PhD Open Days

Thermochemical Liquefaction of Burnt Pine Heartwood – Preliminary Results

Chemical Engineering

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Introduction

Nowadays, the high costs and environmental impacts of fossil fuels have been the primary driving force in researching sustainable resources. Lately, various initiatives have emerged to limit fossil fuel use and reduce the carbon footprint, and the most well-known initiative is renewable energy sources. [1]

Biomass is one of the important and large amount of renewable fuel sources. Biomass energy has numerous advantages such as renewable nature, relatively abundance, carbon neutral ability, low sulphur emission during combustion, easy transportation, and storage. It is a source for producing new liquid fuels, synthetic gas, hydrogen, solid fuels, and valuable chemicals. Liquefaction of biomass lignocellulosic residues, a recently well-known concept, is a highly researched process. [2]

In Portugal, the amount of available forest biomass is approximately 2.2 million tonnes per year (11.578 GWh /year), including residues from wood industry. A possible contribution to tackling this forest biomass deficit could be a sustainable raw material production strategy based on transforming part of biomass production. [3] Wildfires in Portugal each year sometimes kill and injure large. According to the official report of the Portuguese authorities nine firing points were reported and the largest ones were registered as “Pedrógão Grande” (28,914 ha) and “Góis” (17,521 ha) fires. [4]

In this study, the aim is evaluating the thermochemical liquefaction of burnt pine heartwood. The biomass and bio-oil samples are characterized by electron microscopy and infrared spectroscopy.

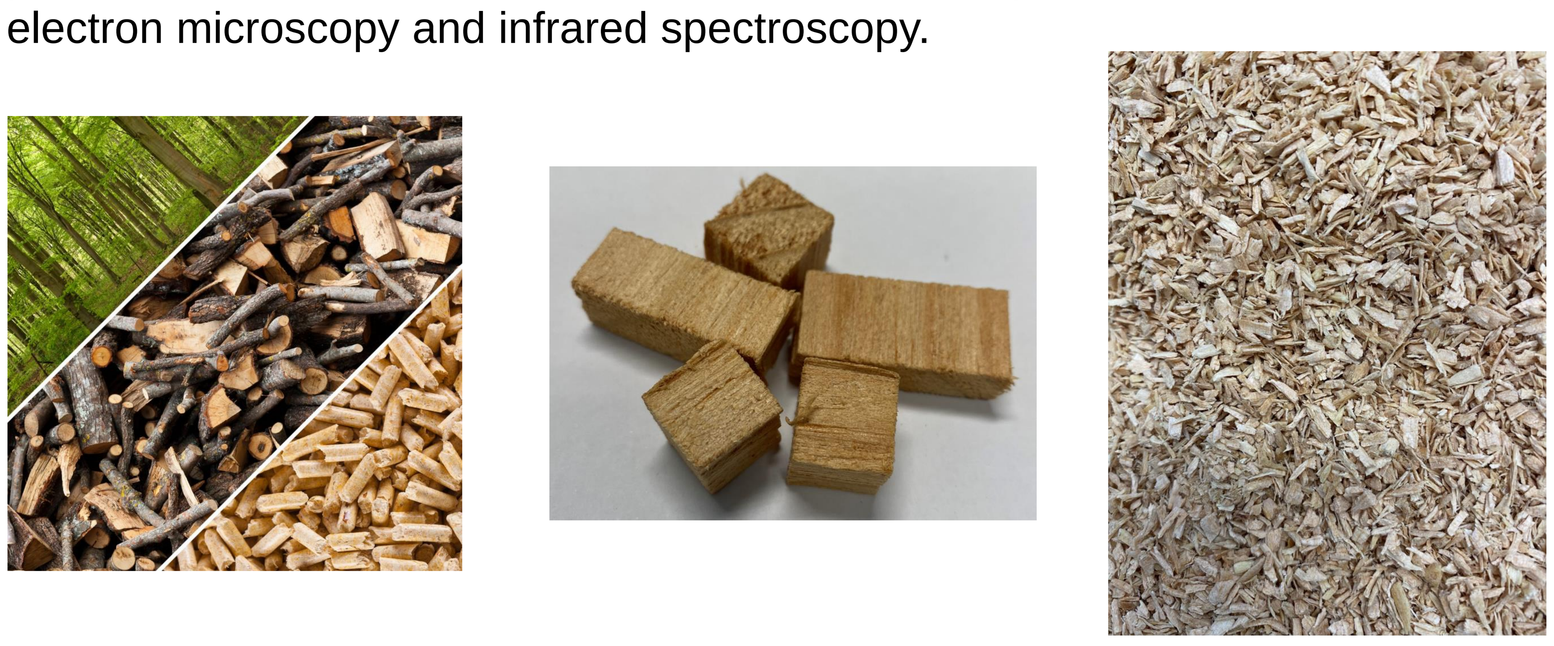

Figure 1. (a) transformation of the woody biomass (b). burnt pinewood bark sample cut into cubes, (b) shredded burnt pinewood bark sample

