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In-Situ synthesis of Metal-Organic Framework (MOF) on Layered Double Hydroxide (LDH) for Adsorptive Removal of Evans Blue Dye

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ABSTRACT

In this work, we report the synthesis of a new hybrid material based on MOF-ZnPA (MOF: Metal Organic Framework, Zn: Zinc, PA: Pyromellitic Acid) and Co-Zn-Al-Co_3 Layered Double Hydroxide (LDH) via a facile solvothermal method using DMF (N,N'-Dimethylformamide) as solvent. The structure and morphology of the synthesized new materials have been investigated by X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR) which confirmed obtaining MOF-ZnPA/LDH at different percentage of LDH (10, 30 and 50%). The adsorption characteristics of the synthesized materials for the Evans Blue dye showed an adsorption capacity of 246 mg/g for MOF-ZnPA/LDH compared to 141 mg/g for MOF-ZnPA without LDH after 40 minutes of contact time.

Keywords: MOF, LDH, Adsoprion capacity, Blue Evans Dye, water treatme

1 Introduction

Latest research efforts have focused on creating innovative and exceptionally effective adsorbents that can overcome the constraints of conventional methods [1]. Within this context, two materials: Metal-Organic Frameworks (MOFs) and Lamellar Double Hydroxides (LDH) gain the attention of the scientists. Metal-organic frameworks (MOFs) are a family of hybrid-type microporous crystalline solids organic-inorganic periodic network formed via multiple metal-ligand bonds with 2D or 3D structure. MOFs exhibit exceptional structural versatility, high surface areas, and tunable pore size [2]. Lamellar double hydroxides (LDHs), also known as hydrotalcites, are a class of two-dimensional clays consisting of cationic brucite-like layers and exchangeable interlayer anions [3]. They have drawn increasing interest for their ion exchange properties, and Specific surface area, which can contain several elements in a single structure, through the combination of cations, typically divalent and trivalent [3]. The incorporation of a layered structure in LDHs and micro/mesoporosity in MOFs can both improve the properties of the materials compared with their original structure. It is possible that the rise in mass diffusion was caused by ion exchange because of the MOFs porosity, and features of LDHs multilayer structure [4]. In this perspective, we will prepare two kind of composite. The first one will be based on MOF and the second will be a mixed material of MOF and LDH for a potential application concerning dye adsorption.

2 Experimental

MOF-ZnPA synthesis was carried out by the solvothermal method using N,N'-Dimethylformamide (DMF) as solvent and by mixing pyromellitic acid as organic ligand and zinc nitrate hexahydrate as metallic ion. The mixture as maintain under stirring for 18h at 120°C. The same procedure was used for the synthesis of MOF-ZnPA/LDH but adding a certain amount of LDH. To test the efficiency of MOF-ZnPA/LDH as adsorbent for the adsorption of organic dye from water, we did an experience using blue Evan's as an example of dye used in the textile industry.

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3 Results and Discussion

FT-IR spectroscopy confirmed the structure of MOF-ZnPA and MOF-ZnPA/LDH. Characteristic bands of both LDH and MOF were observed, indicating the simultaneous presence of both phases in the composite structure. The structure of the diffractogram of MOF-ZnPA/LDH showed the peaks of both MOF-ZnPA and LDH, proving the compound is conventional and that means the development of MOF-ZnPA crystals on the LDH sheets. The results in Table 1 showed that the presence of LDH in the structure of MOF-ZnPA/LDH compound allows improving its capacities for adsorbing BE dye compared with MOF alone.

Table1*: Quantity adsorbed BE according to the initial concentration in dye (t = 40 min) (qt mg/L,*

Compound	**q_t(mg/g) at 10mg/L**	**q_t (mg/g) at 30 mg/L**	**q_t (mg/g) at 50 mg/L**
MOF-ZnPA	25.797	105.872	141.937
MOF-ZnPA/LDH (30%wt)	36.311	138.022	246.335

4 Conclusions

Our findings from this study revealed the potential and the various advantages of these new efficient hybrid materials for the water treatment contaminated with toxic dyes generated by various industries.

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