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Adsorption of methylene blue using Ni/Fe layered double hydroxide

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Abstract
There is a growing concern about environmental issues regarding industrial wastes coming from various industries, textile being one of them. The coloured effluents from textiles like dyes have become a serious concern as the removal is difficult and necessary. Taking this issue into consideration the adsorption studies of Methylene blue have been performed using Ni/Fe Layered double hydroxide also called as anionic clay. The Ni/Fe hydrotalcites were prepared by the co-precipitation method and used for the adsorption studies of Methylene blue. The effects like contact time and initial concentration of dye were investigated in the paper.

Keywords: Adsorption, Ni/Fe layered double hydroxide, Methylene blue

1. Introduction
Annually substantial amount approximately 710 [5] tons of dyes are produced and out of it nearly 710 [4] tons per annum are released by industries like rubber food, textile, paper and pulp industries [1]. Removal of these dyes from water is major environmental issue. The removal of color from wastewater is a major environmental problem because it is difficult to treat colored wastewaters with conventional methods [2]. Colour in effluents can cause problems in several ways; dyes have chronic effects on organisms depending on the exposure time and concentration. Among the various types of processes for dye removal (physical, chemical, biological methods, electrochemical oxidation and adsorption methods), the adsorption process is one of the most efficient [3-6]. Activated carbon is the most popular adsorbent due to its high adsorption capacity for organic and inorganic pollutants [7]. Moreover, the use of low cost materials for adsorption has attracted attention as a color removal technique. For example, natural clays, bagasse fly ash, chitosan and other adsorbents have been used [8-11].

Layered double hydroxides also known as hydrotalcite are nowadays used as an adsorbent in various fields. These materials are not so extended in nature as the well known cationic clays, are easy to prepare and not expensive [12]. LDHs have seeked industrial attention due to their potential in industrial purposes, wherein they are used as Adsorbent, Ion Exchangers, Catalyst and Drug Carrier. LDHs also known as Anionic Clays consists of layered structure similar to mineral Brucite ($Mg(OH)_2$). In LDHs a number of divalent cations (M^{2+}) are substituted with trivalent cations (M^{3+}) which leads to formation of layered structures. General formula of LDHs:

$$[M^{2+}_{1-x}M^{3+}_{x}(OH)_2]^{x+}(A^{n-})_{x/n}$$

2. Materials and Methods
2.1. Preparation of the adsorbent
The preparation of the required adsorbent was carried out by the method of co-precipitation described by Reichle [13]. $NiCl_2.6H_2O$ (1M) and $FeCl_3$ (2M) are dissolved in distilled water with a Ni/Fe ratio 1:5. NaOH (1M) solution was added drop wise in the mixture with vigorous stirring and with a drop rate of one drop per 5 seconds till the pH of this mixture was maintained in the range of 4-5. After complete addition the slurry was filtered and washed several times with distilled water and the precipitate was dried for 15 hours at 100 ºC followed by calcining it at 1000 ºC for 6 hours [14].

2.1.1. Adsorbate

The methylene blue dye used in the adsorption studies whose structural formula is given below in Fig.1.

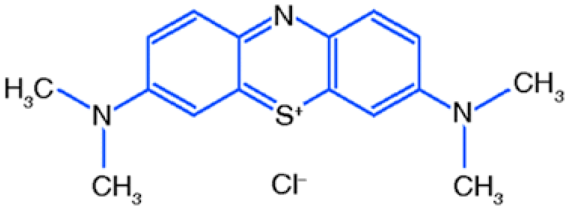

Fig 1: Chemical structure of Methylene Blue

2.3 Preparation of dye solution

A stock solution of 1000mgl^{-1} was prepared by dissolving 1.127g Methylene blue (MB) in 1000ml distilled water. The experimental solution was prepared by diluting the stock solution with distilled water to between 20 - 80mgl^{-1}. The concentration of MB was determined at 648 nm by the using UV 1600 Shimadzu spectrophotometer.

