport and use, in order to meet the EU chemicals regulation.

A comprehensive set of information will therefore be necessary for official notifications in the EU. This will certainly constitute a new challenge for the PyNe members and the pyrolysis community.

HSE Convenor Philippe Girard (centre) with toxicology experts Henk Brandt (left) and Niek Snoeij (right) at the PyNe workshop in De Lutte, the Netherlands, November 1998

Contact details for the Convenor are on the back page.

UPDATE on the Implementation Subject Group

By the Convenor Max Lauer, Joaneum Research, Austria

During its first meeting in the Netherlands in November 1998, the PyNe Implementation Subject Group developed an overview on all the aspects that can influence the rate and extent of implementation of fast pyrolysis technology. Six presentations were given from a range of companies working in the field that showed the problems facing those involved with biomass pyrolysis technologies.

Two workshops were held to consider and overcome the barriers to implementation. As a result of these two workshops, a prioritised list of the barriers that inhibit pyrolysis technology implementation was drawn up and also a set of recommendations developed for handling them. These will be included in the report of the workshops.

The activities of the Implementation Subject Group in the next two years will concentrate on:

- **Development of an information file for assessment of the opportunities for biomass pyrolysis and applications.** This information file will consist of technical data and cost data as well as other necessary information to aid developers and those involved with implementation. PyNe country representatives and other interested persons will then be better able to identify applications with good chances for implementation under the specific regional conditions (such as biomass availability, energy taxes, subsidies etc.) and to also identify applications with more limited opportunities and where further RTD work may be of lower priority.
- **Comparison of the opportunities and requirements** for implementation in different countries and regions.
- **Preparation of recommendations** to give concise but comprehensive views on the opportunities for implementation of all the possible applications for biomass pyrolysis technologies. These recommendations will also be used to identify further promising activities such as research, development and demonstration.

Contact details for the Convenor are on the back page.

UPDATE on the Science and Fundamentals Subject Group

By the Convenor Jan Piskorz, RTI, Canada

The very successful Workshop 'Science and Fundamentals of Fast Pyrolysis' was held in Stratford-upon-Avon UK, 22nd–24th July 1998, (see PyNe Newsletter 6). The Workshop was dominated by international experts in the field of mathematical modelling and computer simulation (including Di Blasi, Wojtowicz, Suuberg, Groenli, Arauzo, Peacocke, Antal, Solantausta). The presentations given at the Workshop have been submitted to a formal peer review process and it is planned that accepted papers will be published by PyNe.

For an introduction to pyrolysis modelling go to the PyNe Website (http://www.pyne.co.uk) and see the summary by Colomba Di Blasi from the University of Napoli 'Federico II', Italy.

The importance of the Workshop lay in unifying scientists on difficult issues related to the kinetics of cellulose pyrolysis. For years, the kinetic parameters of cellulose pyrolysis have been evaluated by many researchers by means of thermogravimetric analysis. Some of the conclusions from the presentations and discussion included:

- There are several varieties of research grade and technical quality cellulose (micro-crystalline and fibrous) available to researches.
- These can be easily differentiated and 'finger-printed' by routine thermogravimetric analyses, often coupled with other modern analytical methods.
- Yes, it is possible to derive rigorous chemical kinetics from carefully obtained thermogravimetric data, but such kinetic parameters should be reported with a detailed characterization of the feed and products. Clearly, important effects of mass and heat transfer limitations in the obtaining and evaluating thermogravimetric data have to be addressed by researchers.

The Group will continue to review and develop this topic and contribute to an improved understanding of the science and fundamentals of fast pyrolysis to aid the technology developers.

Contact details for the Convenor are on the back page.


UPDATE on the Stabilisation and Upgrading Subject Group

By the Convenors Stefan Czernik, NREL, USA and Rosanna Maggi, UCL, Belgium

Biomass pyrolysis oils are known to contain many reactive components and to exhibit significant changes in physical and chemical properties, especially when exposed to air or at elevated temperatures. This oil instability can often be observed as formation of deposits and gums, an increase in viscosity, a decrease of volatility, a phase separation and other undesirable changes occurring on storage or during utilization in boilers, engines or for other applications. These phenomena result from chemical reactions between certain oil components or between the oil components and oxygen. Therefore, an understanding of the bio-oil chemistry is a critical step in preventing or minimising the processes that degrade oil quality and limit its applications.

The goals of the PyNe Stabilization and Upgrading Subject Group are to explore the nature of the chemical processes occurring in the oil and their relationship with the oil physico-chemical properties, and finally, to propose methods to prevent or at least to slow down the undesirable processes. These long-term goals will require a substantial effort which will be difficult to employ within the voluntary activity. For this reason, the following shorter-term, more realistic objectives have been agreed:

- Review the state of the art work on stability of biomass pyrolysis oils.
- Review the literature on stability and stabilization methods for diesel fuel and determine their relevance for bio-oil.
- Review the literature on physical and chemical upgrading of bio-oils.
- Propose methods for bio-oil stability testing.
- Organize a Round Robin test on stability of crude bio-oil and bio-oil stabilized by two selected methods.

