

## MINUTES

IEA Bioenergy Agreement  
Task 33: Thermal Gasification of Biomass  
Spring 2003, Task Meeting, May 28-30, 2003

**DTI Conference Center, London, UK**

Prepared by

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The fifth Task Meeting for the 2001-2003 triennium was held with assistance from Department of Trade and Industry (DTI) and Future Energy Solutions, AEAT. UK. The list of attendees, consisting of Task Members and invited speaker and observers for the first day seminar on Operating Experience with Biomass Gasifiers is shown in Attachment 1. The Agenda for the entire Task Meeting is shown in Attachment 2.

**Wednesday, May 28, 2003:** A one-day seminar on Operating Experience with Selected Biomass Gasifiers, both small-scale moving bed and large-scale high throughput gasifiers was organized with over 50 participants.

Based on the presentations and discussions at the seminar, a brief report on the Summary of Operating Experience with Recent Biomass Gasification (BMG) Demonstration Plants was prepared and enclosed as Attachment 3. Some of the invited presentations are posted on the Task website, under Task Meeting Minutes.

**Thursday, May 29, 2003:** Task Meeting

Attendees: Esa Kurkela, Nick Barker, Emanuele Scoditti, Martin Fock, Ulrik Christiansen, Mike Morris, Ruedi Buehler, Friedrich Lettner, Reinhard Rauch, Ronald Meijer, Suresh Babu, and Christian Aichernig (observer from Austria), Joseph MARTIN (observer from Belgium), and Baptiste BUXANT(observer from Belgium)

Members Unable to Attend: Rich Bain, Erik Winther, Henrik Christiansen, Kees Kwant, Kyriakos Maniatis, and Harry Knoef

The proposed Agenda was reviewed and approved.

The minutes from the Fall 2002 joint task meeting with GasNet was published by GasNet and was essentially made available to all participating members. However, GasNet has certain restrictions to permit posting the minutes on Task 33 website.

### Discussion of Subtask Studies and Schedules for Completion

1. Gas Cleaning for Moving-bed BMG Coupled to Gas Engines (Coordinator: Harry Knoef, BTG, NL with input from CH, DK, IT, FI, UK, and USA) – Joint Subtask study with GasNet.

Harry Knoef has recently forwarded a revised Technology Brief which will be posted on the Task website. The Task members are requested to review and send their comments, if any, to Harry with a copy to the Task Leader.

2. Gas Cleaning and Effluent Characterization for CFB and FB BMG (Coordinator: Esa Kurkela/Pekka Simell, VTT, Finland)

VTT will shortly publish the slip-stream hot-gas (tar) clean-up work that is being conducted at the Lahti co-firing plant. The final draft Technology Brief should be available for review and comments in October 2003. The Technology Brief will also include references for those who want to obtain complete information on published case studies etc.,

3. Toxicity of Waste Water Generated from Gasification of Woodchips (Coordinator: Henrik Christiansen, DEA and Martin Fock, dK Teknik, Denmark)

Martin Fock has forwarded the final report, prepared by Lund University under the sponsorship of the Danish Energy Agency, which is now posted on the Task website.

4. BMG to produce Synthesis Gas and Hydrogen or Hydrogen-rich Gas and Gas Utilization in High-temperature Fuel Cells and Gas Processing to Produce Liquid Fuels and Chemicals (Coordinator – Reinhard Rauch, TUV, Austria, Richard Bain, NREL, USA and Suresh Babu, GTI, USA) - Joint study with IEA Annex 16 : Hydrogen

A draft report on BMG FOR HYDROGEN PRODUCTION – PROCESS DESCRIPTION AND RESEARCH NEEDS, prepared by Suresh Babu was submitted to Annex 16. The report is posted on the Task website.

The draft Technology Brief on BMG to Produce Synthesis Gas for Fuel Cells, Liquid Fuels and Chemicals is posted on the Task website. The final report should be completed by the end of this year.

5. Tar Protocol (on-going multinational study, coordinated by Mr. John Neeft, ECN/NOVEM, NL with support from FI, DK, UK, and USA)

The final report from this subtask study that should be valuable in implementing standard procedures for characterizing and measuring tars in raw BMG product gases. Suresh Babu will contact John Neeft to determine and report the status of this subtask.

6. Review and update on Energy Conversion Devices (Coordinator, Emanuele Scoditti ENEA, IT and N. Barker, AEAT, UK)

The final draft was completed and posted on the Task website. Task members are requested to review and send their comments, if any, to Emanuele with a copy to the Task Leader so that the final report can be completed by the end of this year.

