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Assessment of bimetallic catalysts supported on carbon nanotubes for the conversion of bio-oil into jet fuel

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PURPOSE OF THE ABSTRACT

Currently, sustainability guides the scientific and industrial advances seeking for new processes and technologies without compromising or depleting the natural resources. The aviation sector has experienced a huge market expansion in the last two decades and tends to grow even more. Moreover, this activity contributes to about 5 % of the anthropogenic gas
emissions, aggravating the climate crisis [1,2]. Regarding this scenario, the use of biomass as feedstock for jet fuel production is an alternative to overcome the drawbacks caused by using petrochemical-based fuel. Microalgae bio-oil has attracted attention as a raw material for this purpose, once it is composed of a large amount of C14-C22 long-chain fatty acid, the same carbon range observed in jet fuel (C8-C20) [3]. However, some physical-chemical properties as well as the high acidity, high unsaturation bounds reactivity and especially the high oxygen content leading to low heating value, make it impossible for its use as a drop-in fuel [4]. Catalytic hydrodeoxygenation (HDO) reactions are widely used in the industry to obtain chemical products, being an option to upgrade bio-oil. The catalyst plays an important role in this process, once not only HDO is favored, but also cracking and isomerization reactions, enhancing fuel properties, such as the freezing point [5]. The choice of the metal phase and the support are essential to the appropriate chemical and textural properties, aiming to improve the catalytic performance and also to achieve high substrate conversion into the desirable aliphatic hydrocarbon C8-C20 range [6-7]. In this context, this work focused on the development of bimetallic catalysts to assess their catalytic activity in HDO, cracking and isomerization reactions. As supports, carbon nanotubes (CNT) were used in their original form and modified with nitric acid treatment (CNTox) in order to obtain materials with oxygenated groups on the surface. After that, the catalysts were synthesized by the incipient wetness impregnation method, calcined in nitrogen at 250 °C for 3 h followed by reduction in hydrogen atmosphere at 250 °C for 3 h, obtaining Ir-Mo/CNT, Ir-Mo/CNTox, Ru-Mo/CNTox and Ni-Mo/CNT. All the catalysts were characterized by N2 adsorption at -196 °C, thermogravimetry (TG) and temperature programmed reduction (TPR). Preliminary results showed that the prepared catalysts are essentially mesoporous materials, which is an important textural property to minimize mass transfer limitations when both the reagents and products are long-chain carbon molecules. In addition, the catalysts are thermally stable at the temperature used in typical HDO reactions (250 - 400 °C).

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FIGURES

FIGURE 1

FIGURE 2

KEYWORDS

bio-oil | hydrodeoxygenation | bimetallic supported catalysts | jet fuel

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