Biomass Fast Pyrolysis as an alternative for biofuel production

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Overview

Biomass fast pyrolysis is a thermochemical biomass conversion process, which aims to maximize biofuels production, mainly bio-oil, its main product. Bio-oil is a black (or brown) liquid produced from the condensation of pyrolysis vapors. The unstable nature of bio-oil leads to its polymerization and condensation over time. Bio-oil can be used in the chemical industry, in the generation of electricity and in the production of biofuels and, in the later stage, can also be gasified for use in several types of industries. Because of such instability and its tendency towards aging, bio-oil needs to be processed to improve its quality during storage to enable different uses. One of the challenges is to remove the oxygen contained in the biomass to produce compounds of interest such as fuels or chemicals. It should be noted that for the use of some products of commercial interest it is necessary to refine the bio-oil. The upgrading of the bio-oleo allows the obtaining of several products like fertilizers, adhesives, flavorings and fuels.
This work was carried out with the objective of compiling data and information on the fast pyrolysis and procedures aimed at improving the quality of bio-oil produced from biomass and agricultural and forest residues.

Methods

This paper analyses the technical-scientific information on processes aiming to upgrade the quality of bio-oil obtained from biomass fast pyrolysis, in order to define the importance of this upgrade. A literature review was conducted about the biomass fast pyrolysis followed by a detailed analysis of the current stage on the upgrading of the quality of the bio-oil for some applications, including for the generation of energy in isolated areas also from agricultural and forest residues.

Results

Countries such as Brazil and others in Latin America have several types of agricultural and forestry biomass, as well as their agroforestry residues that can be used in the rapid pyrolysis of biomass, which is a thermochemical process that aims to maximize bio-oil production. There are also the gas and solids fractions produced in the process. The bio-oil is a dark brown color, almost black, with a characteristic smoke smell with elemental chemical composition close to the biomass that originated it. Bio-oil is a complex mixture of oxygenated compounds with a significant amount of water, originating from the moisture of the biomass and the reactions, and may also contain small particles of coal and dissolved alkali metals from the ash. Its composition depends on the type of biomass, the process conditions, the equipment and the efficiency in the separation of the coal and the condensation. Bio-oil can be used in the generation of electricity, domestic heating, organic fertilizers, fuel additives and as fuel (after refining).
The biomass fast pyrolysis is an alternative to be used in isolated areas for the generation of electric energy and domestic heating using different types of biomass or agricultural and forest residues transforming the biomass and residues into a more dense product energetically. For commercial uses and with better economic returns, it is necessary for the bio-oil be submitted upgrading processes that were identified in this study.
Catalytic pyrolysis, esterification and hydrotreatment are nowadays being tested in Brazil and worldwide to improve the quality of bio-oil for direct substitution of petroleum-derived fuels and for chemicals products. It was also identified that the substance needs to follow standardization protocols, including: maximum water content of 30%, maximum viscosity (40°C) of 125 mm^2/s and flash point of at least 45°C, among other characteristics. Researches with these objectives are focused on catalytic pyrolysis, a theme that Brazilian and universities worldwide are already developing, as well as fractionation of the organic phase of the aqueous phase and esterification. From the more acidic

fraction of bio-oil, with the predominance of the carboxylic acids, the emulsions can be produced to be used as biofuels. Hydrotreatment for oxygen removal from bio-oil is also a process of improving its quality.

Conclusions

The results of this work indicate that the future of biomass fast pyrolysis involves developing bio-oil quality improvement research aimed at enabling its use as fuel or other new products for the chemical industry from the chemical components found in bio-oil and in the biomasses that originate it.

It is important to note that bio-oil from biomass and agricultural and forest residues is a renewable source of fuel that can be used in isolated areas for the generation of electric energy and domestic uses. In addition, the biomass fast pyrolysis presents as advantages to produce the bio-oil in small scales facilitating the transport of a more dense product energetically, since the improvement of the bio-oil be applicated for a better storage.