7. Fuelgas Co-firing, (Coordinator - Dr. Ronald Meijer, Kema, NL) - Joint study with Task 32,

## Biomass Combustion and Co-firing

The final draft Technology Brief was completed and posted on the Task website. A copy of the draft Technology Brief was forwarded to the Task 32: Biomass Combustion and Cofiring, Task Leader for review and comments. Task members are also requested to review and send their comments, if any, to Ronald with a copy to the Task Leader so that the final report can be completed by the end of this year.

8. Municipal Solid Waste / RDF Gasification and Energy Recovery – (Coordinator – Nick Barker, AEAT, UK ) - Joint study with Task 36, Energy from Integrated Solid Waste Management Systems and Techno-economic Assessment for Bioenergy Applications.

On behalf of Task 36 David Granatstein has completed a Case Study on Waste-Fueled Gasification Project Greve in Chianti, Italy, which is posted on the Task 33 website.

Following the three-task joint meeting, involving Task 32, 33, and 36 in Tokyo, Japan, from October 27-30, 2003 a joint report on energy recovery from wastes will be prepared and posted on the Task website.

9. Country Reports (Coordinator, Kees Kwant, NOVEM, NL) – Joint study with GasNet.

A report on BMG activities in all the participating countries of Task 33 and GasNet was recently completed and distributed to members of both groups. The report is posted on the Task website.

**Friday, May 30, 2003:** Task Meeting - contd.

10. Legislation Regarding Technical Issues, Emission and Effluent Limits, Safety, Permitting, and Financial Considerations (Coordinator: R. Buehler, U+E, CH) – Joint study with GasNet. After considerable discussion this particular subtask was revised to: Health, Safety, and Environmental Aspects of Small Scale BMG Systems, and the Coordinator and team will be selected from: CH/AT/UK/FI/BE. It was also decided that this subtask should be deferred to the next triennium.

## **METHODOLOGY FOR PERFORMING WORK DURING 2004-2006**

The group has also spent considerable amount of time discussing and developing the methodology for conducting subtask studies for the next triennium, 2004-2006. The Task as a whole selected the topics and agreed to initiate the subtask studies by organizing technical workshops, at the semi-annual Task meetings. Industrial and academic experts will be invited to participate in the workshop with Task members. Each subtask and the associated workshop will have a coordinator supported by a working team of 3 to 4 members. The presentations and discussion at the workshop will constitute the basic information and guidelines for the subtask studies. Reports resulting from these studies will be reviewed by the Task members, revised if necessary, and published to assist and aid private groups and government agencies interested in commercializing BMG. These reports should also be useful for national policy makers to identify the research needs for further development and advancement of BMG. Preliminary reports from the workshops will be published within 6 to 12 months from the workshop date and the final

reports will be published in Fall 2006. The following table lists the subtask studies, workshops, and schedules developed at the Spring 2003 Task meeting:

Meeting	Workshop/Subtask	Workshop Date & Location
Spring 2004	WS1: Short, medium and long term perspectives of biomass gasification technologies Coordinator and team to be selected from: SE/NL/UK/USA	May 5-7, 2004 (Proposed) * Austria *- May 10-14: 2 <sup>nd</sup> World BM Conference, Rome, Italy
Fall 2004	WS2: Co-firing Applications by Biomass and Waste gasification Coordinator and team to be selected from: FI/NL/UK/BE	Date: TBD Belgium or Finland
Spring 2005	WS3: Gas Cleaning & Gas Engines for Small-scale Applications Coordinator and team to be selected from: UK/Denmark/Belgium	Date: TBD Denmark or UK
Fall 2005	WS4: Health, Safety, and Environmental Aspects of Small Scale Systems Coordinator and team to be selected from: CH/AT/UK/FI/BE	Date: TBD UK (No. Ir)
Spring 2006	WS5: Hydrogen and Synthesis gas for Fuels and Chemicals (co-op. with Fossil Energy conversion people) Coordinator and team to be selected from: SE/NL/AT/IT/USA	Date: TBD USA or Sweden
TBD	WS7: Economic, environmental and legislative issues (WID, landfill directives, subsidies, green certificates etc)-Tentative	Date: TBD Location: TBD

The semi-annual Task meetings as proposed will last for three days; one day for the workshop, one day for conducting Task related matters, and the third day will be used for plant visits.

