PYROLYSIS Activities in Germany

IEA BIOENERGY Task 34 - Pyrolysis
15 September, 2009, Sheraton Chicago Hotel & Towers

Dietrich Meier
Status of Pyrolysis Activities in Germany

- Pyrolysis for syngas => Diesel, DME
  - CHOREN
  - BIOLIQ (FZK)

- Pyrolysis for liquid => Power/Heat
  - PYTEC
  - Haloclean
  - PYREG

- High pressure liquefaction
  - IBH Engineering
On **31.1.1990**, 4 employees at the ORGREB Institute for Power Stations took the plunge into self-employed, setting up a company called Umwelt- und Energietechnik Freiberg (UET) GmbH, the current CHOREN Technologies GmbH.

The portfolio of the young company included process technology for steam fluidized bed drying, analyses services for optimizing power station plant sand many other energy processes. A **1992** order to evaluate a gasification process for waste products marked a turning point in the further development of the company. From that time on, the UET engineers concentrated on refining and gasifying organic raw materials for energy purposes.

By 1993 the company was already applying for the first patents in this field. The company changed direction. A joint venture between UET and a mechanical engineering company in the state of Lower Saxony led to the formation of CRG Kohlenstoffrecycling Ges. mbH. It was the forerunner of CHOREN. The company’s declared aim was to make significant improvements in using biomass for energy purposes through gasifying and refining. The Carbo-V Process opened up an enormous opportunity. **A new idea was born: putting "the Sun into your fuel tank"!**
The construction and start-up of a 1MWth Carbo-V pilot plant (Alpha Plant) in Freiberg in 1998 marked an important milestone. The process was then thoroughly tested. Our engineers successfully experimented with a wide variety of feedstock including untreated wood, various types of recycled lumbar, what is known as “dry stabilate” from waste processing, meat and bone meal, black coal and lignite.

By the end of 2004, the plant had been operating successfully for more than 22,500 hours. In 1997 CRG and key UET managers acquired the workshops of the German Fuel Institute. They were then able to bring on board important expertise for manufacturing core equipment for various types of gasification technology from within their own group of companies. The company now responsible is called TAF, Thermische Apparate Freiberg GmbH, the current CHOREN Components GmbH. CRG later changed its name to CHOREN Industries GmbH to reflect its new fields of business and was by then in a position to manage the complete value chain from idea conception through to production processes.
In 2001 the company demonstrated that it was possible to convert biomass into a raw Fischer-Tropsch product, even though initial amounts were very small.

A 150 kW gas engine also successfully ran on Carbo-V gas for 600 hours. Other developments followed rapidly. In November 2002 the foundation stone was laid for the construction of the first industrial-scale Carbo-V prototype plant (with an capacity of 45 MWth) for refining biomass (char production plant) at the Freiberg site. The construction work took only 10 months and the plant (Beta Plant) went into operation in September 2003.

The Alpha Plant was expanded to include an automotive fuel synthesis facility. As a result, CHOREN was able to produce the first synthetic automotive fuel from wood chips in April 2003. This took place within a combined research project sponsored by the German Federal Ministry of Economics and Labor. Our cooperation partners DaimlerChrysler AG and Volkswagen AG also joined the project.
CHOREN now has extensive know-how in gasifying biomass and manufacturing synthetic automotive fuels. The many years of development work are now starting to bear fruit. CHOREN has positioned itself as a future producer of renewable synthetic automotive fuels and for this purpose has established project companies such as CHOREN Fuel Freiberg GmbH & Co. KG currently in the process of building the first scale up production facility.

The building phase of World’s First Commercial Synthetic Biofuel Production Plant has been successfully completed in April 2008. An important phase now follows - the commissioning of the plant, which will result in production of up to 18 million litres of BTL. The commissioning will take place in stages over several months. 113 sub-systems in 26 main operating units will be put into operation individually and then consequetively. But it is not only the company’s goals that have grown. The number of personnel has increased too. The number of employees in the CHOREN Group passed the 230 mark in early 2008.
...Currently the world’s first commercial BTL production plant, the so called Beta plant, is starting up in Freiberg. The production of synthesis gas is due to start in autumn of this year. Fuel production with an annual capacity of 15,000 t of BTL is scheduled to begin in early 2010...
With a targeted production output of 1 million t/a, CHOREN intends to capture a considerable share of the future market for renewable synthetic biofuels. **Five large-scale industrial production units, each with an annual production of 200,000 t/a, will be built in Germany** and at the same time the Carbo-V Process will be commercialized for use in combined heat and power plants.
Institute of Wood Technology and Wood Biology (HTB)

CHOREN Industries sundiesel® (8000 kg/h)
CHOREN - Alpha plant (operational since 2003)
CHOREN Alpha Plant

- 1 MW thermal
- 200 tpa BTL
- 1,000 tpa biomass

Institute of Wood Technology and Wood Biology (HTB)
CHOREN - Beta plant
CHOREN Beta Plant 2008