Experimental Procedure

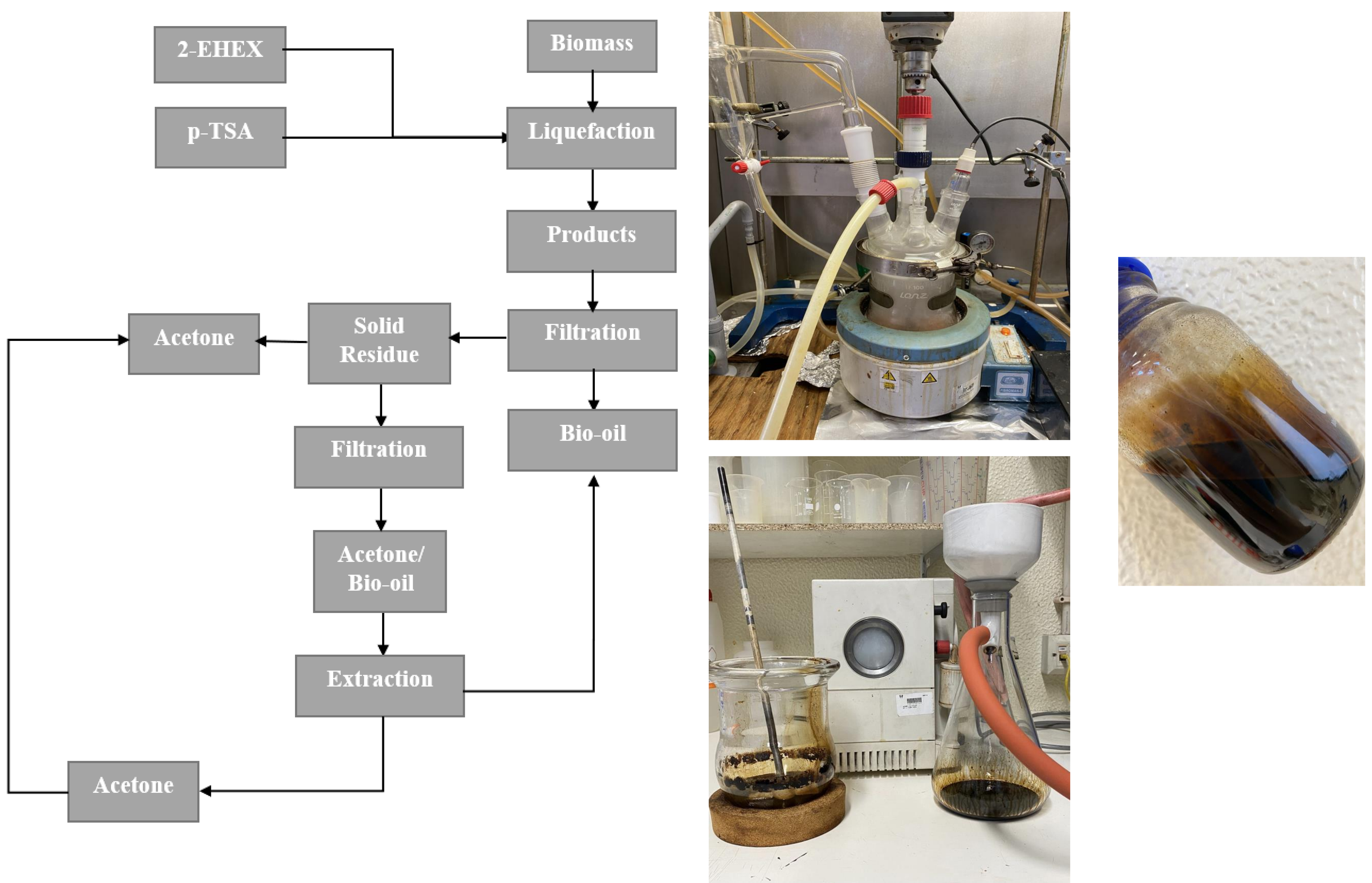

Figure 2. (a) Flowchart of the liquefaction process, (b),(c),(d) pics of the process and the bio- oil (product)

