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Optimization of the bio-oil stabilization process to minimize hydrogen consumpting

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Optimization of the bio-oil stabilization process to minimize hydrogen consumption.

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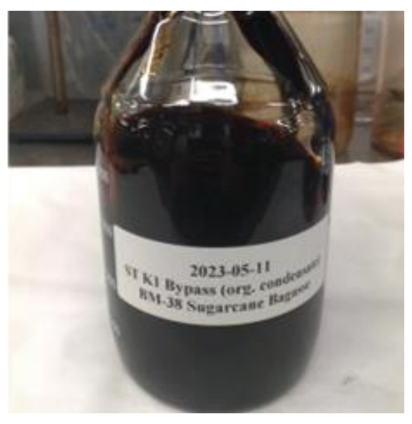
Overview

Sugarcane bagasse

Innovative solutions



Fast pyrolysis bio-oil (FPBO)

Stabilization step

Noble metal catalysts

Catalytic Hydrodeoxygenation (HDO)

Hydrogen (H_2) as a fuel precursor

New products

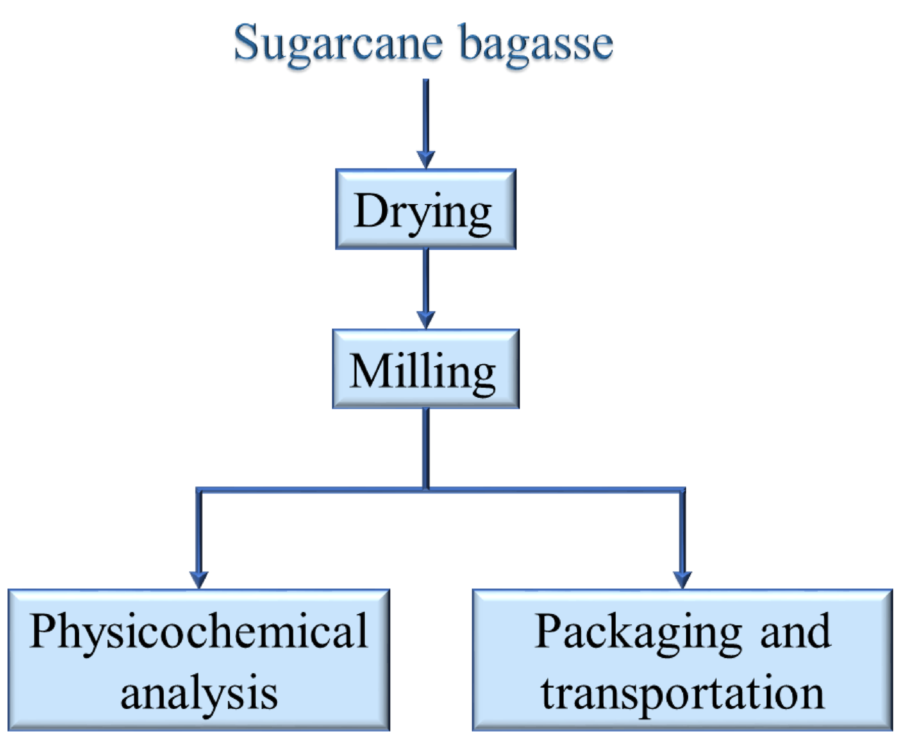
Biofuels

Objective

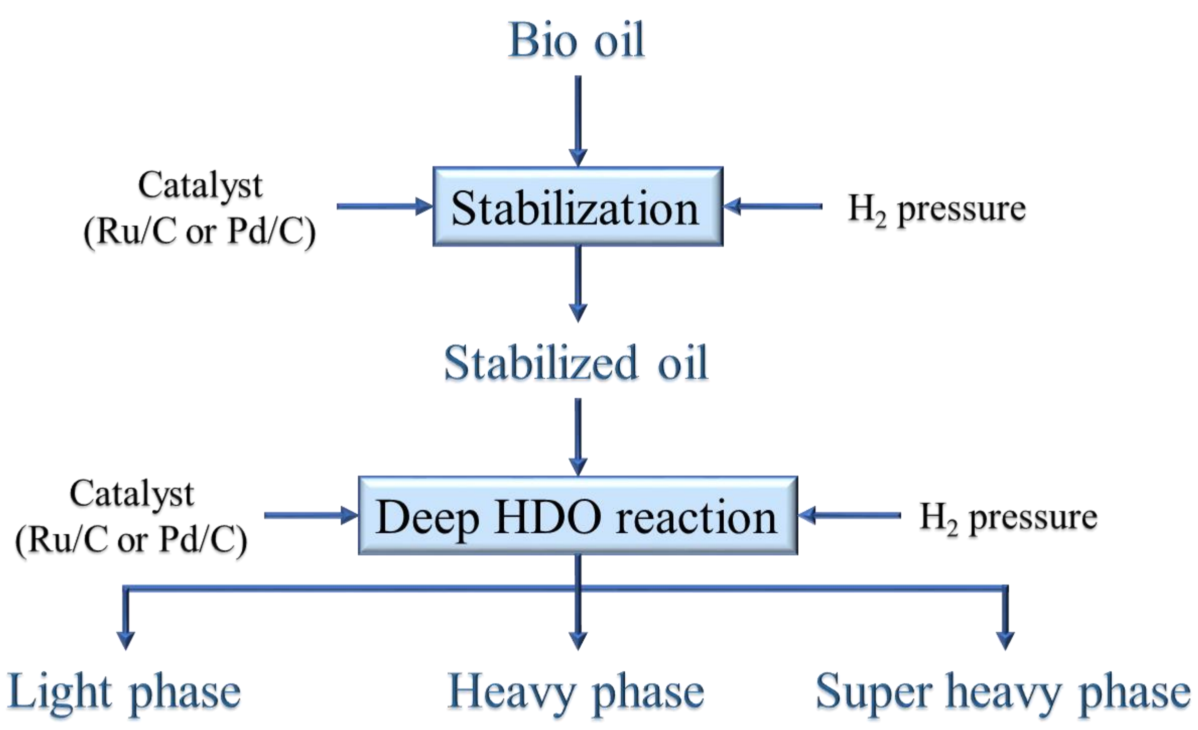
Optimize the stabilization of fast pyrolysis bio-oil and hydrodeoxygenation reactions using Pd/C and Ru/C catalysts

Methodology

Biomass Preparation



Reaction flowchart



Analytical analysis

- Elemental analysis (CHN)
- Inductively Coupled Plasma (ICP)
- Water content
- High heating value (HHV)
- Degree of deoxygenation (DOD)
- GC-FID and GC-MS

