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KINETIC STUDY FOR CONGO RED DYE ADSORPTION FROM WASTEWATER

Gabriela Buema[1], Nicoleta Lupu[1], Horia Chiriac[1], Lidia Favier[2], Gabriela Ciobanu[3], Maria Harja[3]*

1 National Institute of Research and Development for Technical Physics, 47 Mangeron Boulevard, Iasi 700050, Romania
2 Univ Rennes, Ecole Nationale Supérieure de Chimie de Rennes, CNRS, ISCR – UMR6226, F-35000 Rennes, France
3 “Gheorghe Asachi” Technical University of Iasi, Faculty of Chemical Engineering and Environmental Protection, 73 Prof.dr.doc. Dimitrie Mangeron Street, 700050 Iasi, Romania,
*Corresponding author: **mharja@tuiasi.ro**

Introduction

Congo red (CR), an anionic azo dye, is investigated due to negative impacts on human health. Various materials have been used to adsorb CR through adsorption process: NiO/graphene nano sheets; MWCNTs/LDHs; NiMgAl-LDOs; α-Fe2O3 nanorods; Bentonite/Zeolite-NaP; Ca-Al LDH; Al(OH)3/CuMnAl-LDH nanocomposite; NiFe-LDH nanosheet/ carbon fiber nanocomposite. Among of these, LDH type materials are of particular interest due to some advantageous properties.

In the present study, MgAl-LDH was employed as an adsorbent for CR adsorption. The data were processed using Pseudo first order and Pseudo second order models. The kinetics of CR adsorption onto material was described with the Pseudo-second-order model, with a maximum adsorption capacity of 40.44 mg/g.

Materials and methods

The chemical reagents were analytical grade and were used as received. MgAl-LDH was obtained through co-precipitation method, using a Mg/Al ratio of 2/1. The initial CR dye solution of 50 mg/ L was prepared by diluting a stock CR solution (0.5 g/ L) with distilled water. The batch equilibrium experiments were carried out at natural pH, with 20 mg samples dispersed in 20 mg/L CR solution. The CR concentration in the supernatant was analyzed using UV–vis spectrophotometer at 497 nm. The experiments were realized at room temperature with intermittent stirring. The adsorption capacity at different time, qt (mg/g), was calculated using:

$$qt = (Co-Ct)V/m \quad (1)$$

where Ct is CR concentrations at different time intervals (mg/L), qt is the amount of CR adsorbed onto MgAl-LDH, V is the volume of solution (L), and m is the quantity of MgAl-LDH (g).

Results and conclusions

The samples were collected and analyzed until the adsorption capacities became closer. The results are presented in Figure 1 and Tables 1, respectively Table 2. From the Figure 1a it can be observed that the qt of CR increases quickly in the first 20 min, and then increases slowly until the equilibrium is reached.

Kinetic parameters were determined from the slope and intercepts of the linear plots of log(qe-qt) vs. t, respectively t/qt vs. t. Comparing R2 of both kinetic models, it is obvious that the Pseudo second order model is suitable for the adsorption kinetic for CR dye onto MgAl-LDH. The experimental qe value of 40.44 mg/g is very close with the qe value of 40.81 mg/g calculated from the Pseudo second order model. The Pseudo second order kinetic model has been linearized into four different types (table 2). The R^2 value of Linear Type 1 demonstrates that this type of Pseudo second order model represents the CR dye adsorption onto material. Taking into consideration that the Pseudo second order model is more suitable to describe the data obtained, it can be highlights that the chemical adsorption process is predominant for CR adsorption onto MgAl-LDH synthesized material. The data confirm that MgAl-LDH has the ability to retain an anionic azo dye in the studied conditions.

