SOLID HTC BIOFUEL from Hydrothermal Carbonisation

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Introduction

Ingelia SL, a company located in Valencia, is dedicated to sustainable energy systems. In 2006 Ingelia started development of an innovative solution for organic waste processing at the district of Nàquera (Valencia). The biomass to treat was: pruning in urban areas, forest and agriculture.

During 2006 Prof. M. Antonietti from the Max Planck Institute – Colloids and Interfaces in Potsdam published the Hydro Thermal Carbonisation Process as an option for biomass transformation. Ingelia was interested in the HTC process, developed its own technology and implanted a prototype plant in Náquera. Since August 2010 Ingelia operates one of the first plants for biomass treatment by Hydrothermal Carbonisation (HTC) in continuous process.
Hydrothermal Carbonization Process
Technology background

- First publications about the Hydrothermal Carbonisation Process were made by Friedrich Bergius in 1913.
- Almost a century later Prof. Dr. Markus Antonietti detected its significance for biomass treatment and reduction of CO2 emission.
- Currently, Ingelia maintains a scientific cooperation with the Instituto de Tecnología Química (ITQ) of the Universidad Politecnica de Valencia, headed by Prof. Dr. Avelino Corma (CSIC).
- The HTC process dehydrates carbohydrates under high temperature, pressure and acid conditions within relatively short time (4-16 hours), see Figure 3 and 4. The great advantage of this process is that it takes place in a water solution, so humidity of biomass is not a problem.
Ingelia's HTC Project

After several years of development and engineering, the prototype plant in Nàquera was constructed from September 2009 to June 2010. The commissioning of the plant took place between June 2010 and August 2010. Since September 2010 the plant is operating and testing different types of biomass and process parameters.

**HTC parameters:** temperature range: 180-220°C, pressure range: 17-24 bar.
Yearly capacity of biomass treatment in actual Nàquera plant: 1100 tn

Ingelia has developed a unique Pressure and Temperature Control System and Inverted Flow Reactor and is holding patents on this technology.
Sustainability of HTC process

HTC

Agriculture

Forest

Urban

CO₂

Liquid Fertilizer

Carbon energy

Bio-chemicals

Hydrothermal Carbonization Plant

Sludge

Sustainability of HTC process
Ingelia’s HTC Proprietary Technology

- **Proven technology** - the plant has been working since August 2010 in Valencia - Spain
- **Efficient design** to minimize Capex, operation and maintenance costs:
  - The plant works in continuum
  - No mobile parts or heat exchangers in the reactor
- **Integrated and automated plant control** including remote control system that guarantees 24/7 surveillance from our specialists
- **Modular technology** allowing:
  - Operational flexibility
  - Operational security – if one line fails the rest will work
  - Possibility of a modular expansion
- **Self sufficient** in water, very low electricity requirements
- **Low emission** technology, odor free, and highly silent operation
Bio-coal properties

High density energy carrier: Concentrates energy from biomass, HCV: >24 MJ/kg

Coal pellets briquettes, dust

1Tm bio-coal retains about 2.2 Tm of CO₂ emissions from atmosphere

Plants economically feasible from 6,000 Tm/year up

Plants placed near biomass source

Decentralized biomass conversion

Logistics: Coal pellets are water resistant

Post treatment: Standard technology Easy to make pellets
Biocoal offers several advantages compared with biomass

**Logistic cost**

- Significant **higher energy density** (~23 Gigajoules/Mt3) reduces unit energy transportation cost
- Biocoal Pellet is **hydrophobic**, which is key for storage

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCV*</td>
<td>&gt; 24 MJ/kg</td>
</tr>
<tr>
<td>Carbon (C)*</td>
<td>&gt; 60% *</td>
</tr>
<tr>
<td>Hydrogen (H)*</td>
<td>5.8-6.2% *</td>
</tr>
<tr>
<td>Nitrogen (N)*</td>
<td>0.6-1.4% *</td>
</tr>
<tr>
<td>Sulphur (S)*</td>
<td>&lt;0.3%</td>
</tr>
<tr>
<td>Chlorine (Cl)*</td>
<td>&lt;0.3%</td>
</tr>
<tr>
<td>Fusion point of ashes in oxidizing atmosphere</td>
<td>&gt; 1250°C</td>
</tr>
<tr>
<td>Bulk density</td>
<td>950 kg/m3</td>
</tr>
</tbody>
</table>

**Combustion**

- Burning biocoal significantly reduces the needs for boilers and ancillary **equipment retrofit**
- HTC biocoal is particularly **low in alkali and sulfur** so it minimizes the corrosion and clogging problems associated with burning biomass
- HTC Pellets comes with 8% humidity, so it enhances the lower **calorific value** when compared with high water content biomass
Biochemicals

Ingelia's HTC process allows to extract biochemicals from certain type of biomass:

Pine wood: Tall Oil, ...

Orange peel:

- Internal standard
- Orange oil

Identification by GC-MS:

- Limonene
- Terpinolene
- Gamma-terpinene
- Cymene
- Alfa-terpinene

Distillation
Water supply - Liquid fertilizer

- Ingelia’s HTC plants are **self-sufficient in terms of water supply**. Water extracted from biomass humidity supplies required water for the process.
- **Excess of process output water** is being studied for application as a fertilizer in plantations.
- Currently Ingelia makes a trial in collaboration with a semi-public R&D institution about the effects of HTC liquid fertilizer in agriculture and other plantations.
Collaboration, Partners, Service

• Ingelia collaborates with different external R&D institutions in order to develop HTC technology and products.

• Ingelia offers Partnership in order to develop HTC technology for different applications, products and sectors.

• Implantation of Pilotplants for Demonstration Projects.

• Ingelia obtained Ulysses Award 2011 of UNWTO for sustainable solution in tourism

• Ingelia obtained Perseo Price 2011 of Iberdrola for Innovation in biomass conversion
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