Study of autothermal oxidative pyrolysis of forest residues as an alternative to improve the raw material for gasification in the FT-SPK process.

3º CONGRESSO DA REDE BRASILEIRA DE BIOQUEROSENE E HIDROCARBONETOS SUSTENTÁVEIS PARA AVIAÇÃO

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2 - Introduction

Technological advancement and the global growth of commercial aviation have led to growing concern about the environmental impacts associated with the sector. In this context, aviation biofuels emerge as a promising and sustainable alternative to reduce greenhouse gas emissions and mitigate the environmental impact of aviation. Unlike conventional fossil fuels, biofuels are derived from renewable sources such as vegetable oils, agricultural and forestry residues, and can be produced in a more environmentally conscious way. Furthermore, these biofuels offer the possibility of significantly reducing CO2 emissions, as well as other atmospheric pollutants, thus contributing to the environmental sustainability of aviation and the achievement of global greenhouse gas reduction targets.

One of the alternatives for the production of aviation biofuel is through the Fischer-Tropsch Synthetic Paraffinic Kerosene (FT-SPK) process route, which consists of gasifying the biomass and subjecting the synthesis gas to a Fischer-Tropsch process with catalysts that favor the production of aviation biofuel. Biomass pyrolysis is a good alternative as a pre-process to optimize the gasification of *in natura* biomass, however the use of inert and reactor heating can be a problem. Therefore, this work aims to evaluate an alternative route using autothermal oxidative pyrolysis for the production of bio-oil and biochar to be used in gasification using forest residues. Also, it takes part of BR-EU consorption (BioValue-BECOOL) under the Horizon 2020.

3 – Objectives

This study aims to elucidate the outcomes concerning performance, calorific value, and chemical composition of the bio-oil from forest residue (eucalyptus and pinus pruning). These results was compared with experimental observations and pertinent literature on pyrolysis conducted under inert conditions. Moreover, an evaluation of the energy balance and the compositional analysis of the purge gas was undertaken to assess the energy consumption necessary for sustaining the autothermal reaction.

4 – Materials and Methods

The eucalyptus pruning residues (EPR) and the pinus pruning residues (PPR) were obtained from a Brazilian industry. The biomass was characterized by chemical analysis (humidity, ashes, extractives, cellulose, hemicellulose, soluble and insoluble lignin) for the TAPPI and ASTM method, also realized CHNS/O elemental analysis and particle size distribution analysis.

The fast pyrolysis reactions were conducted in a recycling reactor (Figure 1 shows the Oxidative Pyrolysis Pilot Plant), with temperatures between 450 and 580°C, with 12 to 15m³/h of fluidization air flow, recycling ratio 4:1 and 7 to 13kg/h of mass flow rate. The bio-oils were collected from the condenser of the fast pyrolysis reactor. The bio-oils were divided into 3 fractions: acid extract (AE), light bio-oil (LB), and heavy bio-oil (HB), and each of the fractions was separated and analyzed. The gaseous and solid products were also collected for analysis.

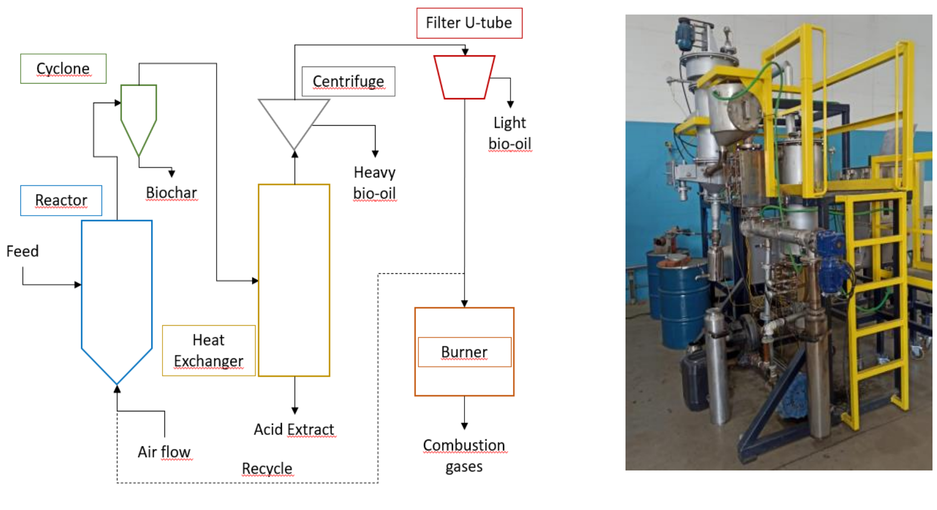

Figure 1 – BioValue Oxidative Pyrolysis Pilot Plant.

Each product was analyzed according to a respective ASTM and methodology.

The performance was made by mass balance and mass consumption using gas chromatography to check the O_2 fraction in the purge gas as a basis for calculating the required energy.

