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BIOMASS FAST PYROLYSIS AS AN ALTERNATIVE FOR BIOFUEL PRODUCTION

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Introduction

- Fast Pyrolysis: Thermochemical process that transform solid into liquid;
- It is possible to use different feedstock (biomass; waste);
- Much of the research is still at a fundamental scale;
- Process in which the biomass is fragmented using heat in an atmosphere having no oxygen to generate optimized liquid (bio-oil), gas and solid (char);
- <u>Yelds:</u>
- 75% liquid;
- 12% char;
- 13% Gases (CO_2; CH_4; CO e H_2)

Source: Bridgwater (2001)

Objective

- The objective of this work is compiling data and technical information on the use of the fast pyrolysis process of biomass as an alternative for the production of biofuels.

Methodology

- Databases available in governamental portal of periodicals;
- Digital libraries of theses and dissertations from national and international universities;
- Bibliographic databases of main national and international institutions of research and higher education.

Biomass

- Any organic matter, either of animal or vegetable origin (SAIDUR et al, 2011), which can be transformed and provide energy, as heat or electricity;
- It is considered organic material from living sources (EOM et al, 2011), such as sugarcane, wood, agroindustrial waste, among others;
- Biomass from lignocellulosic material has complex mixtures of natural carbohydrate polymers:
    - Cellulose;
    - Hemicellulose;
    - Lignin;
    - Extractives;
    - Ashes.

Biomass

- Brazil – Biomass Diversity

- Sugarcane, forests, elephantgrass, oilseeds) and waste generated in different production chains (sugarcane bagasse and straw, forest residues, vegetables, urban solids, animal, industrial)

Fonte: Google Images

Biomass Fast Pyrolysis

Main characteristics of the fast pyrolysis process, aiming at maximum amounts of pyrolytic liquid (bio-oil) are:

- High heating and heat transfer rates, requiring a finely ground biomass;
- Controlled reaction temperature around 500 ° C;
- Low residence time of vapors, typically less than 2 seconds;
- Rapid cooling of vapors.

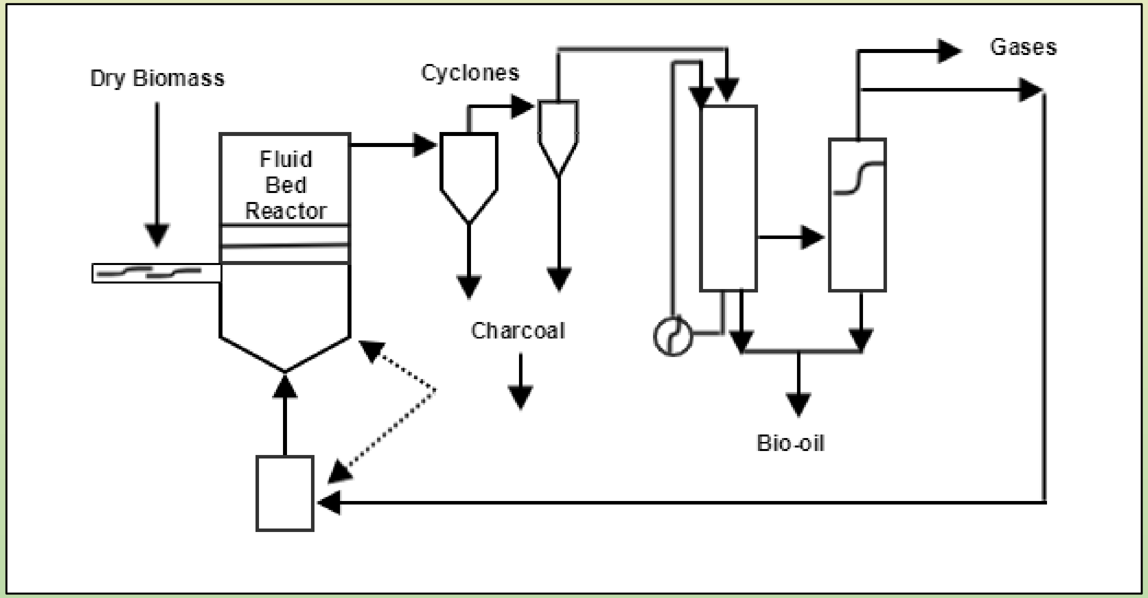
Steps of Biomass Fast Pyrolysis

- Biomass drying, typically at less than 10% moisture, is necessary to minimize the amount of water in the liquid product;
- Biomass milling aims to obtain particles with a sufficiently small size (up to 6 mm);
- After the biomass milling, there is the pyrolysis reaction for the separation of the coal from the gases and vapors;
- Then the rapid condensation of the vapors;
- Finally, collection of the bio-oil.

