IMPROVED CO_2-GASIFICATION OF BIOMASS OVER Ni/CeO_2 CATALYSTS: EFFECT OF CERIA MORPHOLOGY AND CARBONATES ADDITION

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ABSTRACT

The conversion of biomass through gasification into syngas is crucial for achieving energy independence and increasing the share of renewable energy sources in the energy mix[1]. Interestingly, when biomass gasification is combined with industrially captured CO_2 emissions it can reverse the threat of climate change into a CO-rich gas mixture that can be employed for the production of energy, synthetic fuels and platform chemicals. Removal of tars and water from syngas is necessary to create a gas mixture suitable for many downstream applications[2]. In situ tar reforming with efficient catalysts improves syngas quality, reduces purification steps, and lowers gasification time and temperature. Transition metal catalysts, especially nickel, improve tar removal and syngas production by boosting Steam Reforming (SR) and Water Gas Shift (WGS) reactions. Due to synergistic interactions between the metal and support, nickel can boost catalytic activity and selectivity when combined with ceria, a popular support due to its high oxygen mobility and unique redox properties. Moreover, the addition of molten alkali carbonate (MAC) salts directly to biomass boosts carbon conversion and syngas generation due to their rapid heat transfer ability and alkali metal catalytic activity[3]. In light of the above considerations, the present work focuses on the gasification of Greek olive kernel (OK), using CO_2 as a gasifying agent, in the presence of Ni-CeO_2 and/or MAC salt catalysts. The catalyst-aided gasification experiments were performed at non-isothermal conditions in a fixed-bed reactor under batch operation. Various characterization methods were employed to investigate the morphological and structural properties of these catalysts. It was revealed that CeO_2 morphology, NiO particle size and catalyst's redox ability, were crucial parameters towards an improved gasification process. The binary eutectic carbonate mixture (Li-K Molten Salts) exhibited a better gasification performance compared to Ni-based catalysts. However, in the case of combined Ni-based/Li-K Molten Salts catalysts, a synergetic effect was revealed on tar cracking and devolatilization reactions further increasing syngas production and carbon conversion efficiency.

KEYWORDS: Olive kernel, CO_2 gasification, Ni/CeO_2, molten carbonates salt (MS), carbon conversion

REFERENCES

[1] Parvez AM, Afzal MT, Victor Hebb TG, Schmid M. (2020). J CO2 Util., 40, 101217.

[2] Binte Mohamed DK, Veksha A, Ha QLM, Chan WP, Lim TT, Lisak G. (2022). Fuel, 318, 123602.

[3] Abdalazeez A, Li T, Wang W, Abuelgasim S. (2021). J CO2 Util, 43.