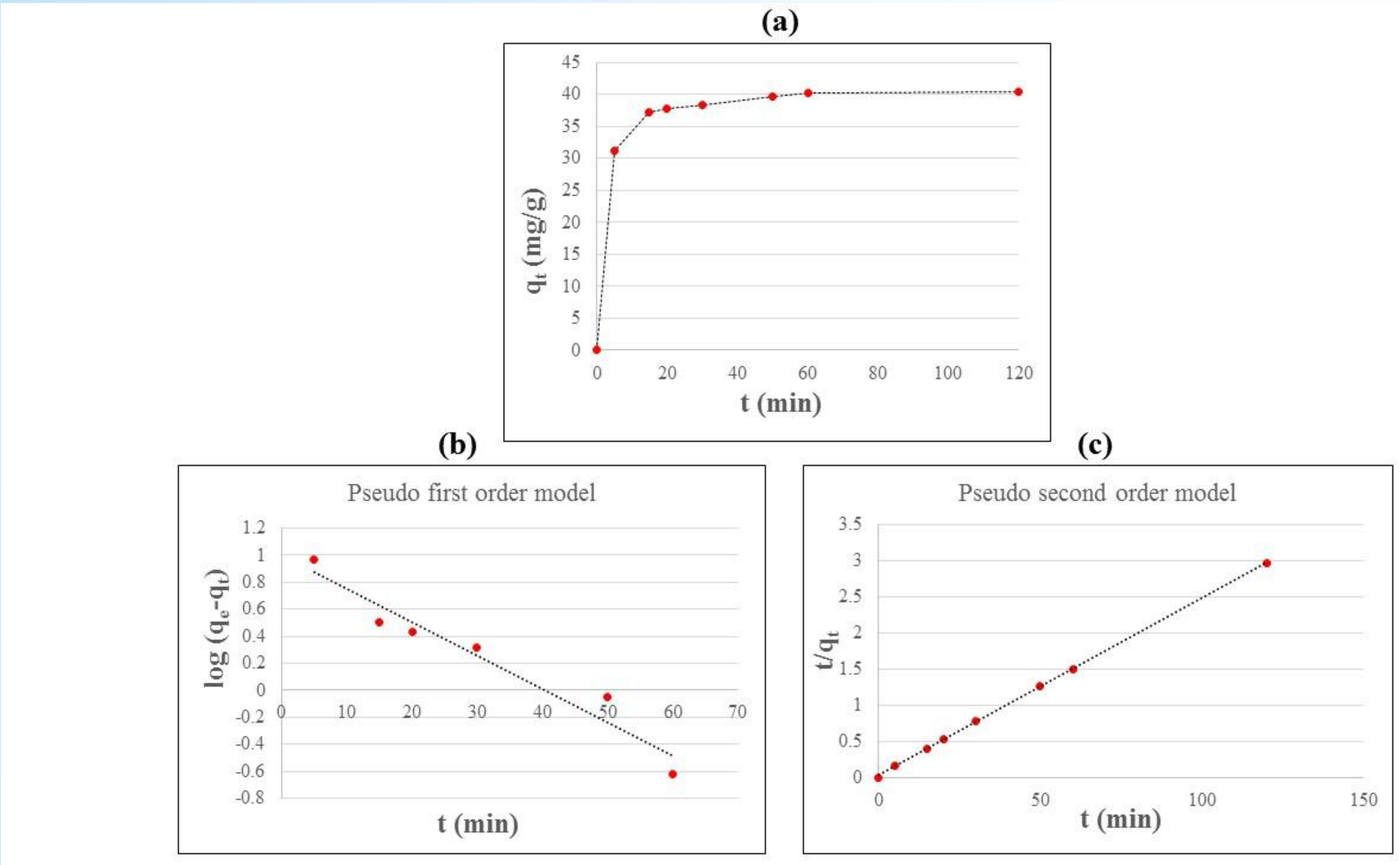

Figure 1 a- Influence of contact time; b - Pseudo first order; c- Pseudo second order

Table 1. Kinetic parameters of CR dye onto MgAl-LDH

Kinetic model	Parameters	Values
Pseudo-first order	k_1,1/min	0.0571
	R^2	0.9395
Pseudo-second order	q_e cal, mg/g	40.81
	k_2, g/mg min	0.0197
	R^2	0.9998

Table 2. Pseudo second order kinetic parameters obtained from the linear forms

Parameters	Type I	Type II	Type III	Type IV
q_e (mg/g)	40.81	40.81	40.85	40.88
k (g/mg min)	0.0197	0.0158	0.038	0.0155
R^2	0.9998	0.9944	0.9911	0.9911

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