Status of the activity

The Upgrading and Stabilisation Subject Group is organising a workshop in common with the Analysis and Characterisation Subject Group in Montpellier from 23rd to 26th April 1999. The activities carried out and studied in these two fields are complementary and extensive interaction is therefore anticipated. The Analysis and Characterisation Workshop will start on Friday 23rd April and finish Saturday 24th April 1999 and the Stabilisation and Upgrading Workshop will start Sunday 25th April and finish on Monday 26th April 1999.

In addition, the group is preparing the review of different chemical and physical upgrading processes. This review entitled 'A Review of Physical and Chemical Methods of Upgrading Biomass Derived Fast Pyrolysis Liquids' is co-authored by Stefan Czernik, Rosanna Maggi and Cordner Peacocke and will be presented at the 4th Biomass Conference of the Americas which will be held in Oakland, USA, from 29th August to 2nd September 1999. (For details see the Diary of Events on page 18).

Contact details for the Convenors are on the back page.

RTI – Resource Transforms International Ltd.

By Desmond Radlein, RTI, Canada

Resource Transforms International Ltd. (RTI) is a small R&D Company, which is a spin-off from the University of Waterloo, Ontario, Canada. Its principals were all intimately involved in the development of the original Waterloo Fast Pyrolysis Process (WFPP) now licensed to Union Fenosa Electrica in Spain.

Our ultimate goal is the establishment of sustainable but profitable industry based on biomass refining through thermal conversion (see Figure 1). But such an effort requires a combination of several different resources and skills including technical, financial, managerial and marketing. Consequently we believe that it is necessary to establish equitable collaborations and partnerships which benefit all parties.

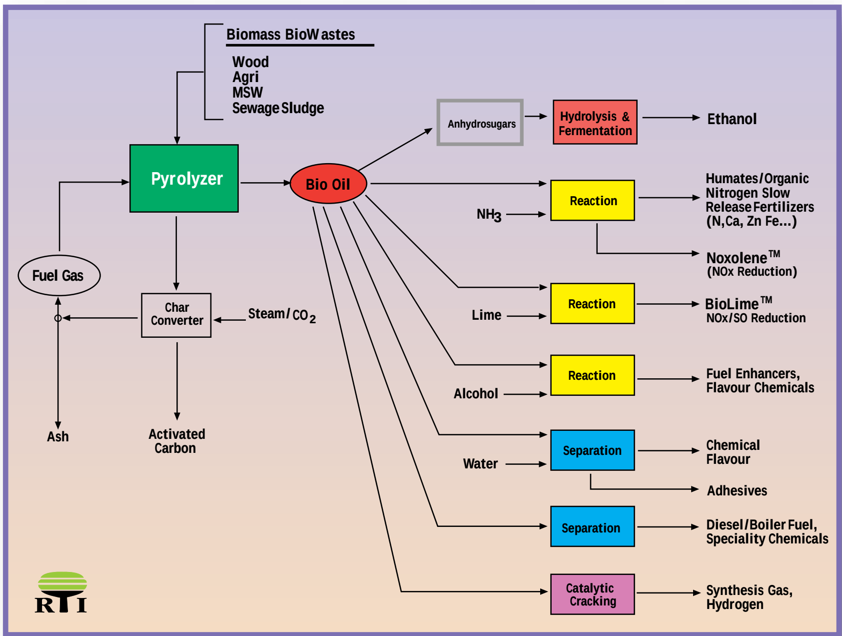

Figure 1: Biomass refinery – concept

In pursuit of these goals our activity is focused at present on the continuing refinement of a fast pyrolysis process for the liquefaction of biomass and the development of value added products from the bio-oil. RTI's business strategy is the development of technology and intellectual property covering all aspects of thermal biomass conversion.

Some recent achievements include:

- A US patent on an improved pyrolysis process (US Patent 5,728,271, March 1998). This process is also the subject of European Patent Application (EP 0 716 056 A1).
- A US patent on the conversion of bio-oil to organic slow release nitrogen fertilisers (US Patent 5,676,727, 1997).
- Patents pending on a method for stabilisation of bio-oil for fuel applications by acetalisation of reactive carbonyl functional groups (pending).

RTI has also established collaborations with a number of organisations, both private and public. Some of these include:

- AETB – CANMET, Ottawa, Canada.
- Aston University, Birmingham, UK.
- CML, Loyettes, France.
- Dynamotive Corp., Vancouver, BC, Canada.
- Foster-Miller Inc., Waltham, Mass., USA.
- Institute for Physical Research and Technology, University of Iowa, USA.
- Kemestrie, Sherbrooke, Quebec, Canada.
- Stone and Webster Engineering Corp., Toronto, Canada.
- Waste Reduction Technology, Cincinnati, Ohio, USA.

Continued on next page...