Results

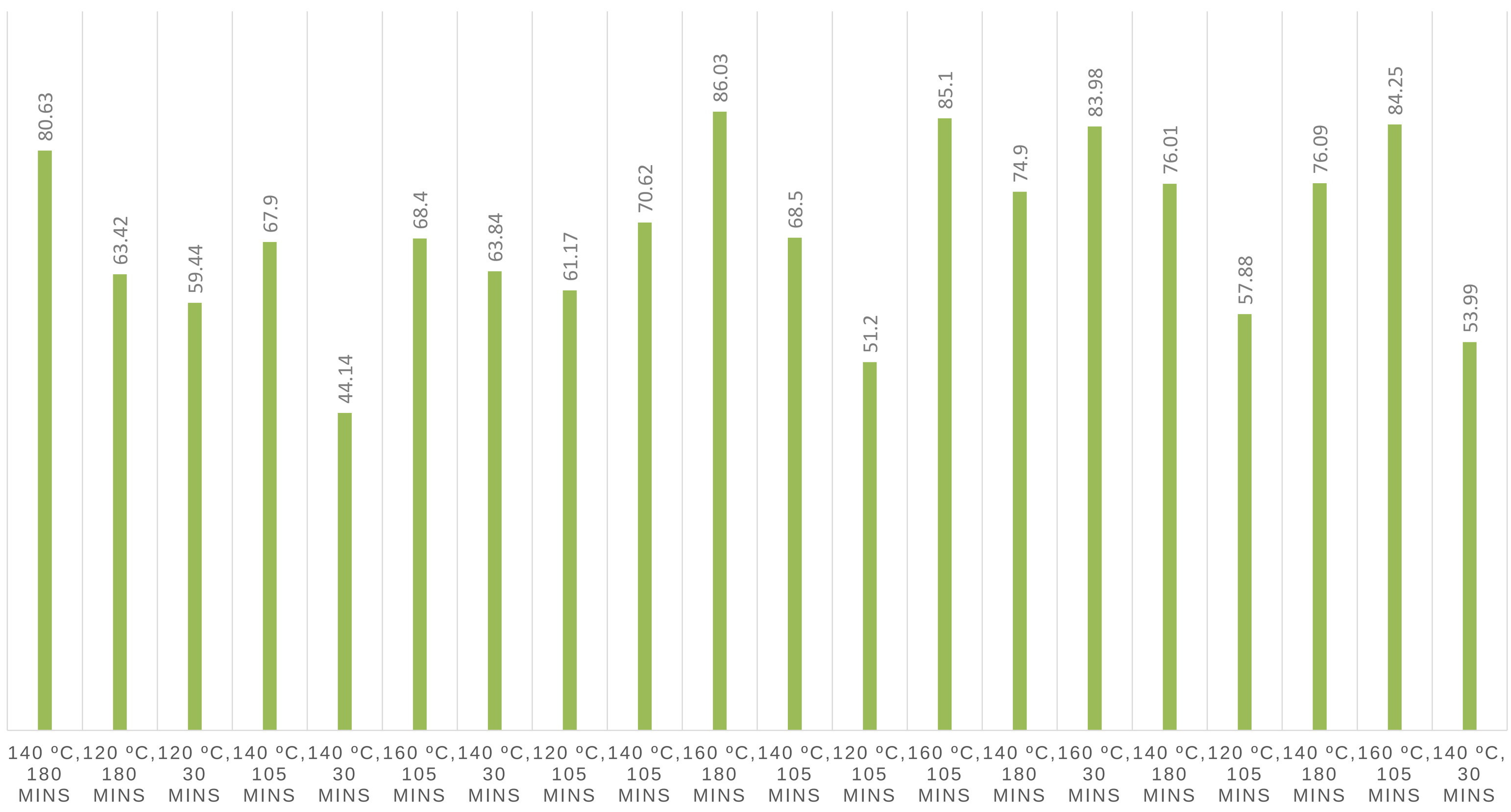

Figure 3. Results of liquefaction yield

* The procedure occurred at 3 different temperature and duration time as shown in the graph, had a solvent:biomass feed ratio of 5:1, the solvent used was 2-Ethylhexanol, the mass of the catalyst fed, the catalyst was p-Toluenesulfonic acid (PTSA), and the feedstock used was burnt pine heartwood.

