PREPARATION OF MONOMETALLIC CATALYST SUPPORTED Cu/CLAY: CALCINED SUPPORT EFFECT

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ABSTRACT

The aim of this work is to prepare the monometallic catalyst supported on clay by impregnation method. Calcined support, pH solution and initial concentration effects are studied. This result shows that adsorption behavior of natural clay and calcined clay are strongly depending on pH solution and initial concentration of Cu.
Keywords: clay, adsorption, catalyst, copper, support

INTRODUCTION

Clay is a natural inorganic mineral, composed primarily of fine-grained minerals, which is generally plastic at appropriate water contents and will harden when dried or fired[1]. Clay minerals provide several advantages, which include their low-cost, non-toxicity[2-4]. Clays found in nature is composed of a base sheet alumino silicate[5]. Moreover, clays are materials that can act as Lewis and Bronsted acid, and offer a large cation exchange capacity in a layered structure. It presents chemical and physical stability and high specific surface area[6,7]. In recent years, special attention has been focused on the use of natural resources as alternatives to conventional support. The clay supported catalyst by natural Ivory Cost clay has not been extensively explored. The aim of this work is to prepare monometallic catalysts copper supported on clay by the impregnation method. For this study, we have used natural and calcined clay. The initial concentration and pH range effect has been elaborated.

EXPERIMENTAL

Material and Methods
The samples were analyzed via perkin-elmer A Analyst 700 flame atomic absorption spectrophotometer. Natural clay from Agboville city in Ivory Cost was used as raw material. Prior clay was grinded to powder using laboratory mortar. The samples were sieving to obtain particles whose sizes were smaller than 125 μm. Two kind of clay were used in this manipulation, natural clay and calcined clay (500°C for 4 h).
1g of clay was dissolved in a beaker containing 25 mL distilled water and vigorously stirred for 15 minutes. An appropriate amount of $CuSO_4, 5H_2O$ was poured into the clay suspension with a total load weight of 1-5% metal. HCl and NaOH solution were used to adjust the pH solution. The resulting suspension was kept under stirring at room temperature for 24h. The solid was separated by filtration and dried at 110°C on the stove for 1 h.

RESULTS AND DISCUSSION

Effect of copper content
The dosage study is an important parameter in adsorption studies, because it determines the adsorption capacity of the clay for a given initial concentration of metallic ion. This study presents the effect of the deposited copper content on naturel clay and calcined clay in a wide range of pH. Figure-1 (a, b) shows that copper deposited content in naturel clay and calcined clay increases with increasing initial concentration. It reaches a maximum at 2.37 mg/g in naturel clay and 1.73 mg/g in calcined clay at pH =

7. These results are comparable to those obtained by Lahrabi and M'leyehin[8]. Mimanne and all study the adsorption of Pb and Cd on Montmorillonite (Na), and show that amount of Pb and Cd adsorbed increases with the one introduced in solution[8]. However note that the deposit is not total, is still low. Our results agree with those of Mimanne. In fact, in our case the deposit is 3.2%. Furthermore, the adsorption capacity of natural clay is higher than calcined clay.
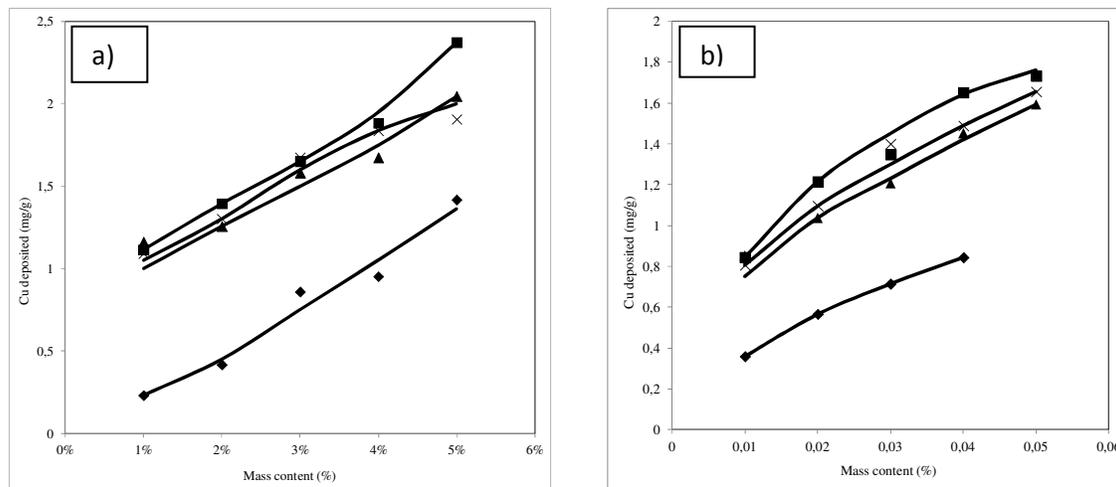

