NEW 2 MW GASIFICATION PILOT PLANT AT CB2G

5th International Freiberg Conference on IGCC and XtL Technologies, 21-24 May 2012, Leipzig, Germany
The development of 2nd generation biofuels is important to reach the target of 10% transportation fuels substitution with renewable fuels by 2020 (Directive 2009/28).

Currently 2nd generation biofuel production technologies are mostly in the development phase.

As stated in the European Strategic Energy Technology Plan (SET Plan 2010-2020), it is necessary to continue to commit to R&D at pilot and demonstration scale. This is the motive for the creation of “Second Generation Biofuel Centre” (CB2G) located in Navarre (Spain).

The CB2G is a platform open to the scientific community and national and international industry.
The general objective of the Second Generation Biofuel Centre is to have **Process Development Units (PDUs)** to produce 2nd generation biofuels on a pilot scale level as an intermediate step towards the industrial scale-up of these technologies and as a biorefinery test platform. The CB2G will constitute an integrated trial and demonstration platform designed to develop process, equipment and specific components, new biofuels and to apply bio-refinery concepts to biofuels production processes.
Phases:

1\textsuperscript{st} Phase: **Finished**
- Civil works and office building.
- Pretreatment Unit, Torrefaction Pilot Plant and Auxiliaries.

2\textsuperscript{nd} Phase: **2012**
- Gasification Unit. \rightarrow 2\textsuperscript{nd} quarter.
- Biochemical Process Unit. \rightarrow 4\textsuperscript{th} quarter.
## Pretreatment Unit

<table>
<thead>
<tr>
<th>Chipping and chopping area</th>
<th>Rotary drier</th>
<th>Milling area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelletizing area</td>
<td>Pellet mill</td>
<td>Reception area and storage</td>
</tr>
</tbody>
</table>
Torrefaction Pilot Plant

Torrefaction system

Biomass feeding system

Torrefaction reactor

Thermal oxidizer

Cooling screw

Boiler and thermal fluid circuit
Biochemical Process Unit

This unit includes enzymatic hydrolysis and fermentation.

This unit is under construction and assembly of equipment.
The gasification unit is a pilot plant with a nominal power of 2 MWt capable of generating a fuel gas suitable for the following cleaning and synthesis processes of 2nd generation biofuels.

The gasification unit is designed to work with a wide range of biomass, with bulk densities between 80 and 800 kg/m$^3$ and moisture content below 20%.

The gasification unit is based on the technology of atmospheric bubbling fluidized bed (ABFB) with two operating modes: using air as gasifying agent or using steam/oxygen as gasifying agent.

**The gasification unit is on commissioning phase.**
Gasification Unit

Process data and main characteristics:

- Reactor type: bubbling fluidized bed
- Nominal power: 2 MWt
- Minimum power: 60% nominal
- Operating pressure: 0.3 barg
- Bed temperature: 650-950°C
- Freeboard temperature: 700-1000°C
- Operating modes:
  - Air gasification
  - Steam-oxygen gasification
    - O2/biomass ratio <0.6 kg/kg daf
    - Steam/biomass ratio <1.2 kg/kg daf

- Biomass: wide range
  - Bulk density: 80-800 kg/m³
  - Moisture content < 20%
  - Size < 30 mm
  - Volatiles: 68-87% daf
  - Ash < 13% base seca
  - LHV: 16.1-20.6 MJ/kg

- Bed materials and additives: wide range
  - Bulk density: 1000-5000 kg/m³
  - Size < 1 mm

- Inertization and purge gas: CO₂
Gasification Unit

This unit will be devoted to:

- Optimization of the gasification process mainly through testing bed materials and additives to improve in bed tar conversion and to reduce ash sintering.
- Develop hot and cold gas cleaning processes for syngas. Plant layout has been carefully designed to facilitate the possibility to test hot and cold gas cleaning equipment on site with real syngas using slip streams from the main gas stream.

The gasification unit is a pilot plant available for testing catalysts/bed materials and to develop different cleaning processes for syngas.
General view of the Gasification Unit

- Gasification island
- Refracted pipe
- Syngas combustion and flue gas cleaning
Gasification Unit

The plant includes the following systems:

- Biomass feeding system
- Bed material and additives feeding system
- ABFB Gasifier
- Cyclone and discharge system
- Bed discharge system
- Start-up combustion chamber
- Syngas combustion system
- Flue gas cooling and cleaning system

Auxiliaries:

- Steam generation
- Oxygen supply
- Carbon dioxide supply
- Compressed air supply
- Cooling water supply
- Natural gas supply
- Distributed control system for remote and automatic operation (SCADA)
Process Flow Diagram of Gasification Unit
Gasification Unit

Daily hopper of biomass (50 m$^3$)
Gasification Unit

Weighting hopper (6 m³) and feeding line to the ABFB gasifier
Gasification Unit

Gasification island and ABFB gasifier
Gasification Unit

Syngas combustion and flue gas cleaning
Results of the first hot tests: Gasification with air

- **Biomass feedstock:** Wood chips (size < 30 mm)

<table>
<thead>
<tr>
<th></th>
<th>% daf</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>48,2</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>6,3</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>0,1</td>
<td></td>
</tr>
<tr>
<td>LHV</td>
<td>18,0 MJ/kg daf</td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td>0,9 % base seca</td>
<td></td>
</tr>
<tr>
<td>Moisture content</td>
<td>16,4 %</td>
<td></td>
</tr>
<tr>
<td>Bulk density</td>
<td>230 kg/m³</td>
<td></td>
</tr>
</tbody>
</table>

- **Bed material:** Bauxite (size < 1 mm and bulk density = 1,830 kg/m³)
Results of the first hot tests: Gasification with air

- Heating of the plant for 10 hours (starting from cold conditions).
- Gasification with air for 2 hours.
- The syngas is burned in the combustion chamber without visible smoke (temperature = 800 – 850°C).

Biomass → Air → GASIFICATION (ABFB gasifier) → Syngas

360 kg/h

ER = 0.35

Bed temperature = 700 – 900°C
Thermal power = 1.5 MWt (75% nominal)
Results of the first hot tests: Gasification with air
Gasification Unit: Next steps

In the next weeks, we will do the following gasification tests:

- Performance test: Gasification with air at full load (2 MWt) for 8 hours and gasification with oxygen-steam for 4 hours using wood chips as feedstock.

- Guarantee test: Gasification with air at full load (2 MWt) for 50 hours using wood chips as feedstock.
Thank so much for your attention

The construction of the plant has been financed by the Government of Navarre (Navarre Plan 2012) and by the Spanish Ministry of Science and Innovation (National Programme for Scientific-Technological Infrastructures).