The methodology described above, the subtask topics, the coordinator and the working group for each subtask will be reviewed and finalized at the beginning of CY 2004, prior to initiating the activities for the next triennium.

Few members have stated the desire to seek nominal financial support from the Task for conducting subtask studies. It is reported that the European GasNet activity pays for such studies and these members asked Task 33 to make similar arrangements. The proposal approved for the current triennium (2001-2003) does not include any provision for financial support for conducting subtask studies. After taking this request under consideration, the Task Leader has revised the Task-continuation proposal, for the next triennium (2004-06), submitted to EXCO. The revised proposal has set aside a sum of \$10 to 15K per year to partially finance such subtask studies. The EXCO will consider this proposal at its next meeting from 27-31 October, 2003 in Campinas Brazil and provide their feed back to the Task Leader.

**Cooperation with Other Tasks:** Task 33 is in active cooperation with some of the IEA Bioenergy Tasks, IEA Annex 16 on hydrogen, and European GasNet. The joint subtask studies are identified above.

In addition to the joint subtask studies, Task 33 has conducted a joint Task Meeting with GasNet on Wed. October 2 and Thursday, October 3, 2002 in Strasbourg, France.

Task 33 is in the process of coordinating the organization of a joint Task Meeting October 27-30, 2003 in Tokyo, Japan with Task 32. Biomass Combustion and Co-firing and Task 36, Energy from Integrated Solid Waste Management Systems and Techno-economic Assessment.

A meeting was held in August 2003 with Mr. Gerard Closset, Coordinator of Annex XV, Black Liquor Gasification, to discuss and identify technology areas of common interest. Mr. Closset presented the mutually agreed proposal to collaborate in the area of gas cleanup and conditioning and the production of liquid fuels and chemicals from biomass-derived synthesis gas, at a meeting of Annex XV held in August 2003 in Sweden. The proposal was well received and approved by Annex XV. The proposed cooperation will be launched beginning CY 2004, subject to approval from the IEA Bioenergy Agreement, EXCO to continue Thermal Gasification of Biomass Task into the next triennium, 2004-06.

## **Attachment 2**

**IEA Bioenergy Agreement  
Task 33: Thermal Gasification of Biomass  
Spring 2003 Task Meeting  
DTI, London, UK  
AGENDA**

**9:30 AM, Wednesday, May 28, 2003**

Invited Industrial Presentations on Start-up and Operating Experience with Selected Biomass Gasification Plants

Welcome and Introduction- DTI Representative, UK  
Suresh Babu, GTI, Leader, Task 33

Small and Modular Biomass Gasification Systems, Moderator: Nick Barker

1. John Gilliland, Rural Energy
2. Rich Bain/Suresh Babu, NREL
3. Viking Demonstration Gasifier – Ulrik Henriksen (HFC et.al to provide details)
4. Biomass Engineering (Nick to provide details)

Q&A and Discussion

**12:30 PM – 1:30 PM LUNCH**

High Throughput Gasification Systems, Moderator, Esa Kurkela

1. Timo Eriksson, Foster Wheeler Energy Oy, Experience with process scale-up, shakedown, and operations
2. Challenges of Launching First-of-a-kind Demonstration Biomass Gasification Projects, Mr. Magnus Neergard, Consultant
3. Matthias Rudloff, Choren Industries GmbH, Unternehmensentwicklung, Carbo-V® Process Development and Operations
4. Mr. Christian Aichernig, Repotec Co., Shake down and Operation of the FICFB-gasifier in Guessing
5. Mr. Patrick Savat, LABORELEC (waiting for confirmation), Electrabel, Ruyen, Belgium Gasification Project Operating Experience

Q &A and Discussion

Wrap-up Summary – Moderators, Task 33 Members

**7 PM: Task Dinner including Invited Speakers – Location TBD**  
TBD – To be determined

**9:30 AM, Thursday, May 29, 2003**

Review and Approve Agenda

Review Minutes from Fall 2002 Task Meeting, held jointly with GasNet  
Presentations and Discussion of Subtask Studies and Schedule for completing and publication of  
Technology Briefs and Reports

Gas Cleaning and Effluent Characterization for CFB and FB Gasifiers - Esa Kurkela/Pekka  
Simell, VTT, Finland, Coordinator.

