An efficient heterogeneous adsorbent based on highly dispersed $CuFe_2O_4$ nanoparticles on activated carbon for deep oxidative desulfurization in gas stream

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Palabras clave: $CuFe_2O_4$, H_2S removal, catalytic oxidation, adsorption, activated carbon.

Introduction

Hydrogen sulfide (H_2S) is a pollutant of high toxicity and corrosivity that inevitably is present in an atmosphere as a result of natural and anthropogenic processes. Its sources include anaerobic digestion, geothermal or volcano eruptions, and oil refineries.it is extremely necessary to develop an efficient technology for capturing and reducing their impact on the environment [1].

Room-temperature hydrogen sulfide catalytic oxidation into elemental sulfur based on porous carbon materials is considered as a promising strategy to address H_2S at low concentrations. Activated carbon is an exemplary support that has been used as a catalyst for the desulfurization process, Furthermore, it has proven that the desulfurization performance can be further enhanced by loading metal oxides on the activated carbon matrix. the resulting materials have both active phases with developed porosity, which can combine both physical adsorption and catalytic oxidation phenomena thereby improving the hydrogen sulfide removal by dissociation of H_2S. [2]

Experimental

Adsorbents with different loadings of $CuFe_2O_4$ (5 wt%, 10 wt%, and 20 wt%) were prepared using a wet impregnation method followed by a calcination process under spesific conditions. the adsorbents materials obtained were characterized using N_2 adsorption at 77 K, XRD, XPS, SEM-EDX, and Raman spectroscopy.

The H_2S breakthrough capacity measurements were performed at room temperature using a fixed-bed column by removing H_2S from the mixed gases containing H_2S and N_2.

Results and discussion

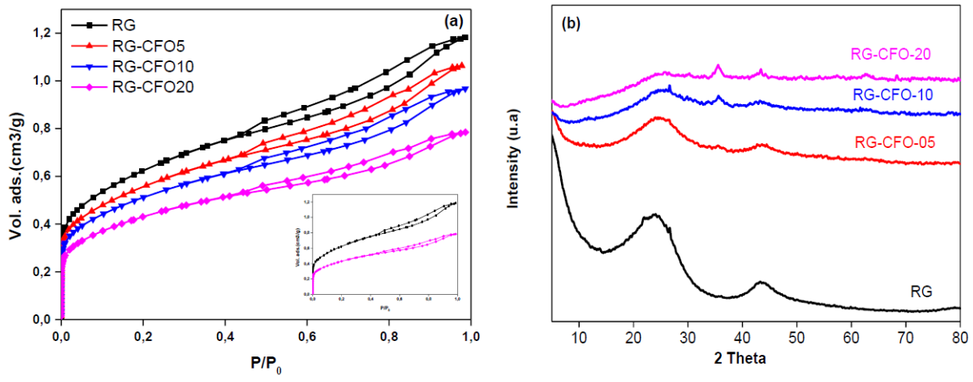

Figure 1. (a) N_2 adsorption/desorption isotherms at 77 k and (b) XRD pattern of the adsorbents.

Figure 1a show the nitrogen adsorption / desorption isotherms at 77 K for all carbon materials. The virgin carbon (RG) and RG-CFO-X sorbents show a mixed type I and IV isotherm with a hysteresis loop, according to the IUPAC classification. where the dispersion of $CuFe_2O_4$ on RG resulted in a decrease in the surface area and total pore volumes.

Figure 1b shows two obvious diffraction peaks corresponding to the (022) and (100) planes at 23º and 43º were contributed to amorphous AC. After supporting $CuFe_2O_4$, these two broad diffraction peaks become weak, together with some new diffraction peaks corresponding to a spinel-structured $CuFe_2O_4$.

XVI REUNIÓN DEL GEC 22-25 OCTUBRE GIJÓN 2023

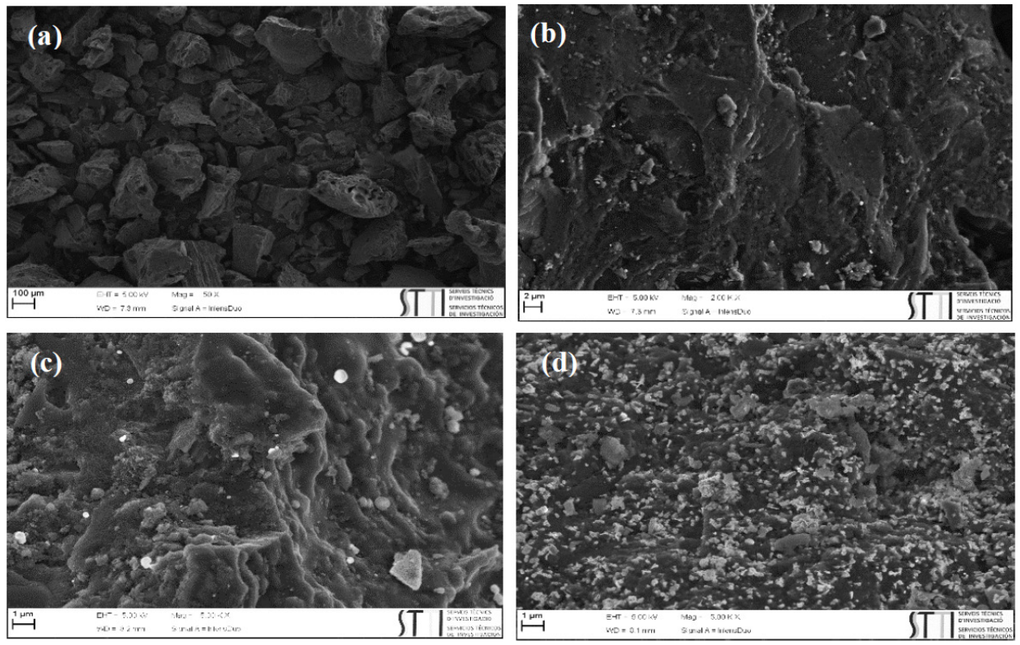

Figure 2. SEM images of (a) RG, and the modified carbons (b) RG-CFO-5, (c) RG-CFO-10, and (d) RG-CFO-20.

Figure 2a shows the image of AC support before $CuFe_2O_4$ modification, the original carbon is bulk material with a 3D-structure and irregular morphology. After loading $CuFe_2O_4$, the morphology of the support remains undistorted, and $CuFe_2O_4$ grains with irregular shapes are well dispersed onto the AC support (shown in Figure 2 (b, d)).

Conclusiones

A new carbon modification procedure based on the deposition of $CuFe_2O_4$ in the carbon pore system resulted in efficient air desulfurization adsorbents capable to remove large quantities of H_2S at ambient conditions.

The highly dispersed $CuFe_2O_4$ phase was deposited in the mesopores of the carbon matrix. Its introduction, besides decreasing the porosity, affected the carbon matrix microstructure.

Referencias

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