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Catalysts produced by the combustion method for H_2 production through the biomass gasification route

Wilson S. Mercês Neto[1,3], João Pedro S. Alves[1,3], Graziele R. Constancio[1,3], Mauricio B. dos Santos[1,3], Fernanda T. Cruz[1,3], Raildo A. Fiuza Junior[1,3], Karen V. Pontes[2,3], Artur J. S. Mascarenhas[1,3]*

[1] Laboratório de Catálise e Materiais (LABCAT), Departamento de Química Geral e Inorgânica, Instituto de Química, Universidade Federal da Bahia (UFBA), 40.170-115, Salvador-BA, Brasil.
[2] Laboratório de Processos Sustentáveis e Energias Renováveis, Escola Politécnica, Universidade Federal da Bahia, R. Prof. Aristides Novis, 2, Federação, 40210-910, Salvador – BA, Brasil.
[3] Programa de Pós-Graduação em Energia e Ambiente (PGENAM), Escola Politécnica, Universidade Federal da Bahia (UFBA), Salvador – BA, Brasil.
**E-mail:* artur@ufba.br

Abstract

Hydrogen energy is the cleanest among alternative energy sources, producing only water as a combustion product, which allows us to truly achieve "zero emissions" of pollutants. Gasification is a type of thermal degradation in an oxidizing atmosphere, which, in the case of biomass, involves its partial oxidation to produce a mixture of gases containing H_2, CO, CH_4 and CO_2 [1], commonly executed at higher temperatures (700-1200 ºC). Literature presents nickel as the current most used metal for its low cost and results of C conversion and H_2 yield and selectivity. Other metal widely used for this reaction is calcium, which is not used as active phase for H_2 production reactions, but as CO_2 adsorbent in the system, indirectly favoring those reactions [2]. Due to this, Ni and Ca oxides were used allied to alumina support, producing oxides with spinel-like structures [3]. The catalysts were synthesized by the combustion method using urea as fuel and the metals nitrates as precursors. After combustion, the materials were characterized by thermogravimetric analysis (TGA), X-ray diffractometry (XRD), N_2 physisorption texture analysis and Fourier-transform infrared spectroscopy (FTIR). TGA data was mainly used to evaluate the possible residues derived from incomplete combustion, which were found in the samples prepared using Ca in the catalyst composition, but also in the samples prepared with urea in sub-stoichiometric conditions. The samples which presented mass losses when heated until 1000 ºC were calcinated at 600-800 ºC for 3h. With the help of XRD data, it was identified $NiAl_2O_4$ with some NiO segregated in the samples containing only Ni and Al. For the samples containg Ca and Ni or Ca and Al, $CaCO_3$ phases were qualitatively observed, even before calcination, until 800 ºC. For samples with sub-stoichiometric urea, non-decomposed nitrates were the main obtained phases, but, after calcination at 800 ºC, pure oxide phases were observed. For the samples containing Ca, the phase $CaCO_3$ was probably formed by the reaction between the CaO and the CO_2 formed in the synthesis. After calcination, the samples containing Al presented the oxide phase peaks of the monometallic oxides or spinel-like bimetallic oxides MAl_2O_4. The BET was measured by the N_2 physisorption, presenting surface areas ranging from 0,8 to 89 $m^2 g^{-1}$, being small surface areas common for oxides synthesized by the combustion method. Infrared spectroscopy showed bands characteristic of M-O vibrations in both octahedral and tetrahedral sites, when spinel-like phases are present, but only octahedral M-O when other oxide phases are predominant. These materials will be evaluated as catalysts in the gasification of biomass in a stainless-steel fixed bed reactor with air and/or steam flow and high temperatures. The effluents will be analyzed in a gas chromatograph to evaluate the products of the reaction and optimize the H_2 production.

Palavras-chave: Hydrogen production, biomass gasification, spinel-like oxides

References

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