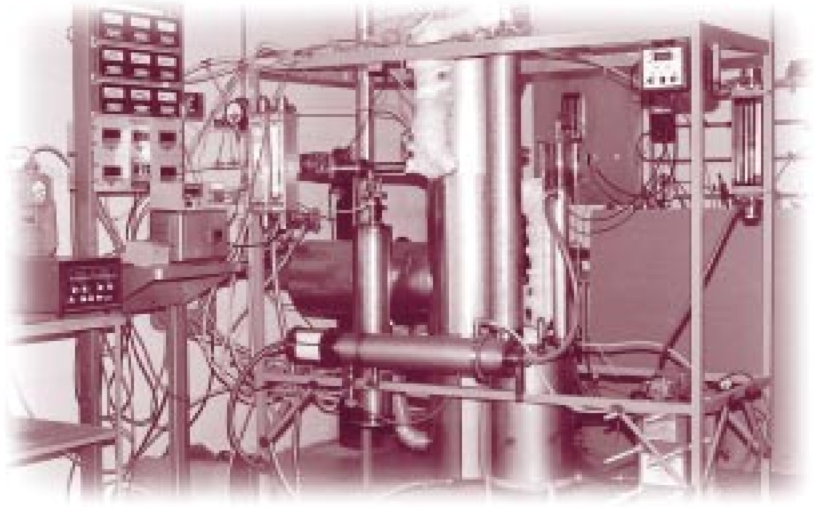

Figure 2: 20 kg/h Fast pyrolysis pilot plant

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Our current research program is directed towards further process refinements and product development. Improvement in (bio-oil) quality is a priority. A recent agreement with Dynamotive Corp. of Vancouver is anticipated to accelerate commercial implementation of our fertiliser product.

We also have the capability of manufacturing laboratory or pilot scale process equipment. Figure 2 shows our current 20 kg/h fast pyrolysis pilot plant. It offers smooth and reliable operation to produce good quality bio-oils from a range of feed stocks. We have supplied pyrolysis as well as high pressure reactors to several different organisations including:

- CANMET, Natural Resources, Canada.
- Dynamotive Corporation, Canada.
- Institute of Wood Chemistry, Germany.
- University of Aston, United Kingdom.
- University of Melbourne, Australia.
- University of Stuttgart, Germany.
- University of Waterloo, Canada.
- University of Zaragoza, Spain.

RTI also produces specialty chemicals by fast pyrolysis, specifically levoglucosan and levoglucosenone.

We welcome inquiries from all interested parties.

CRES- Centre for Renewable Energy Sources

By Yannis Boukis, CRES, Greece

Introduction

The Centre for Renewable Energy Sources (CRES) is the Greek national centre for the promotion of Renewable Energy Sources (RES), Rational Use of Energy (RUE) and Energy Saving (ES). Founded in September 1987, CRES is a public entity supervised by the Ministry of Development, General Secretariat of Research and Technology, having financial and administrative independence. CRES has participated in more than 500 European and national projects including research and development projects, demonstration projects, energy information systems projects, feasibility studies, technical and economic studies, market research, as well as promotional activities for the use of RES/RUE/ES.
To carry out these projects, CRES has a scientific staff of more than 120 experienced and specialized scientists and has co-operated with a large number of public and private organizations, on a national, European and international level.

CRES Structure

The structure of CRES is composed of the following basic units:

- Applied Research and Technology Development.
- Strategic Planning, Programming and Control.
- Energy Policy and Planning.
- Technical Support.
- Energy Information Systems, Dissemination & Training.
- Administrative Support.
- Quality Assurance Office.

In addition to over 2000m^2 of main work space, there are also experimental outdoor installations, specialized laboratories (biomass, photovoltaics, passive solar systems, wind energy), meeting rooms, a library and a considerable computing infrastructure. CRES' laboratories also provide technical services to third parties, such as measurements, materials and systems testing, certification, etc.