Fig.-1 : Deposited copper according to mass content on natural clay (a) and calcined clay (b) at different pH; (♦) 1; (▲) 5; (■) 7; (x) 9.

Effect of pH

The adsorption capacity is not influenced only by the textural properties of the adsorbent, such as specific surface area, and pore size distribution, but also by the chemical nature of its surface[9]. The chemical characteristics of the adsorbent surface can considerably be altered by the pH level of an adsorption system[10]. Furthermore, the pH value can affect the ionization degree of the adsorbate and metal ion speciation in a solution[11,12]. Hence this parameter has a direct effect on the adsorption performance of clay. The interaction process and particularly the adsorption capacity of the sorbent surface created positive or negative charge on its surface depending on the solution pH.

As noted in Figure-2 (a, b, c, d), the adsorption capacity of Cu (II) is strongly dependent on pH, and also dependent on ionic strength. Cu (II) uptake increases quickly with an increase in pH up to 5.0. The maximum adsorption capacity is reached at pH = 7. The same phenomenon has been observed in previous studies carried out by Godfin, Youcef, and Abolino[13,14].

The low adsorption at low pH in natural clay and calcined clay may be to the high concentration and high mobility of H+ ions. The surface charge of the prepared adsorbent is positive due to an excess of protons on the surface[15]. The hydrogen ions are preferentially adsorbed rather than the metal ions. There would also be competition between the Al^{3+} ions, Mg^{2+}, Fe^{3+} released by the octahedral sites of clay in acid solution[16]. For pH = 5 we note the increase in adsorption in natural clay and calcined clay.

At this level, we consider that, there is not a competition between the hydrogen and the metallic ions for the available sorption sites on the clay. At higher pH than 7.0, the precipitation of copper hydroxides has been the dominating mechanism[17]. The predominant species of metal in solution are M^{2+} and $M (OH)^+$ ions. The formation of anionic hydroxide complexes decreases the capacity of Cu adsorption[18]. The number of negatively charged sites increases, which must be less favorable to the adsorption of Cu ions due to electrostatic repulsion.