- 1 Biomass conditioning
- 2 Biomass storage
- 3 Biomass dryer
- 4 Carbo-V® gasifier
- 5 Power station
- 6 Gas conditioning & Fischer-Tropsch synthesis
- 7 Compressor building
- 8 Storage for offsite & utility gases

- 45 MW thermal
- 65,000 tDM/a feedstock
- 18 Million Liter BTL
CHOREN Pyrolyzer

Institute of Wood Technology and Wood Biology (HTB)
CHOREN Hight Temperature Gasifier with Tar Oxidation and Endothermic Quench
CHOREN Scale-up Beta=>Sigma

**BETA:** 45 MW = 1 NTV 30 MW + 1 NTV 15 MW

**SIGMA:** 640 MW = 4 x 4 = 16 NTV 40 MW

Scale-up factor: 1,33

**BETA:** 45 MW = 1 HTV 45 MW

**SIGMA:** 640 MW = 4 x 1 = 4 HTV 160 MW

Scale-up factor: 3,55
### CHOREN Sigma 1 planned

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>Fuel production BTL</strong></td>
<td>200,000 t/a equals 5,000 BOPD equals 270 million litres</td>
</tr>
<tr>
<td><strong>Gasification capacity</strong></td>
<td>4 x 160 MW_{th} parallel operation = 640 MW_{t}</td>
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<tr>
<td><strong>Biomass demand</strong></td>
<td>approx. 1 million t_{dry}/a</td>
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<tr>
<td>- Integration of biogas and bio-oil possible</td>
<td></td>
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<tr>
<td>- Turnover from biomass supply</td>
<td>60 – 80 million €/a</td>
</tr>
<tr>
<td><strong>Area required for the facility</strong></td>
<td>32 ha, expansion area available</td>
</tr>
<tr>
<td>- Production plant</td>
<td>11 ha</td>
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<tr>
<td>- Biomass store</td>
<td>9 up to 27 ha</td>
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<tr>
<td>- Tank farm and peripheric systems:</td>
<td>6 up to 12 ha</td>
</tr>
<tr>
<td><strong>Employment (primary)</strong></td>
<td>850</td>
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<tr>
<td>- Biomass supply</td>
<td>600 up to 700</td>
</tr>
<tr>
<td>- Production</td>
<td>200</td>
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<tr>
<td><strong>Investment</strong></td>
<td>&gt; 800 million €</td>
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<tr>
<td><strong>Reduction of greenhouse gas emissions</strong></td>
<td>650,000 t CO₂ / a</td>
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Bioliq® Process, FZK (500 kg/h)

Involving Partners
- FZK
- Lurgi

Status
- Test phase of pyrolysis plant
Bioliq Plant Construction
D.M.2 (Blue Tower Herten), 200 kg/h

Involved Partners
- H2NRW
- D.M.2

Status
- Test phase
- New project with 2600 kg/h

Institute of Wood Technology and Wood Biology (HTB)
BTO® Process pilot plant (250 kg/h)

Involved Partners
• PYTEC
• TEC
• vTI
• Universities

Status
• Optimization tests
  • Pyrolysis plant
  • Diesel engine
• Malliβ Project ongoing (48 tpd)
Haloclean® for Electronic Waste and Biomass

- In and output of pieces of material, grinding not necessary (optimal water content 5 – 20 %)
- Continuous residence time variation by means of internal conveyor screw
- Preheated steel spheres for
  - improved heat input & transfer
  - self cleaning
- Temperature range 300° to 550 °C depending on feed materials
- Particle free liquids and gases realised through hot gas filtration
- Dry residues (char) obtained
Haloclean® (50 kg/h)

- Flexible feed stock (different biomass, shapes and mixtures of those)
- High quality pyrolysis products and variable yields of products
- Economic plant size at 12,000 t/a – 20,000 t/a
PYREG for Sewage Sludge (40 kg/h)
<table>
<thead>
<tr>
<th><strong>Standort:</strong></th>
<th>Kläranlage des Abwasserzweckverband untere Selz (AVUS) Ingelheim</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Genehmigungsbehörde:</strong></td>
<td>SGD-Süd, nach §54 LWG (17. BlmSchV)</td>
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<tr>
<td><strong>Thermische Leistung:</strong></td>
<td>ca. 100 kWth</td>
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<tr>
<td><strong>Durchsatz:</strong></td>
<td>ca. 40 kg/h (TS), bzw. ca. 300 t/a (TS)</td>
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<td><strong>Entsorgungsleistung:</strong></td>
<td>15.000 EW</td>
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HP DoS® Process (50 kg/h)

Involved Partners
- IBH Engineering GmbH
- Technische Werke Ludwigshafen AG (TWL)
- Univ. Appl. Sci., Hamburg (Prof. Willner)

Status
- Test phase