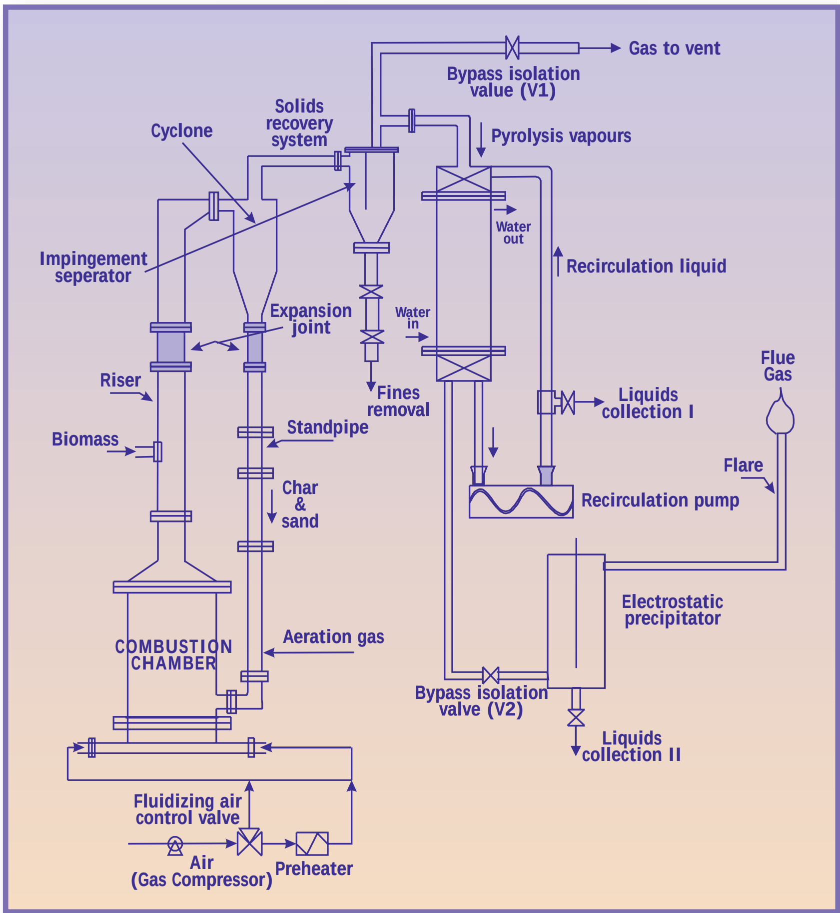

Figure 1: The CFB pilot plant

Pyrolysis
The main research effort is focused on the development of an innovative reactor for the fast pyrolysis of biomass, producing a liquid fraction that can be used as a fuel.
This reactor is a pilot scale recirculating fluidizing bed unit (Figure 1), which can convert 10 kg/h of biomass with liquid yields up to 65% wt. on dry biomass basis. In the frame of this effort, close collaboration with various European Institutes e.g. Aston University (UK), VTT (Finland), University of Stuttgart ZSW (Germany) and companies such as Ormrod Diesels (UK), TPS (Sweden), SOLO (Germany), WS (Germany) has been established.

Gasification
Research activities have been expanded to biomass gasification, as well. In this context, CRES is participating, in the development of a pilot fluidised bed gasification unit, with nominal capacity 50 kg/h of biomass in collaboration with the Agricultural University of Athens.

In addition, a demonstration downdraft gasification plant has been installed in Thrace. This plant converts 1 tonne forestry waste every 8 hours to gas which is directly combusted in a modified diesel generator to generate 70 kWe power and 240 kWth of hot water.

Result
As a result, considerable know-how in the field of biomass conversion technologies has been acquired, permitting CRES to provide technical assistance and develop co-operation in national, European and international level under the framework of related programmes.

Division of Applied Research and Technology Development
This Division is responsible for planning, co-ordination, management and execution of research, demonstration and pilot programmes. The Division is composed of eight departments covering all aspects of RES/RUE/ES including biomass.

The CFB pilot plant

Biomass activities
Promotion of bioenergy is a priority since Greece offers substantial biomass potential, particularly in the form of agricultural residues and wastes. During the last 10 years CRES has acquired extensive experience in the fields of:

- Exploitation of biomass resources notably agricultural and forestry residues, energy crops, industry wastes.
- Biomass conversion technologies including direct combustion, gasification and fast pyrolysis.
- Regional energy planning based on biomass.

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Website: http://www.cres.gr

Wellman Process Engineering Limited

By Richard McLellan, Wellman Process Engineering, United Kingdom

Wellman Process Engineering Limited is one of five companies belonging to the Wellman Group, a private limited company of 500 employees with headquarters in Oldbury, West Midlands, UK. All the companies within the group have specialist design and manufacturing facilities supplying equipment to industrial codes and standards in a competitive international market.

Company activities

Wellman Process Engineering Limited (WPEL) has three product ranges as described below.

Evaporators and crystallisers

These are designed and built under license from Swenson USA and supplied to industries varying from the production of food products to the concentration of plating chemicals in the steel industry.

Environmental atmosphere purification equipment

WPEL are the Design Authority for carbon dioxide removal plant and catalytic oxidisers used in all Royal Naval nuclear submarines and the Design Authority for carbon dioxide removal plant used on Australian Collins class submarines.

Gasification

Gasifiers and the associated gas clean up equipment have been designed and manufactured by Wellman since the 1920's with over 1,800 updraught single stage gasifiers supplying fuel gas to UK industries in the 1940's. Later the two stage gasifier was developed to gasify bituminous coal and plants based on this technology have been supplied to America, South Africa and more recently China and Khzakhstan. Seeing the potential for biomass as a fuel, in 1984 Wellman developed a circulating chemically active fluidised bed gasifier for the production of syn-gas, the project being part funded through the EU's Energy from Biomass programme. More recently the company has developed a catalytic cracking system enabling the production of a clean fuel gas from a wood chip feedstock utilising updraught fixed bed gasification as the primary conversion technology (see Figure 1).

Figure 1: 140 kg/h Updraught wood gasifier with thermal and catalytic organics cracking

Biomass Pyrolysis

Biomass pyrolysis and the production of bio-oil has opened up interesting possibilities for WPEL with its experience in both the thermal processing of biomass and the design of related gas clean up systems. The company is currently pleased to be involved in an EU project for the development of a fast pyrolysis process for the production of heat and power part funded under the JOULE programme (see PyNe Newsletter 6).