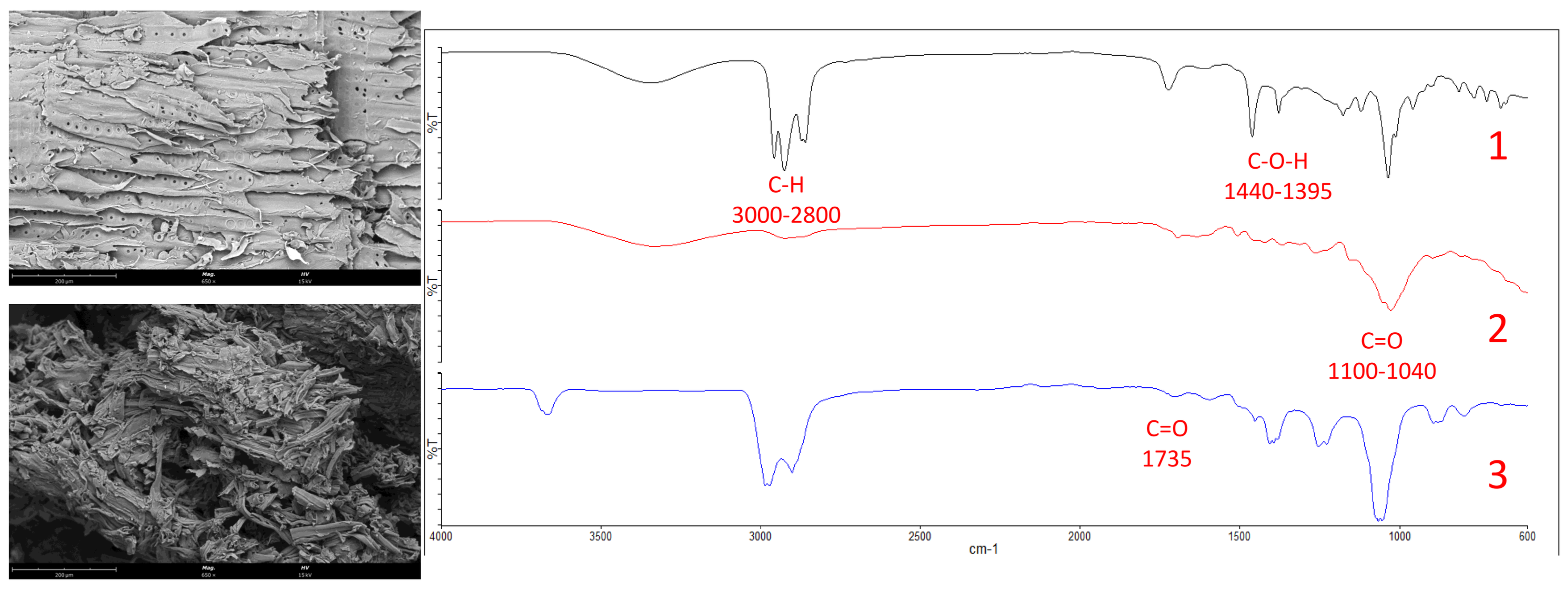

Figure 4. a) SEM micrograph of fresh biomass (on top) and solid residue (on bottom) after the liquefaction process, b)FTIR-ATR result of (1) bio-oil, (2) biomass and (3) solid residue

Conclusion

- The best liquefaction yield was 86.03%, when the reaction occurred at 160 ºC and applied for 180 mins with 5.5% (w/w) catalyst, p-TSA.
- According to the FTIR-ATR results of the bio-oil samples; the first peak is located between 3000-2800 cm-1, significates the presence of solvent. At the 1675 cm-1 which is corresponding to the C=O and significates aldehydes or ketones which is related to the conversion of hemicellulose. Lastly C-O-H single bond which is between 1440-1395 cm-1 and C=O double bond, may show aromatic carbohydrate derivates.
- Regarding SEM analysis to determine morphological changes in the biomass; before the liquefaction process the biomass consists of a pile of irregularly shaped and porous fibres. After the liquefaction process, the structure of the biomass was destroyed and changed completely, but still some holes were observed due to the value of liquefaction yield.

References

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