Emissions and Effluents, Process Waste Water from All Sources, Emissions Regulations,  
Permitting, Toxicology and Environmental Issues - Henrik Christiansen, DEA and Martin Fock,  
DK Teknik, Denmark, Coordinators

Biomass Gasification to produce Synthesis Gas and Hydrogen or Hydrogen-rich Gas and Gas  
Utilization in High-temperature Fuel Cells and Gas Processing to Produce Liquid Fuels and  
Chemicals - Reinhard Rauch, TUV, Austria, Richard Bain, NREL, USA and Suresh Babu, GTI,  
USA, Coordinators, Joint study with IEA Annex 16:H2

Health and Safety of Biomass Gasification Systems – Ruedi Buehler, Coordinator, Joint Study  
with GasNet

Tar Protocol - TBD

### **12:30 PM – 1:30 PM LUNCH**

Fuel Gas Co-firing, Ronald Meijer, Kema, NL, Coordinator - Joint study with Task 32, Biomass  
Combustion and Co-firing

Review and update on State-of-the-art Energy Conversion Devices, E. Scoditti ENEA, IT and N.  
Barker, AEAT, UK, Coordinators

Municipal Solid Waste / RDF Gasification and Energy Recovery – Nick Barker, AEAT, UK,  
Coordinator (Joint study with Task 36, Energy from Integrated Solid Waste Management  
Systems and Techno-economic Assessment for Bioenergy Applications)

Legislation Regarding Technical Issues, Emission and Effluent Limits, Safety, Permitting, and  
Financial Considerations, R. Buehler, U+E, CH, Coordinator – Joint study with GasNet.

Feedback from EXCO51 Meeting (30 April to 1 May, 2003) in Sydney, Australia- Suresh Babu

### **9:30 AM, Friday, May 30, 2003**

Country Reports – Kees Kwant, NOVEM, NL, Coordinato/SPBr – Joint study with GasNet.

### **Proposed Program of Work for 2004-2006** (To be selected from the following topics)

1. Case histories of selected biomass gasification projects to document technical and non-  
technical hurdles encountered and overcome. Such case histories should shed additional light on

developing strategies for resolving technical as well as non-technical hurdles (ex: financing and seeking permits for new biomass gasification projects.) – AEAT\*

2. Review of integration of selected process system components in chemical industries, refineries and clean coal technology projects:

Task members will select the critical system integration issues. Some examples are given below:

- gasifier with gas upgrading (tar decomposition, particulate removal, heat recovery) – TPS\*
- raw gas scrubbing, handling, compression and gas processing (water-gas shift, hydrogen production) – NREL\*
- fuel gas and prime mover (gas engines and turbines) – DEA\*
- synthesis gas conversion to co- products/fuels/chemicals /power (polygeneration) – TUV\*
- co-utilization with natural gas – GTI\*
- water recycle, waste water treatment, and effluent disposal – ENEA\*, DEA\*

### **12:30 PM – 1:30 PM LUNCH**

3. Research and technology development needs with focus on gas handling and clean-up (inc. tars and other contaminants) – VTT\*, GTI\*
4. Country Reports – NOVEM\* (jointly with GasNet)
5. Biomass gasification data book (compilation of basic design information) – GTI\*, EC\*
6. Synthesis Gas from Biomass – TUV\*, NREL\*, & GTI\*
  - Methanol
  - DME
  - Fischer-Tropsch Liquid Fuels
  - Ammonia
7. Hydrogen – rich Gas for Fuel Cells, Hydrogen
8. Compilation of existing and impending regulations, carbon taxes, and renewable portfolio standards – U+E\*
9. Update and maintain the Task 33 Thermal Gasification of Biomass website – GTI\*
10. Co-operation with Related Bioenergy Tasks – GasNet, Task 32, Annex 16 on H2 – U+E\*, TUV\*, and GTI\*

### **Future Meetings**

Fall 2003 – Oct. 27 to 30, 2003, Joint Meeting with Tasks 32 and 36, Yokohama (subsequently changed to Tokyo), Japan

### **Next Triennium**

Format, Minutes, Reports, Industry Participation, Special Topics, Meeting Dates, and Locations