Wellman Process Engineering Ltd's aim is to design, construct, commission and operate an integrated fluidised bed fast pyrolysis reactor system for the optimal production of liquids. The development of a reliable fast pyrolysis system, capable of continuous operation is essential for subsequent commercialisation. To this end, a fully integrated system has been designed which minimises dependence on external fuel sources by utilising the by-product char and non-condensable gas into the process to provide process heat, fluidising and inert gases.

Specification

The design biomass feed rate is 250 kg/h softwood (dry basis) with anticipated pyrolysis liquids of 75% at a pyrolysis temperature of about 500^{o}C. The pyrolysis char and gas yields are expected to be 12–14 wt% each. The energy provided by the by-products is more than sufficient to provide the heat required for the pyrolysis process, based on detailed mass and energy balances over the system (see Figure 2).

The Fast Pyrolysis Process

Wood will be fed continuously through a water cooled screw conveyor into the reactor via a lock-hopper system. The pyrolysis reactor will consist of an inner sand bed reactor fluidised using recycled pyrolysis gases which have been oxidised using air over a catalyst bed. Char is removed from the pyrolysis vapours and gases in an internal cyclone where the majority of the char is recovered. A second external cyclone removes the remaining char. The char combustor is a separate sand bed reactor, located in the annulus surrounding the pyrolysis reactor. This arrangement allows the pyrolysis process and char combustion to be controlled independently allowing more flexibility when dealing with different feedstocks. Approximately 75% of the process heat is supplied indirectly by the char combustor and the remaining heat is provided by the hot fluidising gases.

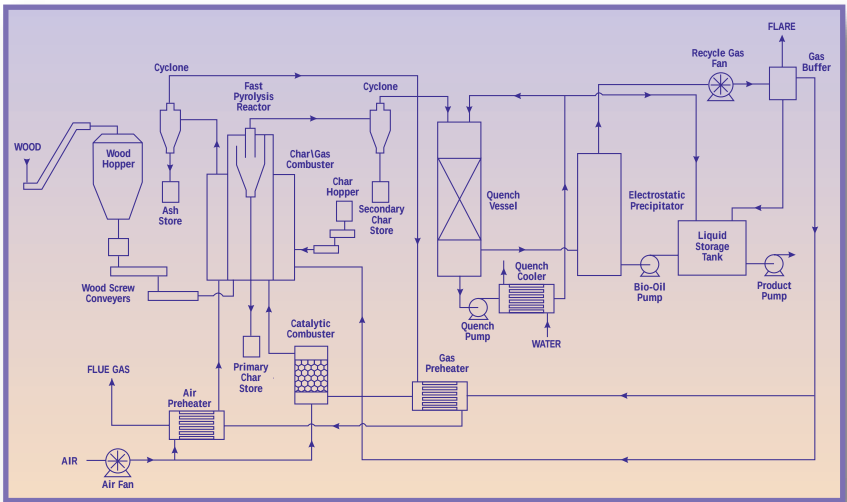

Figure 2: 250 kg/h Fast pyrolysis pilot plant

Product Recovery

After char removal the remaining pyrolysis vapours and gases enter a two stage quench column where approximately 70 wt% of the liquids will be recovered. The total residence time of pyrolysis vapours will be less than 2 seconds from production through to quenching. An electrostatic precipitator is used to collect remaining organics and water.

By-product Use

The pyrolysis char is collected by two cyclones and used to provide 75% of the energy for the pyrolysis process. A proportion of the non-condensable gas, consisting mainly of CO, CO_2, CH_4 and H_2, will be recycled for use as fluidising gas in the pyrolysis reactor after catalytic oxidation. Excess gas is flared.

Group activities

The other Wellman Group companies include:

- Wellman Furnaces, designers and manufacturers of industrial furnaces with specialist skills in roller hearth and sealed quench systems.
- Wellman Robey which are the largest European manufacturers of water shell boilers.
- Wellman Graham which manufacture tube and shell heat exchangers and pressure vessels for the process industry.
- Wellman CJB, the Design Authority for oxygen production and gas management plant on Royal Naval nuclear submarines; and manufacturer of high purity hydrogen plants and are currently involved in the development of gas conditioning systems for use in conjunction with fuel cells.

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BTG – Biomass Technology Group

By Wolter Prins and Bert Wagenaar, BTG, Netherlands

Figure 1: 200 kg/h Rotating cone pilot plant

Company Description

The Biomass Technology Group BV has been an independent private company of consultants, researchers and engineers since 1987. It has its roots in the Faculty of Chemical Technology of the University of Twente, where the current director Huub Stassen started the enterprise in the early eighties as a co-worker of Professor Van Swaaij. Close links are maintained with the University where Wolter Prins also works part-time. In 1997, BTG was taken over by TNO, which is the largest organisation for applied research in the Netherlands. This provides for BTG to continue to operate as an independent daughter company.