5 – Discussions and Results

Comparing the values of lower calorific value, performance, and chemical composition of autothermal oxidative pyrolysis with the inert one in the literature, we can observe that the values are close and within what is expected for this type of process. The lower calorific value of 22.2 to 26.2 MJ/kg and 21.6 to 25.5MJ/kg for BC and HB respectively compared to the average value of 27MJ/kg and 24MJ/kg (biochar and bio-oil) among different literatures for the same type of biomass. The performance of liquid fraction was between 47.1 and 55.7%, close to the expected 50 to 70% from the literature, yet with the gas analysis, we observed that there is still room to improve the condensation system, with an increase of 15 to 25% in liquid fractions that were not possible to be recovered in the current configuration. Regarding the bio-oil composition, we observed a small increase in the methoxy and dimethoxy phenol derivatives such as guaiacol and syringol compounds.

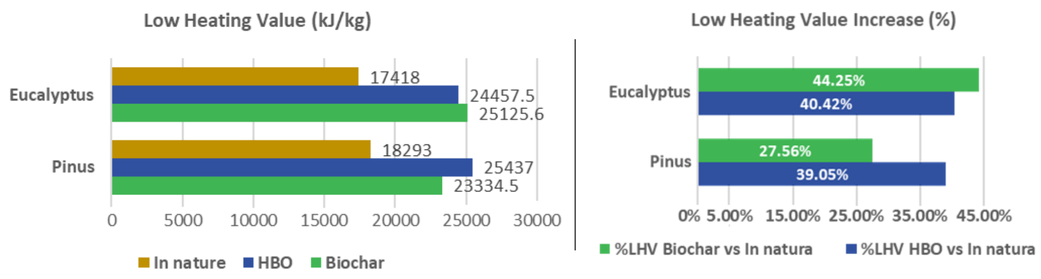

Figure 2 – Low Heating Value comparison

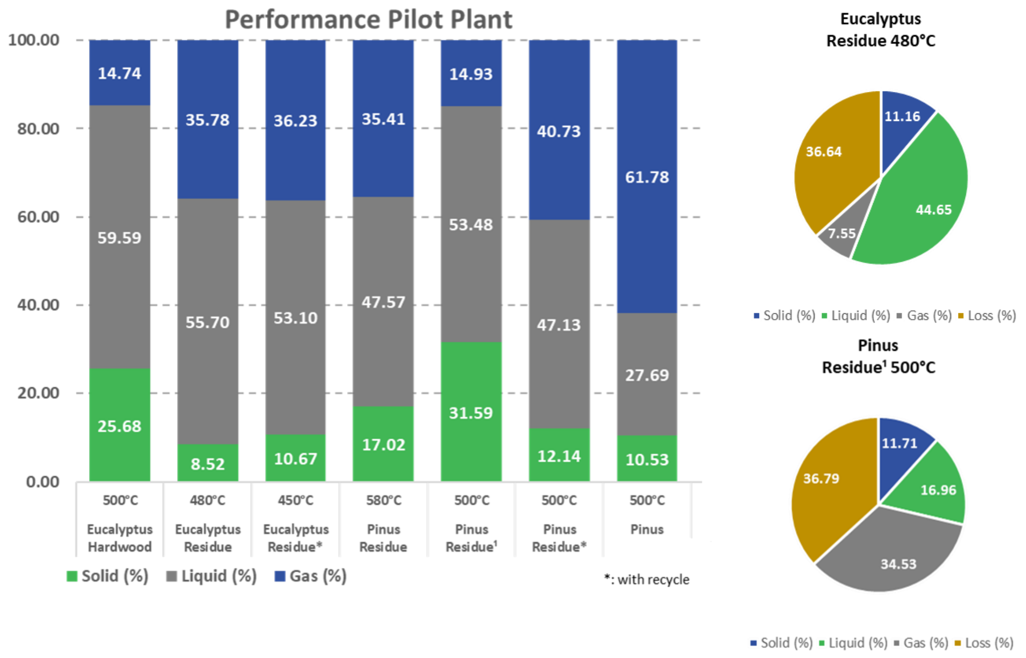

Figure 3 – Pilot Plant performance and %C

Regarding energy consumption, with the analysis of the purge gas, it was observed that all O2 introduced is consumed in the process, considering that the consumption was due to the biomass combustion reaction to maintain the reaction temperature, we observed that only 4 to 6%wt of the biomass is used to sustain the autothermal process. It still requires more study to define whether only biomass is consumed or whether it interacts with biochar as well.

4 – Conclusions

Autothermal oxidative pyrolysis presents itself as a good alternative in the FT-SPK process as a way of enabling the pyrolysis process on an industrial scale and providing raw material for the formation of synthesis gas and consequently producing aviation kerosene through the reaction of FT. The results are promising, but there are areas for improvement and evaluation, such as the liquid recovery system and a techno-economic asset study, both will be produced soon.

5 – Agradecimentos

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6 - References

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