OPEN

3 PM to 4 PM - Action Items/Wrap-up

\* - Proposed Coordinators

# ATTACHMENT 3

## Summary of Operating Experience with Recent Biomass Gasification Demonstration Plants

### FEED AND SOLIDS HANDLING

- The capacity of feed storage system should be sufficient for a two-day continuous operation. This will permit operation of the system while fixing any unexpected problems with the feed dryer, or any other feed handling equipment and also to cover operations over weekends and short holidays.
- Carryover of dirt and rock with feed material hinders solids flow and may produce sparks leading to explosions.
- The presence of oversize biomass materials may cause jamming of rotary valves.
- For biomass feed bins, ultrasonic or radioactive level detectors are preferable compared to instruments that protrude into feed vessels and may obstruct solids flow.
- Condensation of moisture in feed silos may lead to solids sticking to the walls. Therefore, care must be taken to prevent any condensables from flowing into the feed bin.
- Co-feeding biomass and make-up inert solids or tar cracking media to BFB or CFB gasifiers may interfere with smooth flow of biomass into the gasifier. Therefore, separate solids feeders are advisable. Any hold-up of solids in the gasifier feed screw will lead to pyrolysis of the trapped solids ultimately leading to plant shutdown.
- System design to purge air from feed-bins must be designed to avoid complications due to dust explosion and to prevent condensation of fuel moisture.
- For overall plant safety, reliable shut-off should be provided to isolate the feed bin from the gasifier.

### REFRACTORY INSTALLATION

- Selection and sequential installation, curing, and firing of gasifier refractories is important. Although the high-alumina refractories are wear resistant, they are prone to cracking. This could be a problem when the gasifier is subject to unscheduled temperature excursions, particularly during the start-up phase of a new gasification plant.
- Formation of alkali-silicates lead to expansion of refractories. This should be taken into consideration by proper scheduling of construction, curing, and finishing the refractory lining work.

### PLANT START-UP AND GASIFICATION

- Installation of an over designed start-up heater may have several benefits, including adequate capacity to heat the entire gasification system above condensation temperature prior to initiation of gasification with in a reasonable period of time.
- Surplus start-up heater capacity facilitates adding additional downstream gas clean-up or processing equipment.
- Gasifiers with access to steam could effectively use steam to control rising gasifier temperatures.
- Increasing gasification temperature reduces the amount of tars produced but the relative amount of heavy tars increase. The result is a loss in cold gas thermal efficiency.

- Proper recirculation of carbon containing carry-over solids is critical to improve operational reliability and achieving carbon conversion in gasifiers.
- The gasifier and other ash/solids discharge valves often wear with service and hence, they should be checked for effective sealing before each test campaign..
- In general, it is advisable to design the ash discharge system with contingent capacity to discharge solids if required at higher rates.
- In general, dolomitic and other active solids systems work well for reducing tar content in product gases. However, it is desirable to learn more about the effective longevity of these solids in extended commercial operations. This may also shed light on the need for supplementary tar cracking to meet performance targets.
- Many important lessons were learnt during the design and operation of gas coolers in high throughput gasifiers. The design of gas coolers for biomass gasifiers operating with tar crackers employing a variety of tar decomposition solid materials are not paid the attention they deserve. Design and operating experience with related gas coolers in the chemical processing industry may be helpful in preventing blockage of heat exchanger tubes.

#### RAW GAS HANDLING

- Recent biomass gasification demonstration plants have tested a variety of bag filters and candle filters for dust removal. Solids bridging is not a problem with bag filters and in addition they operate with low pressure drops. However, dust may escape because of the difficulty with leak-proof mounting of bags.
- A major concern with candle filters is the build-up and retention of dust between filter elements which cause undue destructive forces during the back-flush pulsing cycles.
- Sintered metals are stronger and operate with lower pressure drop compared to ceramic filters. However, further development and improvement in structural integrity of ceramic filters may provide the low-cost option.
- The operating experience with both high-temperature and low-temperature (liquid scrubbing) gas cooling in biomass gasification processes is limited. Long duration tests are essential to understand the fate of fugitive contaminants and the effectiveness of liquid treatment and recycle, to mention a few critical issues.
- Both start-up and shut-down operating procedures should ensure that oxygen is purged from downstream equipment, particularly the bag filters or candle filter assemblies to avoid any fires. As a matter of fact it is important to pay attention to the varying environment in all components of the system which will be handling flammable gas mixtures even when the plant is in stand-by mode.
- Of the different types of air compressors used in gasification plants, it was found that the piston type compressors presented many operational problems.

#### INSTRUMENTATION AND CONTROLS

- In contrast to biomass combustors, biomass gasification is more difficult to operate and requires more sophisticated instrumentation and controls. It is absolutely necessary for the people designing control system to understand the gasification process and related process steps, and to work in collaboration with process developers to design and implement a safe and reliable operating system. The optimization of the instrumentation and control system could be attempted after satisfactorily demonstrating the operational reliability of the entire system.