2.4 Batch Adsorption Procedure

The experiments were performed using a LDH dose of 25 mg with 20ml of dye solution at desired contact time and initial MB concentration. A 0.025g each of the powdered sample was collected and weighed using an electronic weighing balance; the weighed sample was placed in cleaned beakers. 20ml of the dye solutions (MB) with standard concentrations were made from the stock solution and added to weighed mass of LDH [15]. The samples were equilibrated by shaking (agitation) for each time intervals of 5, 10, 15, 20 and 25 minutes respectively. The sample suspensions were centrifuged for 5 minutes, decanted and the supernatants stored for the time studies of dye (MB), initial concentration of 20, 40, 60 and 80 mg/L were used for the time differential studies and supernatants store and used for UV-analysis (UV 1600-Shimadzu).

2.5 Data Analysis

The experimental data for different parameters were subjected to equilibrium and the interpretation of adsorption was done using the amount of dye retained per unit mass of solid at equilibrium calculated by:

$$qe = (C_0 - C_e)V/m \qquad (1)$$

Where qe (mg/g) is the amount of dye adsorbed per gram of adsorbent; m(g) is the mass of the LDH adsorbent, C_o and C_e (mg/L) are the dye concentrations respectively at t = 0 and at equilibrium.

3. Results and Discussion

Optimizing the adsorption process conditions need a study of effect of concentration and time for designing. The contact time between the pollutant and the adsorbent and initial concentration of dye is presented in figures below. Fig. 2 shows the effect of contact time between the LDH and MB dye solutions (20, 40, 60 and 80 mg/L). Thus, Rapid adsorption and equilibrium in a short period of time is related to the efficacy of the adsorbent [14, 16]. Fig. 3 shows a plot of equilibrium concentration with initial dye concentration.

The results indicate as time increases equilibrium concentration increases for various initial dye concentrations (20, 40, 60, 80 mg/L) and equilibrium concentration for a particular time period is found to increase with dye concentration till a certain limit and then further increase in concentration leads to decrease in equilibrium concentration. Rapid adsorption in the experiment is associated with the presence of a large number of vacant sites at the surface of LDH and available for adsorption. Equilibrium is reached after saturation of the entire surface. Most of the adsorbate species are physically adsorbed within a short time frame. However, strong chemical bonds between the adsorbate and the adsorbent require a longer contact time to achieve equilibrium.

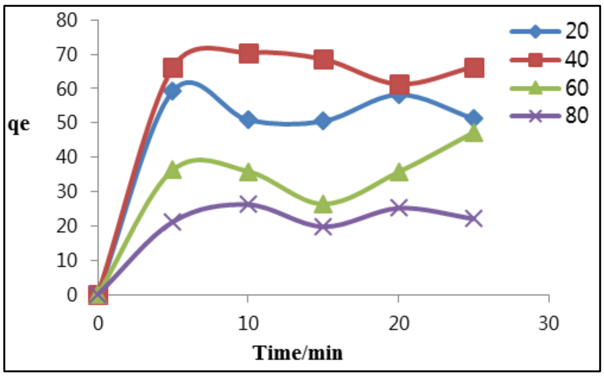

Fig 2: Effect of time on the adsorption of MB dye onto LDH

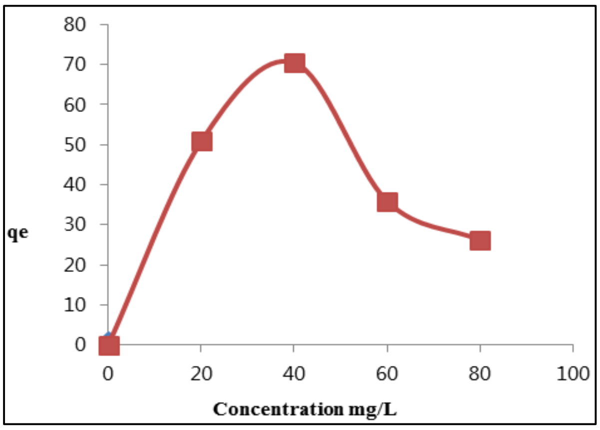

Fig 3: The graph of variation of equilibrium concentration with concentration of dye used for adsorption.

