

UPGRADING OF PYROLYSIS OIL BY ESTERIFICATION WITH ALCOHOLS

INTRODUCTION

Bio-oil is a product of pyrolysis that can be used in several applications, for instance, as a transportation fuel. Although it is considered to be a potential renewable energy alternative, bio-oil shows some drawbacks, compared with fossil fuels, such as high acidity, low heating value, high corrosiveness, high viscosity and low stability. One of the methods to upgrade the bio-oil is by esterification with alcohols (Figure 1).

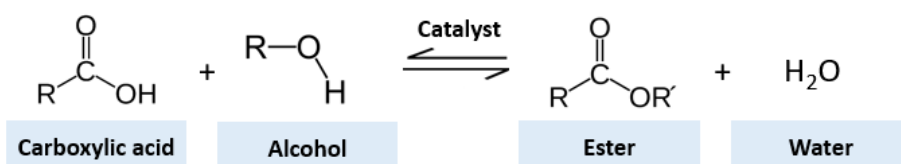


Figure 1. Scheme of esterification of carboxylic acids.

GOALS

This work aimed to investigate the upgrading of bio-oil via catalytic esterification, applying different conditions of reaction, such as temperature, time of reaction, amount of catalyst, type of bio-oil and alcohol, type of catalyst and addition of stabilizer compounds. It also aimed to test a rotating bed reactor in order to increase the conversion of the reaction and to improve the process.

METHODOLOGY

Reactions were performed in a simple batch reactor (Figure 2.a) and in a rotating bed reactor (Figure 2.b).

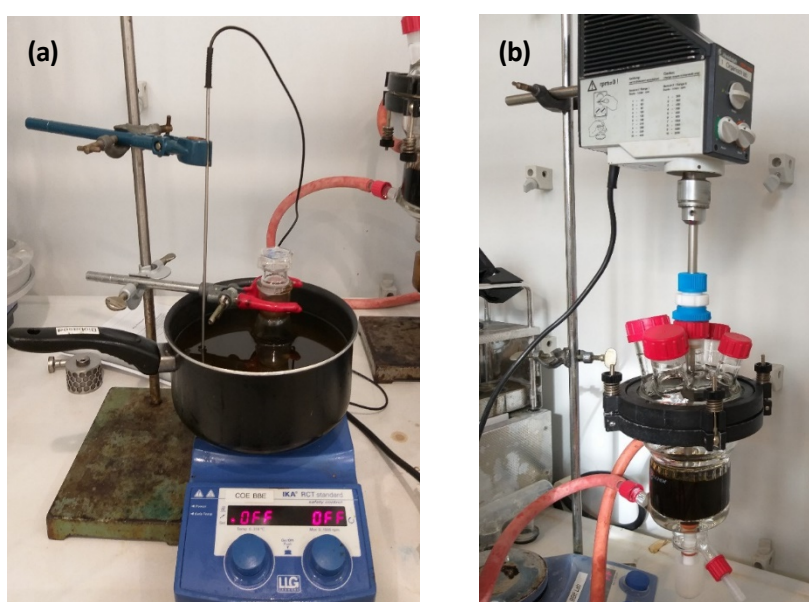


Figure 2. Batch reactor (a) and rotating bed reactor (b) used in the experiments.

To analyze the samples, three techniques were used:

1. Potentiometric titration (Acidity)
2. Karl Fischer titration (Water content)
3. Gas chromatography (Composition)

RESULTS

- After the addition of alcohols to the bio-oil, it was noticed that acid numbers decrease substantially;
- The presence of heptane in the system bio-oil/alcohol influenced positively the conversion of the reaction and this compound probably help to stabilize the catalyst. A solubility diagram was prepared in order to find miscible ratios of bio-oil: butanol: heptane that can be tested;
- It was also found that the conversion of carboxylic acids is higher at 40°C;
- The alcohols that presented better results were ethanol, butanol and 3-methyl-1-butanol;
- It was found that the higher the amount of catalyst, the higher conversion is. The same thing was noticed concerning to the duration of the reaction;
- The water content increased after reaction;
- It was possible to detect the production of some esters after the reaction, through gas chromatography.

FINAL CONSIDERATIONS

Esterification with alcohols was effective to decrease the carboxylic acid number of many samples. It was noticed that heptane can be used to stabilize the catalyst. The rotating bed reactor was tested, and it was noticed that it can facilitate the process, mainly because it is not necessary to filtrate the final product and it is easier to reuse the catalyst. However, reactions made in a batch reactor have to be repeated in the RBR in order to conclude about its efficiency.

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