

Sustainable carbon-based Cu/Zn catalysts for the water gas shift reaction

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Hydrogen is a versatile energy carrier, which provides a viable pathway toward sustainable development. Among the various existing production routes, the water gas shift (WGS) reaction is fundamental to producing high purity H₂ and is widely used in a few industrial applications. However, its efficiency is highly dependent on the type of catalyst. In this context, the search for more active, stable, and sustainable materials has gained relevance, highlighting the use of alternative supports to alumina such as activated carbons derived from lignocellulosic biomass. These materials offer favorable texture and chemical properties, promoting the development of more efficient catalysts with less environmental impact. Therefore, the aim of this work is to evaluate Cu/Zn catalysts supported on activated carbons derived from lignocellulosic biomass, such as olive stone, in the WGS reaction.

The carbonaceous support, activated carbon with a specific surface area of approximately 1200 m²/g, was prepared by physical activation of an olive stone char obtained at 800 °C for 1 h, followed by steam gasification at 850 °C. Catalyst preparation was carried out by wet impregnation of the support with a theoretical CuO mass loading of 15 % w/w and different ZnO contents, ranging from 0 to 15 % w/w. In a typical experiment, 500 mg of catalyst, with space time of 61 mg_{cat}·s/μmol, was used in a fixed bed reactor. Before reaction, the catalyst was reduced in situ with H₂ at 300 °C. The feed stream was set at 75 ml/min, with a composition of 16 % CO and 32 % H₂O in N₂. The reactions were carried out in a temperature range from 150 to 360 °C.

The catalyst with the highest catalytic activity was CuO15@OSG, reaching a CO conversion close to 80 %, a value close to thermodynamic equilibrium, and a H₂ yield of 39 % at 300 °C, Fig 1. (A). The addition of ZnO does not seem necessary to disperse the active phase, possibly due to the high porosity development of the support, which favors a homogeneous distribution of copper. The CuO15@OSG maintains high stability and selectivity after 24 h of reaction at 300 °C, achieving an equimolecular conversion of CO into CO₂ and H₂, Fig 1. (B). After the stability test, the catalyst shows no change in porosity. XRD reveals peaks associated with metallic copper and a certain increase in crystal size is observed, suggesting a possible sintering of the metal.

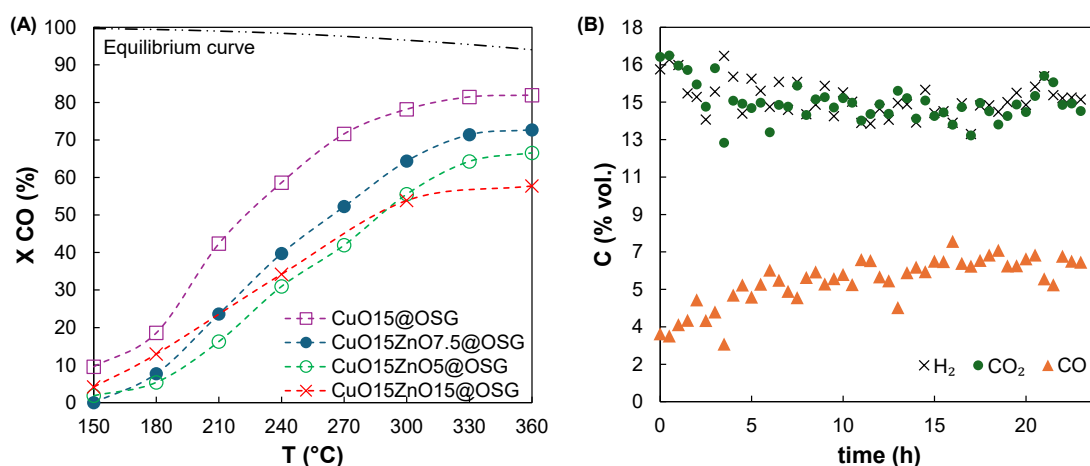


Fig 1. (A) CO conversion at WGS as a function of temperature for the different catalysts and, **(B)** volumetric concentration profiles of H₂, CO₂ and CO after 24 h of reaction with CuO15@OSG at 300 °C.

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