Results

Figure 1. GM-MS of stabilized oil

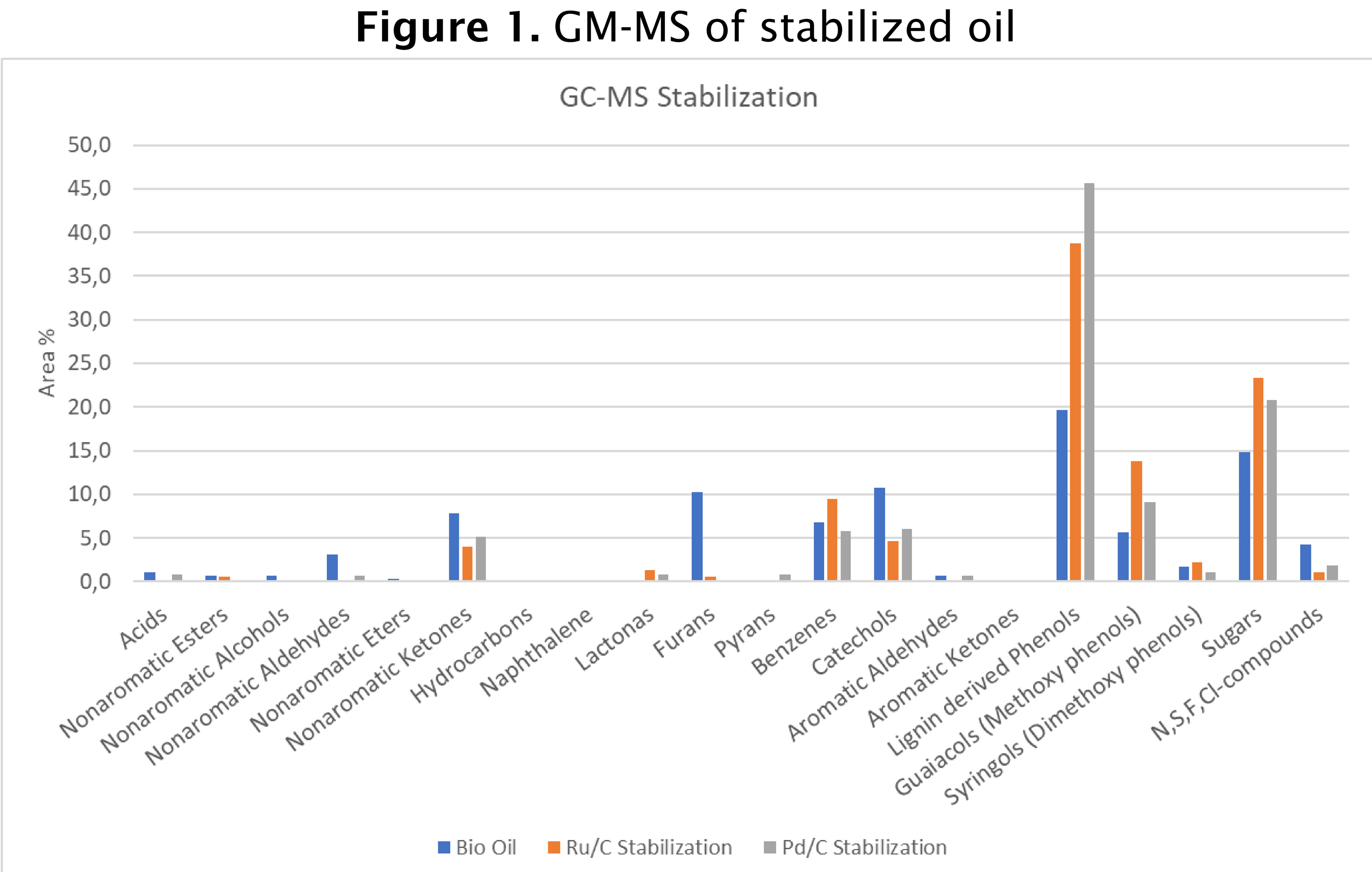


Figure 2. GM-MS of HDO

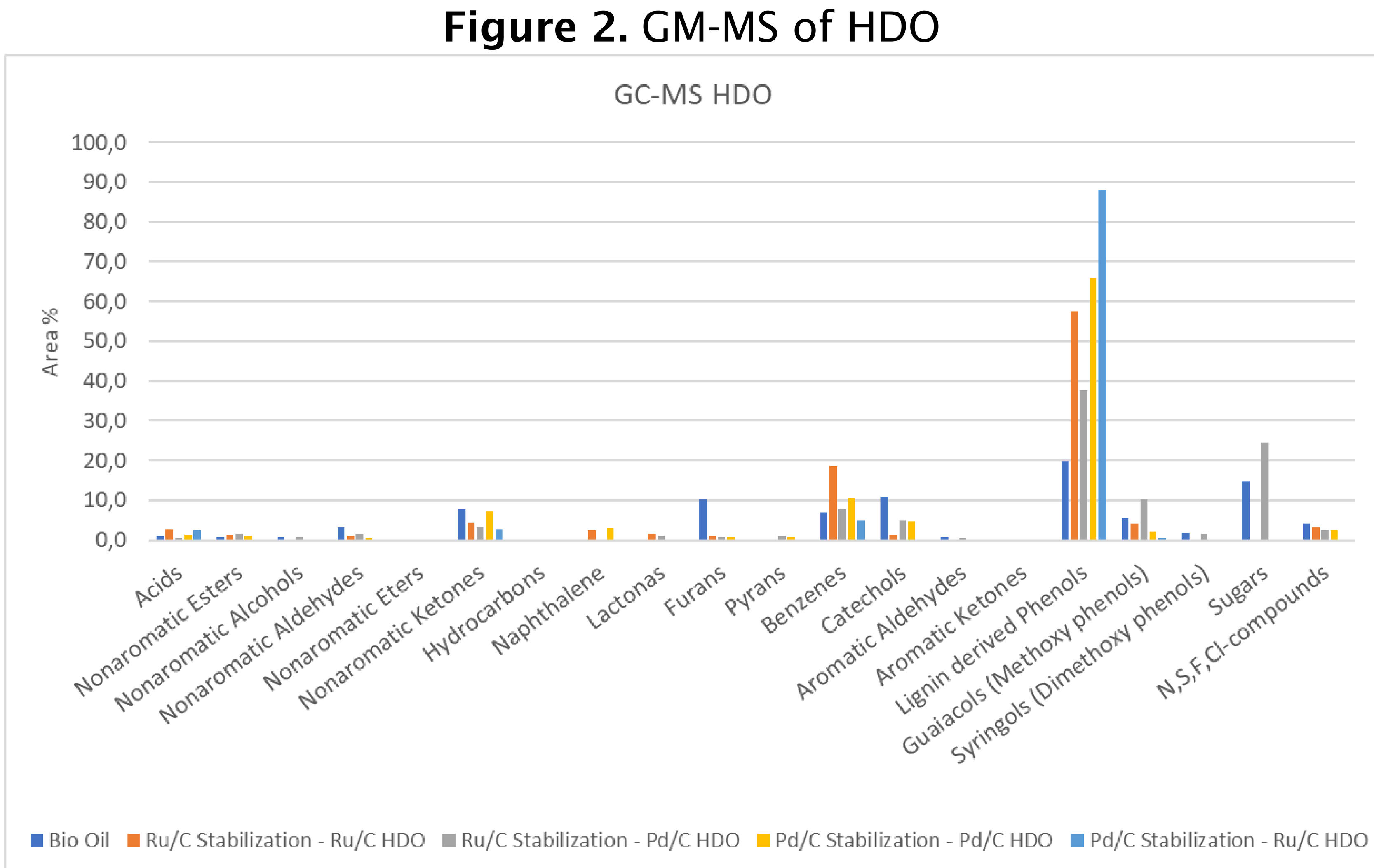


Table 1. Reactions parameters results

Reaction	HHV (MJ/kg)	DOD (w.t. %)	H_2 consumption (mol %)
Bio oil	24.0	-	-
Stabilization with Ru/C	25.7	17.42	23.47
Stabilization with Pd/C	24.8	0.82	24.35
HDO with Ru/C (Stabilization with Ru/C)	33.4	53.77	93.23
HDO with Pd/C (Stabilization with Ru/C)	34.1	55.12	93.18
HDO with Pd/C (Stabilization with Pd/C)	33.3	50.48	91.87
HDO with Ru/C (Stabilization with Pd/C)	34.4	53.41	78.35

Conclusions

- The best combination of catalysts was observed for: Pd/C for FPBO stabilization and Ru/C for HDO of the stabilized oil.
- Pd/C Stabilized oil followed by HDO with Ru/C presented a significant reduction of 53.4 wt.% in oxygen and H_2 consumption of 78.4 vol.%.
- FPBO stabilization proved to be efficient for the conversion of ketones, aldehydes and furans.

Optimization of the bio-oil stabilization process to minimize hydrogen consumption

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Keywords: sugarcane bagasse, bio-oil stabilization, catalytic hydrodeoxygenation, hydrogen consumption

Sugarcane bagasse (SCB) is widely explored in alternative processes for generating steam and electrical energy [1]. The aim is to apply it in innovative solutions capable of converting it into new products that contribute to circular delivery systems. SCB fast pyrolysis bio-oil (FPBO) enhanced