

Área: INO

Synthesis, Characterization, and Application of Cobalt Hydroxide Salts in Dye Adsorption

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Highlights

Cobalt hydroxide salts were synthesized with varying anions (Cl^- , NO_3^- , SO_4^{2-}) by urea hydrolysis. Anion variation affected structural and optical properties, exhibiting excellent anionic dye adsorption.

Abstract

Hydroxide salts are compounds with structures that can host anions between their structures. In this work, cobalt hydroxide salts were synthesized with different intercalated anions, namely Cl^- , NO_3^- , and SO_4^{2-} . These materials were produced using the urea hydrolysis methods and then characterized through X-ray diffraction, Fourier transform infrared spectroscopy, scanning electron microscopy, and colorimetry. These analyses confirmed the synthesis of cobalt hydroxide sulfate (HSCo), cobalt hydroxide nitrate (HNCo) and cobalt hydroxide chloride (HCCo). In the XRD analysis, it was observed that the intercalated anions influenced the distances between the layers, with larger anions resulting in greater interplanar spacing. The first diffraction peak showed 10.23 Å for HSCo, 6.97 Å for HNCo, and 5.50 Å for HCCo. In addition, it can also be observed that HSCo has low crystallinity, while HNCo and HCCo have high crystallinity. Infrared analyses revealed the characteristic bands of each hydroxide salt, such as OH^- bonds, NO_3^- and SO_4^{2-} groups, and Co-O bonds. On the other hand, SEM analyses revealed the morphologies of these materials, as well as their distribution. In colorimetric analyses, HSCo presented a blue color (a^* 1.09 and b^* -9.60), HNCo presented a purple color (a^* 13.72 and b^* 0.14), and HCCo presented a pink color (a^* 18.79 and b^* 21.76). After being characterized, the hydroxide salts were applied as adsorbent materials in the removal of various dyes, including methylene blue, fast green FCF, sodium fluorescein, orange G, sunset yellow, methyl orange, and congo red. In general, the dyes that showed the best removal rates were methyl orange and Congo red using HSCo and HNCo, where HSCo showed an adsorbent capacity corresponding to 477.64 mg/g for the methyl orange dye and 463.29 mg/g for Congo red. HNCo, on the other hand, showed an adsorption capacity of 470.27 mg/g for Congo red and 242.85 mg/g for methyl orange. For HCCo, the dye that achieved the highest removal was sunset yellow, with an adsorption capacity of 298.98 mg/g. In contrast, methylene blue was the dye that showed the lowest removal for the three materials, with an adsorption capacity of 26.88 mg/g, 19.02 mg/g, and 4.68 mg/g for HSCo, HNCo, and HCCo, respectively. Therefore, cobalt hydroxide salts have an interesting adsorption capacity, especially in the removal of anionic dyes.

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