Whatever the pH of the solution, it shows that the adsorption of Cu in the natural clay is greater than calcined clay. It is probably due to the presence of impurities, mainly carbonate.
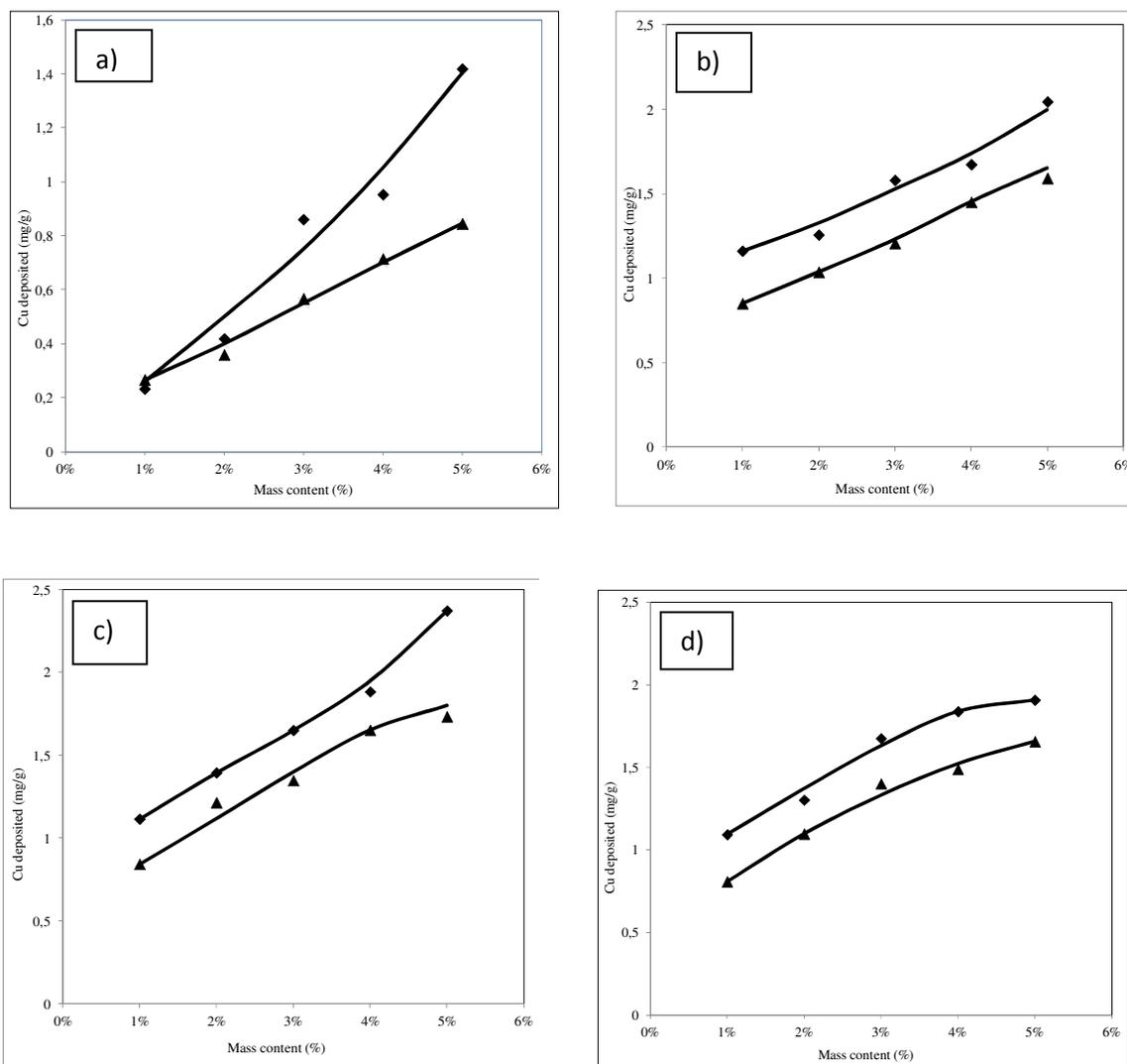
Fig.-2: Deposited copper according to mass content on natural clay (♦) and calcined clay (▲) at different pH; (a) 1; (b) 5; (c) 7; (d) 9.

CONCLUSION

In this study we have prepared monometallic catalysts copper supported on clay. The results reveal the ability of the copper to be deposited on the natural and calcined clay. In this investigation the deposited does not depend only on the chemical and physical properties of these adsorbents, but also on the composition of pH and the concentration. From this study, it is apparent that the adsorption of Cu on the natural clay is greater than that of calcined clay.

ACKNOWLEDGEMENTS

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[RJC-1417/2016]