### **Fast Pyrolysis Bio-Oil Technology and Production**



Presentation Studiegroep bijeenkomst Bio Energie Gerhard Muggen December 6<sup>th</sup> 2018











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### What is pyrolysis?



#### • Thermal cracking of organic material in the absence of oxygen

- Main Product = Liquid Bio-oil
- Process conditions:
- T = 400 600 °C
- P = atmospheric
- By products:
  - Heat (Steam)
  - Power (Electricity)

### Works with most lignocellulosic (non-edible) feedstocks

• Wood chips, sugar cane bagasse, straw, sunflower husk, etc.



Typical Pyrolysis Oil Characteristics	
Composition	$C_2H_5O_2$
Density	1100 - 1200 kg/m³
Heating value	17 - 20 GJ/m <sup>3</sup>
Water content	20 - 30 wt.%
• Ash	< 0.1 wt.%
Acidity (pH)	2.5 <b>-</b> 3



## Why pyrolysis?

- Decouple biomass resource from location and scale of application
- Works with a variety of biomass feedstocks
- Produces a homogeneous, 2<sup>nd</sup> generation liquid, that serves as a sustainable alternative to fossil fuels
- Produces bio-oil which is easier to store and transport due to significant volume reduction of solid biomass of about 12 on average
- High overall efficiency of ~ 85%: Conversion of biomass to main & products
- Versatile application: Heat, power and transportation fuels
- Utilize existing fossil fuel infrastructure:
  - Pyrolysis oil provides a viable link between the agriculture and (petro-) chemical industry.
  - Renewable feedstock for petrochemical industry in the production second generation biofuels



### Fast Pyrolysis Bio-Oil Process at Empyro





## **BTL - TechnipFMC collaboration**

# Rolling out Fast Pyrolysis Bio-Oil technology & commercial production:

- Complete turnkey (EPC) delivery of Fast Pyrolysis Bio-Oil (FPBO) units
- Operational support for commercial production of pyrolysis oil

### About TechnipFMC:

- Global footprint with ~37,000 people in 48 Countries
- Technology leader in Hydrogen, Ethylene,
- Refining & Petrochemical projects
- >35 years experience in development,
- design and construction of proprietary FCC
- technology

### • About BTG-BTL:

- Founded in 2007, BTL (BTG BioLiquids B.V.) is a biomass technology provider based in The Netherlands.
- Owns the first commercial scale plant in The Netherlands.
- Owns proprietary technology, originally developed at the University of Twente
- BTL owns international patents regarding biomass pyrolysis





### **Benefits of Technip – BTL FPO Plants**

- Plant functions autonomously (stand-alone installation)
- High operating plant efficiency (~ 85%) as no external fuel or power is consumed during normal operation
- High quality Fast Pyrolysis Oil that meets international standards (EN16900:2017/ ASTM D7544)
- Plant can produce enough LP steam to dry biomass from 55%.wt moisture content down to 5%.wt moisture
- At lower biomass moisture content, plant can:
  - Export excess steam to an external local user and/or,
  - Electricity generation via steam turbine, enough for the plant and export excess to an external grid.
- Absence of inert carrier gas recycle, results in minimum downstream equipment size and thus a small plant with **low CAPEX**.
- Modular approach for turnkey delivery of pyrolysis oil plant
  - Shorter delivery time and safer construction
- Plant can be operated and controlled by one operator



### **Commercial Production**

### **Empyro in Hengelo, the Netherlands**



- Electricity 2,200 MWh
  Steam 80,000 tonnes
- CO2- eq. reduction 24,000 tonnes

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### EMPYRO – status after 14 quarters of operation (June 2018)

#### Commissioning

- □ March 2015: First litres of oil; delivery steam to AkzoNobel;
- August 2015: delivery FPBO to FrieslandCampina
- October 2016: Steam turbine commissioned

#### Production

- □ Scale up RCR very successful;
- **D** 7 operators; One operator to run the plant at night;
- □ ~ 25 million litres produced (3 years);
- □ Runtime and production capacity still (gradually) increasing;
- Oil yield around design value 65 wt%; quality excellent from start
- □ 3.3 tons of oil per hour + 7.4 MW<sub>th</sub> steam; 650 kW<sub>e</sub> Electricity (near 90% heat efficiency)

#### **Economics**

- Overall investment within original budget
- □ Actual oil production costs in line with predictions







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## **Pyrolysis Oil Application** Industrial Steam Generation at FrieslandCampina



Schematic drawing of Process Steam Boiler at FrieslandCampina





### Pyrolysis Oil Application Industrial Steam Generation at FrieslandCampina







## **Pyrolysis Oil Application**

Industrial Steam Generation at FrieslandCampina







### **Pyrolysis Oil Application** Industrial Steam Generation at FrieslandCampina





Picture taken of the inside of the FCD boiler when firing both pyrolysis oil and natural gas



# Pyrolysis Oil Application

Industrial Steam Generation at FrieslandCampina

## FrieslandCampina is Royal FrieslandCampina is a global dairy company

They are our launching customer for pyrolysis oil

Process steam used in their milk powder process

- Pyrolysis oil off-take agreement concluded for a period of 12 years (equivalent to ~ 200 million litres);
- New natural gas fired steam boiler has been designed suitable to co-fire natural gas and pyrolysis oil (up to 70%) with 100% back-up of natural gas (= guaranteed supply) to produce process steam
- □ Large CO2 reduction when using pyrolysis oil: 89%<sup>\*</sup>
- ❑ As a result of using pyrolysis oil, the immediate carbon emissions for the entire Borculo site will be reduced by 15% and 10 million m<sup>3</sup> of natural gas will be saved each year.





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