BTG's expertise primarily covers biomass energy technologies including combustion, gasification, carbonisation, pyrolysis, densification and anaerobic digestion. Other important issues are solar energy, electricity generation from fossil fuels, and simple technologies for developing countries. The activities, which may range from fundamental research to commercial application, are being undertaken in a wide variety of countries throughout the world (e.g. China, Sudan, Ukraine, Costa Rica, Eastern Europe, and all countries of the EU). Major clients include multilateral agencies (World Bank, EBRD, UN system agencies), Dutch Ministries, Provinces, and utilities as well as private companies. Most research is contracted by Novem, the Netherlands Agency for Energy and Environment and DG XII of the European Commission.

BTG has about 40 employees and is organised into four separate groups:

1. Project identification, development and training.
2. Sector technology assessments and feasibility studies.
3. Project engineering and implementation.
4. Research and development.

This profile will be focused on the activities in the R&D group, which currently has 10 employees.

EC Funded R&D Projects

Before providing a summary of flash pyrolysis activities, the following list of EC funded projects illustrates the main topics of interest – it is noteworthy that BTG is the project co-ordinator of five of them:

- Indirectly fired gas turbine for rural electricity production from biomass (FAIR CT95-0291).
- Catalytic upgrading of gas from bio-fuels and implementation of electricity production (JOR3 CT95-0053).
- Integrated small scale CHP fixed bed gasification fuelled by standard gasifier fuel (JOR3 CT95-0084).
- Gasification of biomass with enriched oxygen in a reverse flow slagging gasifier (JOR3 CT97-0130).
- Scale-up and operation of a flash pyrolysis system for bio-oil production and application based on the rotating cone technology (FAIR CT97-3203).
- Co-firing of bio-oil with simultaneous SOx and NOx reduction (JOR3 CT97-0179).
- Development of advanced fast pyrolysis processes for power and heat (JOR3 CT97-0197).

BTG biomass technology group B.V.

Flash Pyrolysis Technology Development

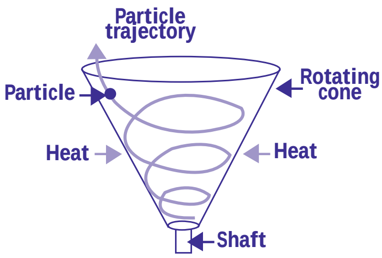

Figure 2: Schematic representation of the rotating cone reactor

Principle
The rotating cone is a novel reactor for fast pyrolysis of pulverised biomass, invented by the group of Professor van Swaaij at the University of Twente which is being scaled up and commercialised by the Biomass Technology Group (BTG). Figure 2 illustrates the principles: wood particles are fed to the bottom of the rotating cone, together with an excess flow of inert or catalytically active particles. Pyrolysis occurs as the wood and inert particles are
transported spirally upwards along the hot cone wall. The main advantage of the reactor is that no carrier gas is needed, which considerably reduces the size and cost of the secondary oil-collection system. In addition, the reactor is very compact and has an extremely high solids throughput capacity (up to 3 kg solids per second).

Figure 3: 50 kg/h Rotating cone pyrolysis unit

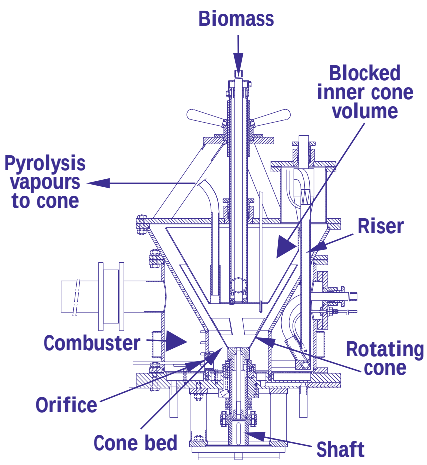

Figure 4: The continuous pyrolysis pilot plant and its main dimensions

Developments
BTG and Royal Schelde have delivered a 50 kg biomass per hour test-unit to the Shenyang Agricultural University in China. The plant which was built and commissioned in Vlissingen, shipped to China and re-erected in Shenyang. The first 'made in China' bio-oil is now available.

Meanwhile, the European Union (FAIR programme) and the Dutch Government through Novem have committed themselves to support further scale-up to a size of 200 kg biomass per hour. This is shown in Figure 1. In addition, Novem has agreed to co-finance a 50 kg/h unit to produce sufficient bio-oil for application research purposes. This is shown in Figure 3.

Two additional projects are worth mentioning, both of which are being carried out by PhD. students at the University of Twente. The first project concerns the development and testing of a fully heat-integrated, improved bench-scale unit of 20 kg biomass per hour in the framework of a EC-JOULE project on catalytic pyrolysis as shown in Figure 4. The second project is aimed at the recycling of plastic waste by flash pyrolysis in another bench-scale unit, based on the prototype rotating-cone concept.

