

IEA Task 33  
Task Meeting, Fall 2009  
Breda, The Netherlands  
November 2-5, 2009

## **Work Shop Summary**

# **Operating Experience with Biomass Gasifiers: R&D needs to improve gasification plant operation**

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# BIOMASS GASIFICATION

## Commerical technology?

Rich Baines, NREL

*”3 commercial units operating for 5 years  
i.e. 120 000 hours of track record”.*

Kasper Lundtorp, Baccokc-Völund

*”10 plant 10 years operation”*

# BIOMASS GASIFICATION: FB

## Downdrafts

- Numerous, (*none named, hence none forgotten*)

## Updrafts (examples only)

- Babcock-Völund: Harboöre 13 years, of which CHP 9 years.  
Ansager 2 years
- JFE Japan (Babcock-Völund) Yamagata, Ishigawa, Daio, 2-3 years
- Nexterra Tolko 3 years+ others
- Bioneer Kauhajoki, Kankanpää, Vilhelmina, Byggelit >10 years each
- Metso: Kauhajoki, 2 years, Viitasaari, 1 year
- Kokemäki approx. 1 year, CHP 2 000 hr?
- Others e.g. Plasco (< 1 000 hours)

# BIOMASS GASIFICATION: Indirect gasifiers

## Dual beds (examples only)

- Gussing 6 years
- Oberwart < 1 year
- Villach
- Burlington and varieties by Silvagas and Taylor Bioenergy
- Waste fuel projects in Japan in the 70's and 80's

## Others

- TU Graz/Agnion Heat pipe
- WoodRoll
- RangeFuels
- other

# BIOMASS GASIFICATION BFB

(examples only)

- Oulu HTW 1-2 years ?
- Corenso 10 years
- Skive 4 000 hours
- Hawaii
- Biosyn
- Energy Products of Idaho years
- Enerkem 1 000 hrs
- Others e.g. Norampac, MTCI

Co-gasification (examples only)

- Tampella tests

# BIOMASS GASIFICATION CFB

(examples only)

- Värö 20 years
- Pöls 3-5 years
- Essent/Amer9 3-4 years
- Greve in Chianti 10 years
- Arbre
- Pietersaari 15-20 years
- Norrsundet 20 years
- Karlsborg 15 years
- Varkaus 1 years
- Portocell 10 years.
- Lahti 10 years
- Ruien > 5 years
- Värnamo 7 000 hrs
- HoST 2-3 years?

# BIOMASS GASIFICATION: EF

## Direct biomass (examples only)

- Chemrec DP1 1 year
- Chemrec New Bern 10 years
- BioLiq
- Choren
- WoodRoll
- Others

## Co-gasification

- Elcogas      10 years      co-gasification 1000 hrs
- Nuon        8 years        co-gasification 3 years

# BIOMASS GASIFICATION: Pressurised

- Oulu FB
- Karhula CFB
- Värnamo CFB
- Tampella BFB
- ReNugas BFB
- GTI Flexfuel BFB
- Choren beta plant EF
- Chemrec EF
- TU Graz/Agnion BFB
- Enerkem
- others

# BIOMASS GASIFICATION: Optimisation

## Availability, efficiency, investment cost, O&M cost

### Fuel

- Fuel quality, quality assurance
- Fuel pretreatment, milling, drying, other
- Fuel flexibility and variations

### Fuel feeding

- In relation to fuel quality and flexibility
- Inert gas usage

# BIOMASS GASIFICATION: Optimisation

Availability, efficiency, investment cost, O&M cost

## Efficiency (*"best use of limited resources"*)

- Oxygen production
- "Pinching", use of energy at appropriate temperature level,
- Drying
- Fouling and "safe" temperature regimes
- Combinations with waste, indirect co-firing, Waste-boost

## Gasification

- Ash properties
- Fuel quality variations, fuel flexibility

# BIOMASS GASIFICATION: Optimisation

## Availability, efficiency, investment cost, O&M cost

### Gas cleaning

- Contaminants: tar, ammonia, Cl, S, HM etc.  
range from % to ppb
- Gas cleaning, thermal, catalytic
- Scrubbers and scrubber solvents
- Fouling of heat exchangers
- Filtration ( "filter tests", "filter crisis")

### Life time cost issues

- Material aspects (corrosion, hydrogen diffusion)
- Refractories,

# BIOMASS GASIFICATION: Optimisation

Availability, efficiency, investment cost, O&M cost

**Emissions, residues**

- Emissions, in particular from motors.
- Waste legislation
- Additives and sorbents
- Ash properties and disposal
- Tar/water residues,
- Water net usage
- Overall engineering aspects of the complete system

**System aspects**

- Overall engineering and integration issues
- System controls
- Maintaining gasifier running (flaring, dual feed systems, surge volumes etc.)
- Nuisances for neighbours, noise, odour etc.

# BIOMASS GASIFICATION: R&D

Fuel quality, fuel pretreatment (drying), quality assurance

- Fuel characterisation is a good starting point
- Two avenues: standardised fuels (e.g. pellets, RDF etc.)  
niche fuels ( agrowaste, bagasse etc.)

Fuel feeding

- Pressurised feeding
- "Difficult fuels"

Gas cleaning incl. for waste applications

- Catalyst development for tar etc.
- New traditional catalyst systems e.g. WGS
- Filtration including use of sorbents
- Scrubbing

# BIOMASS GASIFICATION: R&D

## Gas cleaning contd.

- "Deep cleaning" to ppb:s
- Analytical procedures compatible with requirements
- Process supervision with regard to contaminants

## Ashes and residues

- Ash "beneficiation", recycling
- Waste liquids
- Emissions in particular for engines

## End uses

- Motors, gas turbines
- New applications for CHP (FC, Stirling)
- Chemical synthesis

# BIOMASS GASIFICATION: To go forward

## Other issues

- Permitting, in particular when combining with wastes
- Lack of references for BAT. ( incl. requirements Industrial Emissions Directive for large installations)
- Public acceptance

## Project development and execution

- Client expectation and credibility
- "Project stability", partnerships, industrial partner, fuel availability, product value, host installations
- Risk management
- Extended commissioning periods
- Capacity building, operators, engineering staff

## Last but not least: Support and funding

# BIOMASS GASIFICATION: Acceleration of R&D

Integration as side activity in operating plants

- Lahti slip-stream test
- Värö slip-stream tests
- Chemrec downstream units
- Gussing side streams at 0.06 €/Nm<sup>3</sup>
- Chalmers CFB heating boiler

*More plants, potentially more acceleration*

**Sidestream applications:** Pyrolysis, FT, SNG, MeOH, mixed alcohols, DME, FC, gas cleaning



**GAME OVER  
TRY AGAIN**

# BIOMASS GASIFICATION:

## Summing up

Fuel gas and indirect co-firing, limited gas cleaning

- Many years of operational experience with mainly FB and CFB, some BFB

**years**

Including gas cleaning for e.g. ICE and/or gas turbines

- Reasonably long experience, mainly with FB and Indirect Gasifiers, some CFB.

**1000 hours-years**

Including extensive gas cleaning for synthesis purpose

- Pilot and other development units up to 1 MW

**< 1 000 hrs.**

# BIOMASS GASIFICATION: Summing up