4. Conclusion

The research indicates that there are many factors of the adsorbent and the adsorbate which can affect the extent and rate of the adsorption process. The structure of dye, size, shape and charge influence the uptake. Significant research remains to be done into the development of economical and environmentally friendly adsorbent.

5. References

1. Gupta VK, Suhas. Application of low-cost adsorbents for dye removal – A review, J. Environ. Manage. 2009; 90:2313-2342.
2. Rafatullaha M, Sulaimana O, Hashima R, Ahmad A. Adsorption of methylene blue on low-cost adsorbents: a review, J. Hazard. Mater. 2010; 177:70-80.
3. Ladhe UV, Patil PR. Removal of Yellow 2G dye from aqueous solutions using activated carbon prepared from mosambi and cotton an agricultural waste, IOSR-JESTFT. 2014; 8(1):49-54.
4. Jannatul Ferdous Rumky, Zainal Abedin, Hafizur

Rahman, Ali Hossain. Environmental Treatment of Dyes: Methyl Orange Decolorization Using Hog Plum Peel and Mix-Bacterial Strains, IOSR-JESTFT, 2013; 5(3):19-22.
5. Zhu M-X, Lee L, Wang H-H, Wang Z. Removal of an anionic dye by adsorption/precipitation processes using alkaline white mud, J. Hazard. Mater. 2007; 149:735-741.
6. Dotto GL, Pinto LAA. Adsorption of food dyes acid blue 9 and food yellow 3 onto chitosan: stirring rate effect in kinetics and mechanism, J. Hazard. Mater. 2011; 187:164-170.
7. Zahrim A, Tizaoui C, Hilal N. Evaluation of several commercial synthetic polymers as flocculant aids for removal of highly concentrated C.I. Acid Black 210 dye, J. Hazard. Mater. 2010; 182:624-630.
8. Mall ID, Srivastava VC, Agarwal NK. Removal of Orange-G and Methyl Violet dyes by adsorption onto bagasse fly ash-kinetic study and equilibrium isotherm analyses, Dyes Pigments. 2006; 69:210-223.
9. Fungaro DA, Bruno M. Removal of methylene blue from aqueous solution using zeolite synthesized from different coal fly ashes samples, Quím. Nova. 2009; 32:955-959.
10. Zhu H-Y, Fu Y-Q, Jiang R, Jiang J-H, Xiao L, Zeng G-M *et al*. Adsorption removal of congo red onto magnetic cellulose/Fe_3O_4/activated carbon composite: equilibrium, kinetic and thermodynamic studies, Chem. Eng. J. 2011; 173:494-502.
11. Dawood S, Sen TK. Removal of anionic dye congo red from aqueous solution by raw pine and acid-treated pine cone powder as adsorbent:Equilibrium, thermodynamic, kinetics, mechanism and process design, Water Res. 2012; 46:933-1946.
12. Layered double hydroxides: present and future, Vincente Rives, Nova science publishers Inc., Newyork, 2001. ISBN 1-59033-060-9
13. Fuerhardt DS, Reichle WT. Synthesis of anionic clay minerals (mixed metal hydroxides, hydrotalcite). Solid State Ionics. 1986; 22:135-141.
14. Sadik R, Lahkale R, Hssaine N, Diouri M, Sabbar EM. Removal of textile dye by mixed oxide-LDH: kinetics,isotherms of the adsorption and retention mechanisms studies. 2014; 8(8):28-36.
15. Ayawei Nimibofa, Ebelegi Augustus N, Wankasi Donbebe. Comparative sorption studies of dyes and metal ions by Ni/Al layered double hydroxide. International journal of materials and chemistry. 2017; 7(2):25-35.
16. Dehbashi Mohsen, Aliahmad Mousa RM, Shafiee Mohammad, Ghashang Majid. NiO-SnO2 Composite Nano-Powder: Preparation and Evaluation of their Catalytic Activity in the Synthesis of 1-amido alkyl-2-naphtholes. Letters in Organic Chemistry. 2012; 9:711.