Main type of reactors of Fast Pyrolysis:

- Fluid Bed
- Bubbling Fluidized Bed
- Circulating Fluidized Bed:
- Rotating Cone

Figure 1. Fast Pyrolysis Process Flow Chart



Source: Adapted from Bridgwater, 2012

Equipments

Source: Personal Archive and Google Images

Bio-oil

- Liquid dark brown;
- Odor of smoke;
- Complex mixture of oxygenates* (more than 200) with significant amounts of water (15 a 30%);
- Chemical composition near the biomass;
- Yelds: It depends on the process conditions;
-             It depends on the equipment;
-             It depends on the separation efficiency of char and condensation of the vapours;
- Unstable: can occur polymerization and condensantion;

- *Oxygenates: acids, sugars, alcohols, aldehydes, ketonas, esters, furans, phenols, oxygenated mixed, guaiacois, seringóis.

Characteristics of bio-oil

- High content of oxygen (35-45%) and water (15-30%),
- High acidity (pH ~ 2.5),
- High density (1.2 kg / l),
- Lower calorific value (13-18MJ / kg), which represents about 40% of the calorific value of the fuel oil (43 MJ / kg).
- Soluble in 17 polar solvents but completely immiscible in hydrocarbons;
- It is possible increased viscosity and phase separation

Source: Personal Archive and Google Images

Uses of the bio-oil

- Substitute for fuel oil or diesel in static applications: boilers, machines, furnaces and turbines;
- Electricity generation;
- Several types of chemical products:
    - Flavoring agents;
    - Hydroxyl acetaldehyde;
    - Resins;
    - Agrochemicals;
    - Fertilizers.

Problems of the bio-oil

- Low volatility,
- High viscosity,
- Coke formation
- Corrosivity

<u>Examples:</u>

- For burning in diesel engines, the main difficulties are difficult ignition, coke formation and corrosion;
- For direct use in diesel engine, the bio-oil needs to be refined or mixed (HUBER et al., 2006).

Advantages of the use of bio-oil

- Produced in small fast pyrolysis plants near the source of the feedstock;
- The low-density biomass is converted into a much denser and ash-free liquid;
- Transported under economically favorable conditions for a processing plant;
- It is possible gasified by synthesis gas.

Upgrade of bio-oil

- To add catalysts to the process, modifying the fast pyrolysis for catalytic pyrolysis;
- The use of catalysts has the objective of obtaining a higher and more stable bio-oil, by means of the removal of the oxygenated compounds and increase of hydrocarbons;
- Other Possibilities:
  - Hydrotreatment;
  - Catalytic steam cracking;
  - Esterification;
  - Syngas to gassing.

Final Considerations

- The fast pyrolysis process is a liquid biomass conversion process (bio-oil) increasing the energetic density;
- It can be produced in small fast pyrolysis plants and transported to gasification plants or other processing plants, with the advantage of transporting the liquid instead of the *in natura* biomass;
- The generation of waste in a fast pyrolysis plant is very small, about 12% of coal fines and 13% of gases, and can be recycled in the process;
- The major challenges are to improve the quality of bio-oil for direct replacement of petroleum-derived fuels and for chemicals;
- The development of the research with these objectives is focused on the catalytic pyrolysis, fractionation of the organic phase of the aqueous phase and esterification;
- The HDO – Hydro treating for removal of the oxygen from the bio-oil is also an improvement process;
- <u>Conclusion:</u> the future of fast pyrolysis is to develop bio-oil improvement research aimed at a product that can be used as fuel or new products for the chemical industry from the chemical components found in the bio-oil and in the biomass that originate it.

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THANKS!
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