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What Is Pyrolysis?

BIOMASS PYROLYSIS RESEARCH
at the Eastern Regional Research Center

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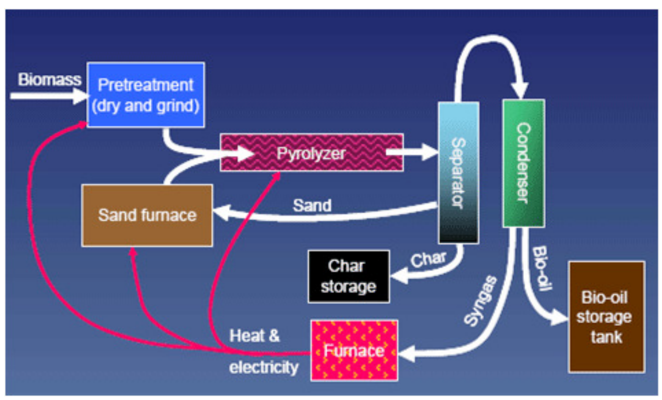
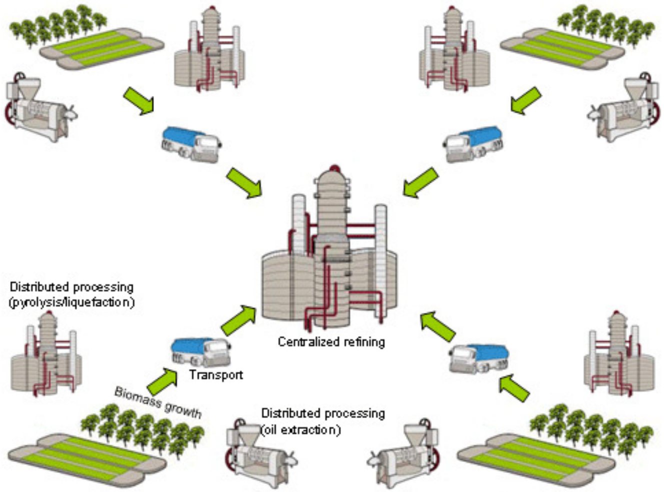
What Is Pyrolysis?

Pyrolysis is the heating of an organic material, such as biomass, in the absence of oxygen. Because no oxygen is present the material does not combust but the chemical compounds (i.e. cellulose, hemicellulose and lignin) that make up that material thermally decompose into combustible gases and charcoal. Most of these combustible gases can be condensed into a combustible liquid, called pyrolysis oil (bio-oil), though there are some permanent gases (CO_2, CO, H_2, light hydrocarbons). Thus pyrolysis of biomass produces three products: one liquid, bio-oil, one solid, bio-char and one gaseous (syngas). The proportion of these products depends on several factors including the composition of the feedstock and process parameters. However, all things being equal, the yield of bio-oil is optimized when the pyrolysis temperature is around 500 °C and the heating rate is high (i.e. 1000 °C/s) i.e. *fast pyrolysis* conditions. Under theses conditions bio-oil yields of 60-70 wt% of can be achieved from a typical biomass feedstock, with 15-25 wt% yields of bio-char. The remaining 10-15 wt% is syngas. Processes that use slower heating rates are called *slow pyrolysis* and bio-char is usually the major product of such processes. The pyrolysis process can be self-sustained, as combustion of the syngas and a portion of bio-oil or bio-char can provide all the necessary energy to drive the reaction.



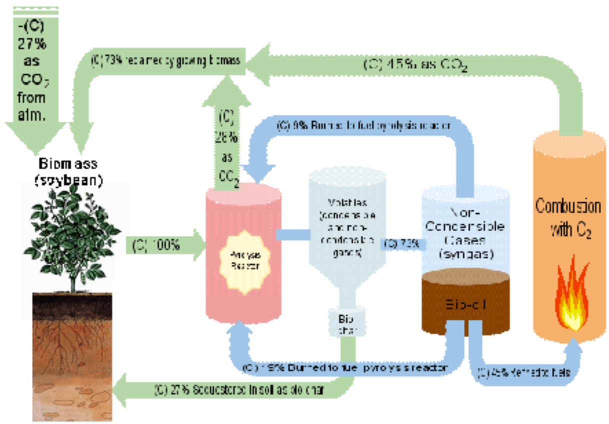
Schematic of the Fast Pyrolysis Process.

Bio-oil is a dense complex mixture of oxygenated organic compounds. It has a fuel value that is generally 50 – 70% that of petroleum bases fuels and can be used as boiler fuel or upgraded to renewable transportation fuels. It density is > 1 kg L^{-1}, much greater than that of biomass feedstocks, making it more cost effective to transport than biomass. Therefore we envision a distributed processing model where many small scale pyrolyzers (i.e. farm scale) covert biomass to bio-oil which is then transported to a centralilized location for refining. Our studies show that when employed in a distributed "farm scale" systems feeding into a central gasification (for Fisher Tropsh liquids production) plant the transportation cost savings alone are enough to offset the higher operational and biomass costs.



Distributed processing of biomass by fast pyrolysis.

Furthermore, the bio-char produced can be used on the farm as an excellent soil amender that can sequester carbon. Bio-char is highly absorbent and therefore increases the soil's ability to retain water, nutrients and agricultural chemicals, preventing water contamination and soil erosion. Soil application of bio-char may enhance both soil quality and be an effective means of sequestering large amounts of carbon, thereby helping to mitigate global climate change through carbon sequestration. Use of bio-char as a soil amendment will offset many of the problems associated with removing crop residues from the land.



Sequestering Carbon by application of bio-char to the soil.

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