by catalytic hydrogenation (HDO) appears as one of the alternative intermediate products to produce biofuels [2]. However, to avoid unwanted reactions, as polymerization, a preview stabilization step (SS) at mild HDO reaction conditions of the bio-oil is proposed [3]. This work aimed to optimize the stabilization of FPBO and HDO reactions using two noble metal catalysts. The FPBO was produced using a Brazilian SCB and the pyrolysis was carried out in the fast pyrolysis unit, located at IKFT. The upgrading reaction were conducted in a lab scale autoclave. Key parameters to determine HDO reaction were conducted as follow: H_2 consumption was estimated after the HDO reactions, calculated by the pressure and gas composition differences. Elemental analysis, water content, and higher heating value (HHV), were determined for the upgraded FPBO. The degree of deoxygenation (DOD) was computed under the assumption that the samples exclusively consisted of carbon, H_2, nitrogen, and oxygen. The optimal catalyst combination identified consisted of Pd/C during the FPBO stabilization stage and Ru/C for the HDO stage of the stabilized oil. The HDO results for the stabilized oil revealed a significant reduction of 53.4 wt.% in oxygen content in comparison to the initial FPBO and H_2 consumption of 78.3 vol.%. Nevertheless, additional upgrading steps are deemed necessary to further mitigate the remaining oxygenate content.

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