UPGRADING OF PYROLYSIS OIL BY ESTERIFICATION

INTRODUCTION

Bio-oil is produced by pyrolysis of biomass and has the potential to be employed in several applications. However, its properties such as high acidity and viscosity prevent this oil to be extensively used. This scenario can be improved by upgrading the properties of the bio-oil, enabling it to be used in a wider range of applications and with a higher cost-efficiency. One of the methods to upgrade the bio-oil is by esterification with alcohols (Figure 1).

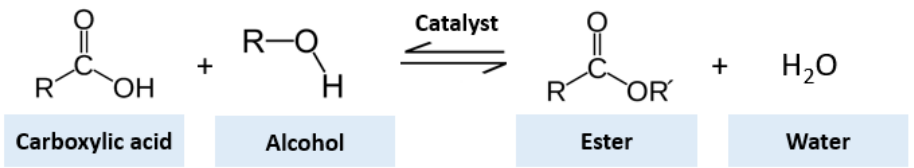

Figure 1. Scheme of esterification of carboxylic acids.

GOALS

The aim of this work is to evaluate different types of alcohol for the esterification of bio-oil. A two-level factorial design of experiments (DOE) was used to evaluate the influence of amount of catalyst, acid/alcohol ratio and temperature in the esterification using butanol.

METHODOLOGY

The reactions were performed in a simple batch reactor (Figure 2).

Figure 2. Batch reactor used in the experiments.

To analyze the samples, two techniques were used:

1. Potentiometric titration (Acidity)

2. Gas chromatography/mass spectroscopy (Composition)

RESULTS

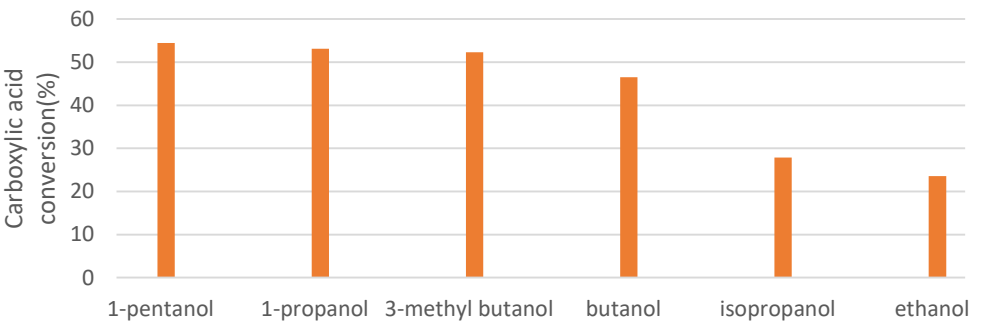

Figure 3. Extent of esterification of the bio-oil at 40 °C using different types of alcohol and 5% of catalyst.

Conclusions

- Esterification can effectively decrease the acidity of bio-oil, which was proven through gas chromatography/mass spectrometry (GC/MS) and titration.
- Alcohol types influence the esterification efficiency. Pentanol, 1-propanol, 3-methyl butanol and butanol led to a higher carboxylic acid conversion.
- A factorial design of experiments (DOE) showed that only the amount of enzymes was a significant factor for the esterification with butanol, whereas temperature and acid/alcohol ratio were less important in this study.

Recommendations

As suggestion to future works, the reactions that showed best results should be performed in a rotating bed reactor to increase the mass transfer of the reaction. The viscosity and heating value of the bio-oil, as well as the characterization of the catalysts before and after reaction, should also be investigated.

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