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R&D Laboratories:
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7521 PS Enschede,
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Fax: +31 53 4325399
Email: Wagenaar@btg.ct.utwente.nl
Website: http://btg.ct.utwente.nl

Diary of Events

Fourth European Symposium on Industrial Crops together with the Products Sixth Symposium on Renewable Resources for the Chemical Industry

Venue: Bonn, GERMANY
Date: 23rd–25th March 1999
Contact: Sarah Wilkinson
Fourth European Symposium
Elsevier Science Ltd.,
The Boulevard, Langford Lane,
Kidlington, Oxford, OX5 1GB, UK
Tel: +44 1865 843691
Fax: +44 1865 843958
Email: sm.wilkinson@elsevier.co.uk
Website: http://www.elsevier.nl/locate/icp99

IdentiPlast – International Conference and Exhibition

Venue: Brussels, BELGIUM
Date: 26th–28th April 1999
Contact: Jeanne Thunin,
Conference Co-ordinator
APME, Avenue E. Van Nieuwenhuyse 4, Box 5,
B-1160 Brussels, BELGIUM
Fax: +32 2 675 4002
Email: jeanne.thunin@apme.org
Website: htpp://www.apme.org

ICheaP-4 The Fourth Italian Conference on Chemical and Process Engineering

Venue: Palazzo Congressi,
Piazza Adua 1,
Florence, ITALY
Date: 2nd–5th May 1999
Contact: AIDIC, ICheaP-4 Secretariat,
Piazzo Morandi 2,
20121 Milano, ITALY
Tel: +39 02 7602 1175
Fax: +39 02 799644
Email: aidic@aidic.it
Website: htpp://www.aidic.it

IT3 International Conference on Incineration and Thermal Treatment Technologies

Venue: Orlando, Florida, USA
Date: 10th–14th May 1999
Contact: Lori B. Cohen, Conference Co-ordinator,
University of California, EH&S,
300 University Tower, Irvine,
CA 92697 2725, USA
Tel: +1 949 824 5859
Fax: +1 949 824 1900
Email: 1barnow@uci.edu
Or
Contact: Joyce Feldman, Technical Chair
Environmental Consultant,
259 Tuttle Parkway, Westfield,
NJ 07090 USA
Tel: +1 908 654 8721
Fax: +1 908 518 9097
Email: joyfeldman@att.net

SUSTAIN '99 – The World Sustainable Energy Trade Fair

Venue: R.A.I. Exhibition and Congress Centre, Amsterdam,
THE NETHERLANDS
Date: 25th–27th May 1999
Contact: European Media Marketing Ltd.,
PO Box 259, Bromley,
BR1 1ZR, UK
Tel: +44 181 289 8989
Fax: +44 181 289 8484
Email: sustain@emml.co.uk
Website: http://www.emml.com

ECEEE 1999 Energy Efficiency and CO_2 Reduction

Venue: Cote D'Ázur, FRANCE
Date: 31st May–4th June 1999
Contact: ECEEE 1999 c/o ADEME/GREEN,
13 bd Rochechouart, 75009
Paris, FRANCE
Tel: +33 1 4463 04 29/4656 7620
Fax: +33 1 4463 0433
Email: green75@wanadoo.fr

Renewable Energy Europe '99 *(As part of POWERGEN Europe '99)*

Venue: Frankfurt, GERMANY
Date: 1st–3rd June 1999
Contact: Caroline van Broekhoven,
Exhibition Co-ordinator,
PO Box 9402, 3506 GK Utrecht,
THE NETHERLANDS
Tel: +31 30 265 09 63
Fax: +31 30 265 09 28
Email: caroline@pennwell.com
Website: htpp://www.pennwell-europe.com

AgEnergy '99 Energy & Agriculture towards the Third Millennium

Venue: Athens, GREECE
Date: 2nd–5th June 1999
Contact: Professor G Papadokis,
AgEnergy '99, Dept. of Agricultural Engineering,
Agricultural University of Athens, 75 Iera Odos Street,
GR 118 55, Athens, GREECE
Tel: +30 1 529 4002, 529409
Fax: +30 1 529 4023
Email: agenergy@auadec.aua.gr
Website: http://www.aua.gr/conferences/agenergy

World Renewable Energy Congress '99

Venue: Palace of the Golden Horses,
Kuala Lumpur, MALAYSIA
Date: 8th–11th June 1999
Contact: Secretariat, WREC '99 MALAYSIA,
3rd Floor, 78 Jalan SS 22/21,
Damansara Jaya, Selangor,
MALAYSIA
Tel: +6 03 7172612/13
Fax: +6 03 7172616
Email: transe@tm.net.my

2nd Olle Lindström Symposium on Renewable Energy, Bioenergy

Venue: Royal Unstitute of Technology,
Stockholm, SWEDEN
Date: 9th–11th June 1999
Contact: Prof. Fredrik Setterwall
KTH, Royal Institute of Technology, Department of Chemical Engineering and Technology, Division of Transport Phenomena,
SE 100 44 Stockholm, SWEDEN
Fax: +46 8 10 52 28
Email: setter@ket.kth.se
Website: http://www.ket.kth.se/O_L_Symposium.html

