ETIP Bioenergy
European Technology and Innovation Platform

Intermediate bioenergy carriers for power and heat

LAB SCALE → BENCH SCALE → PILOT PLANT → DEMONSTRATION → PRODUCTION

DEFINITION

This factsheet presents two conversion routes to bioenergy carriers, pyrolysis and torrefaction. For these processes, any lignocellulosic material is suitable as feedstock.

PROCESS TECHNOLOGY

Pyrolysis is the chemical decomposition of organic matter by heating in the absence of oxygen. The feedstock decomposes into organic vapours, steam, non-condensable gases and char. The pre-treatment typically includes drying to less than 15% moisture and crushing/milling to particles of less than 5 mm. The highest yield of the desired liquid fraction, up to 65 wt% on a dry feed basis, is obtained by thermal fast pyrolysis, which takes place in order of seconds at around 500°C. The heating medium is typically circulating sand, but also other forms of heating have been used. On cooling, the organic vapours and the steam condense to a dark brown viscous liquid called fast pyrolysis oil (FPBO) or Fast Pyrolysis Bio Oil (FPBO). The word "oil" used in this context is misleading, the energy content is only half of that of fuel oil. It contains ash solids, the oxygen content is almost as high as for biomass (35-40%). It is acidic (pH usually below 2) and non-miscible with either conventional oil or with water.

Torrefaction is a partial carbonisation or slow pyrolysis process, carried out typically at 200-350°C, in absence of oxygen, at atmospheric pressure, with low particle heating rates and a reactor time of one hour. The process causes biomass to partly decompose, creating torrefied biomass or char, also referred to as 'biocoal'. Biocoal is stable, brittle and water resistant, and is thus easier to grind than the original biomass material and also harder to be biodegraded. If combined with pelletisation, biomass materials can be converted to torrefied pellets, that are

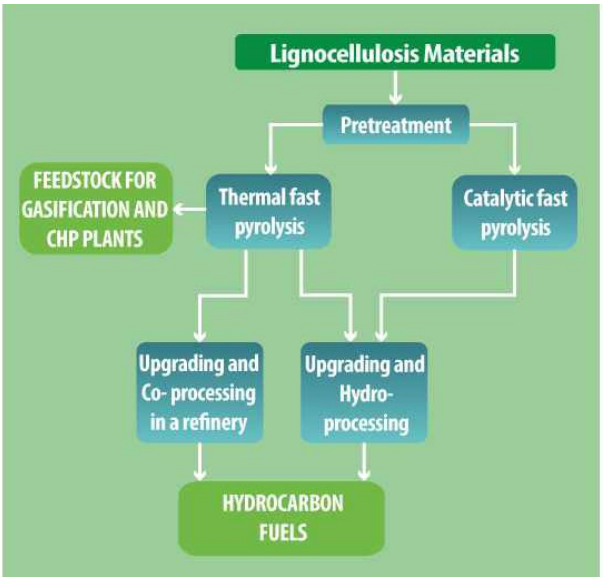

Figure 1: scheme of the pyrolysis process

easier to transport, handle and store and also have superior properties (i.e. higher energy density and heating value) in many major end-use applications.

APPLICATIONS

- Pyrolysis oil can be directly combusted or co-combusted in boilers, furnaces or used in turbines to produce heat and power. Moreover, this liquid is transportable, storable and can without upgrading to some extent be used as a fuel oil substitute, in particular when a catalyst is used during pyrolysis to reduce oxygen content and acidity, at the expense of a lower mass and energy yield. The char and gas produced in the pyrolysis process are used internally to provide the process heat required, and additionally also energy for export.
- The main application of torrefied materials is large-scale co-firing in pulverized coal heat- and power plants. Torrefaction significantly improves the suitability of biomass for co-firing and enables higher co-firing percentages at reduced cost. Problems during storage (e.g. soaking or outgassing) are mitigated, because torrefied materials have higher resistance to water absorption and decreased biological activities compared to other biomass fuels such as woodchips or sawdust. The increased energy density also reduces transport costs. Co-firing of torrefied biomass decreases share and amount of fossil fuels, reduces CO_2 emissions and is therefore in line with green energy support mechanisms. Torrefied biomass can also fully substitute for coal in new-built facilities.

EXAMPLES OF DEMOPLANTS

https://www.etipbioenergy.eu/databases/production-facilities

Location: Gävle, Sweden

Plant: Pyrocell plant (Joint Venture of Setra and Preem), started operation in 2021 (TRL 9)

Technology: Process technology provided by TechnipFMC and BTG BioLiquids (BTG-BTL)

Feedstock: Sawdust 85,000 t/y

Products: Pyrolysis oil, 24,000 t/y, will be refined into biofuel at Preem's refinery in Lysekil

Link: Preem's press office, press@preem.se

https://news.cision.com/setra-group/r/pyrocell-has-started-production,c3420250

ETIP Bioenergy
European Technology and Innovation Platform

Location: Grasmo, Norway

Plant: ArbaOne plant of Arbaflame, start of operation planned in 2021 (TRL 9)

Technology: Torrefaction via steam explosion technology (the process has been carried out by Arbaflame since 2010 at a test-scale plant)

Feedstock: Woody residues, in the future also low-grade feedstock

Products: Arbacore torrefied pellets 70,000 tonnes/y

By-products: 1,500 tonnes/y of biochemicals (furfural, methane and methanol)

Link: https://www.arbaflame.no/technology-1, https://www.a rbaflame.no/about-arbaflame

More information on www.etipbioenergy.eu.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 825179