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Adsorption of Pb(II) with MOF [Co2(Btec)(Bipy)(DMF)2]N in Aqueous Solution

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Abstract : Water pollution has become one of the most serious environmental problems. Multiple methods have been proposed for the removal of Pb(II) from contaminated water. Among these, adsorption processes have shown to be more efficient, cheaper and easier to handle with respect to other treatment methods. However, research for adsorbents with high adsorption capacities is still necessary. For this purpose, we proposed in this work the study of metal-organic Framework [Co2(btec)(bipy)(DMF)2]n (MOF-Co) as adsorbent material of Pb (II) in aqueous media. MOF-Co was synthesized by a simple method. Firstly 4, 4' dipyridyl, 1,2,4,5 benzenetetracarboxylic acid, cobalt (II) and nitrate hexahydrate were first mixed each one in N,N dimethylformamide (DMF) and then, mixed in a reactor altogether. The obtained solution was heated at 363 K in a muffle during 68 h to complete the synthesis. It was washed and dried, obtaining MOF-Co as the final product. MOF-Co was characterized before and after the adsorption process by Fourier transforms infrared spectra (FTIR) and X-ray photoelectron spectroscopy (XPS). The Pb(II) in aqueous media was detected by Absorption Atomic Spectroscopy (AA). In order to evaluate the adsorption process in the presence of Pb(II) in aqueous media, the experiments were realized in flask of 100 ml the work volume at 200 rpm, with different MOF-Co quantities (0.0125 and 0.025 g), pH (2-6), contact time (0.5-6 h) and temperature (298,308 and 318 K). The kinetic adsorption was represented by pseudo-second order model, which suggests that the adsorption took place through chemisorption or chemical adsorption. The best adsorption results were obtained at pH 5. Langmuir, Freundlich and BET equilibrium isotherms models were used to study the adsorption of Pb(II) with 0.0125 g of MOF-Co, in the presence of different concentration of Pb(II) (20-200 mg/L, 100 mL, pH 5) with 4 h of reaction. The correlation coefficients (R2) of the different models show that the Langmuir model is better than Freundlich and BET model with R2=0.97 and a maximum adsorption capacity of 833 mg/g. Therefore, the Langmuir model can be used to best describe the Pb(II) adsorption in monolayer behavior on the MOF-Co. This value is the highest when compared to other materials such as the graphene/activated carbon composite (217 mg/g), biomass fly ashes (96.8 mg/g), PVA/PAA gel (194.99 mg/g) and MOF with Ag12 nanoparticles (120 mg/g).

Keywords : adsorption, heavy metals, metal-organic frameworks, Pb(II)
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