Analytical and Applied Pyrolysis

Date: June 1999
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6th International Conference on Circulating Fluidized Beds

Venue: Würzburg, GERMANY
Date: 22nd–27th August 1999
Contact: Christiane Mitter,
DECHEMA e.V., Congress Office,
PO Box 15 01 04, D-60061
Frankfurt am Main, GERMANY
Tel: +49 69 7564 280
Fax: +49 69 7564 304
Email: nick@dechema.de
Website: http://dechema.de/cfb-6

Fourth Biomass Conference of the Americas

Venue: Oakland Marriott City Center,
Oakland, California, USA
Date: 29th August–2nd Sept 1999
Contact: Dee Scheaffer,
National Renewable Energy Laboratory, 1617 Cole Boulevard, MS 1613, Golden,
Colorado, USA 80401 3391
Fax: +1 303 375 2905
Website: http://www.nrel.gov/bioam

REWAS'99 – Global Symposium on Recycling, Waste Treatment and Clean Technology

Venue: San Sebastian, SPAIN
Date: 5th–9th September 1999
Contact: Dr Rodolfo Solozabal, General Secretary of REWAS '99
INASMET, Camino de Portuetxe,
12, B. de Igara, E-20.009,
San Sebastian, SPAIN
Tel: +34 43 31 6144
Fax: +34 43 21 7560
Email: rsoloza@inasmet.es

CEM '99 International Conference on Emissions Monitoring

Venue: Coventry, UK
Date: 6th–8th September 1999
Contact: Dave Curtis, Source Testing Association, Camino de Portuetxe, 12 B de Igara, E20 009, San Sebastian, SPAIN
Fax: +44 1462 457157
Email: CEM))@s-t-a.org

ISO '99 Innovation in Selective Oxidation by Solid Catalysts 6th European Workshop on Selective Oxidation

Venue: Palacongressi Rimini, ITALY
Date: 10th–11th September 1999
Contact: S Perathoner, Scientific Secretary University Messina, Salita, Sperone 31, 98166 Messina, ITALY
Tel: +39 090 393134
Fax: +39 090 391518
Email: perathon@imeuniv.unime.it
Website: http://www.fci.unibo.it/ec4/oxid.htm

14th International Symposium on Analytical and Applied Pyrolysis

Venue: Seville, SPAIN
Date: 2nd–6th April 2000
Contact: Viajes El Monte, Departamento de Congresos C/Santo Domingo de la Calzada, 5-1 SP 41018 Seville, SPAIN
Tel: +34 95 498 10 89
Fax: +34 95 457 78 63
Email: congresos.itc@caymasa.es

Progress in Thermochemical Biomass Conversion

Venue: Tyrol, AUSTRIA
Date: 21st–26th May 2000
Contact: Prof. Tony Bridgwater or Miss Nina Ahrendt, Bio-Energy Research Group, Aston University, Birmingham, B4 7ET, UK
Tel: +44 121 359 3611 (Ext. 4647 or 4633)
Fax: +44 121 359 6814
Email: a.v.bridgwater@aston.ac.uk ahrendtn@aston.ac.uk
Website: http://www.pyne.co.uk/PITCB2000

Renewable Energy 2000

Venue: Metropole, Brighton, UK
Date: 1st–3rd July 2000
Contact: Reed Exhibition Companies

ISWA 2000 8th World Congress of ISWA

Venue: Paris, FRANCE
Date: 3rd–7th July 2000
Contact: Secrétariat pour le 8e Congrès Mondial de l 'ISWA, c/o AGHTM 83, Avenue Foch – BP 39 16 75761, Paris Cedex16, FRANCE
Tel: +33 1 53 70 13 53
Fax: +33 1 53 70 13 40

ENERGEX 2000 8th International Energy Forum

Venue: Las Vegas, USA
Date: 23rd–28th July 2000
Contact: Dr. Chenn Q. Zhou, Purdue University Calument, Department of Engineering, Hammond IN 46323, USA
Tel: +1 219 989 2665
Fax: +1 210 989 2898
Email: qzhou@calument.purdue.edu
Website: htpp://www2.regina.ism.ca/ief/index.htm htpp://www.energysource.com/ief/updates/

11th European Energy from Biomass

Venue: Seville, SPAIN
Date: September 2000

Conference & Meeting Reports

BOIS ENERGIE 98 – International Fair

Lons le Saunier, France 5th–7th Nov 1998

This was the first in a series of fairs devoted to bio-energy. The main focus was on the utilisation of biomass, particularly wood for heating. Over 100 exhibitors covered all aspects of bio-energy with practical demonstrations including biomass harvesting, processing, wood furnaces and boilers, and engineering, all corresponding to an integrated approach of bio-energy. Over 8000 people attended the Fair, representing a wide and diverse interest in biomass utilisation.

Visitors had the opportunity to attend seven workshop sessions. The latest innovations presented showed that there is a high standard of development in the field of combustion on both small and large scale for heating and cogeneration plants. Tours to two wood fired district heating plants were provided. The 1999 Fair will be held in Switzerland.

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