CHEMISTRY JOURNAL OF MOLDOVA. General, Industrial and Ecological Chemistry. 2016, 11(2), 74-83
http://cjm.asm.md
http://dx.doi.org/10.19261/cjm.2016.11(2).10

REMOVAL OF METHYLENE BLUE BY ADSORPTION ONTO *RETAMA RAETAM* PLANT: KINETICS AND EQUILIBRIUM STUDY

Dalila Badis[a], Zoubir Benmaamar[b*], Othmane Benkortbi[a], Houcine Boutoumi[c], Houria Hamitouche[b], Amele Aggoun[c]

[a]*Biomaterials and Transport Phenomena Laboratory, University of Dr Yahia Fares, Ain d'hab, Medea 26000, Algeria*
[b]*Hydrogen Energetical Application Laboratory, University of Blida1, Soumaa, Blida 9000, Algeria*
[c]*Chemical Engineering Laboratory, University of Blida1, Soumaa, Blida 9000, Algeria*
**e-mail: benmaamarzoubir@yahoo.fr*

Abstract. The feasibility of using medicinal plants species *Retama raetam* as a low cost and an eco-friendly adsorbent for the adsorption of cationic dye methylene blue from simulated aqueous solution has been investigated. Adsorption kinetics of methylene blue onto *Retama raetam* plants was studied in a batch system. The effects of pH and contact time were examined. The methylene blue maximum adsorption occurred at pH 8 and the lowest adsorption occurred at pH 2. The apparent equilibrium was reached after 120 min. Optimal experimental conditions were determined. Adsorption modelling parameters for Freundlich and Langmuir isotherms were determined and, based on R^2, various error distribution functions were evaluated as well. Adsorption isotherm was best described by non linear Freundlich isotherm model. Thermodynamic studies show that adsorption was spontaneous and exothermic. For determining the best-fit-kinetic adsorption model, the experimental data were analyzed by using pseudo-first-order, pseudo-second-order, pseudo-third-order, Esquivel, and Elovich models. Linear regressive and non-linear regressive method was used to obtain the relative parameters. The statistical functions were estimated to find the suitable method that fit better the experimental data. Both methods were appropriate for obtaining the parameters. The linear pseudo-second-order (type 9 and type 10) models were the best to fit the equilibrium data. The present work showed that plant *Retama raetam* can be used as a low cost adsorbent for the removal of methylene blue from water.

Keywords: *Retama raetam*, methylene blue, removal, modelling, adsorption.

Received: June 2016/ Revised final: November 2016/ Accepted: November 2016

Introduction

The textile industry is one of industrial waste water source. This contaminated water is very toxic for the humans and animals [1]. Methylene blue is used in colouring paper, dyeing cottons, wools, silk, leather and coating for paper stock. Although methylene blue is not strongly hazardous, it can cause some harmful effects, such as heartbeat increase, vomiting, shock, cyanosis, jaundice, quadriplegia, and tissue necrosis in human organisms [2].

Chemical coagulation–flocculation [3], different types of oxidation processes [4], biological process [5], membrane-based separation processes [6] and adsorption [7] were the treatments used in the purification of waters. The most efficient method used for the quickly removal of dyes from the aqueous solution is the physical adsorption [8]. Biosorbents, such as wood sawdust [9], waste-biomass [10], delonix regia [11], agricultural solid waste [12], are able to remove efficiently the colour from water.

Retama raetam plants can be used as biosorbent. This species belonging to the *Fabaceae* family has a very productive vertical and horizontal root system, which can reach 20 m. This, in turn, increases substantially the stabilization of the soil. Moreover, the *Retama* species contributes to the biofertilisation of poor grounds, because of their aptitude to associate with fixing nitrogen bacteria *Rhizobia*. Therefore, the genus of *Retama* is included in a re-vegetation program for degraded areas in semi-arid Mediterranean environments [13].

Retama raetam is a common plant in the North African and East Mediterranean region. In Algeria, it is located in Sahara and Atlas regions and is used in folk medicine under the common name "R'tam" to reduce the blood glucose and skin inflammations, while in Lebanon it is used as folk herbal medicine against joint aches and in Morocco against skin diseases. Previous pharmacological studies on the plant have revealed its various medicinal properties: antibacterial, antifungal, antihypertensive, antioxidant, antiviral, diuretic, hypoglycaemic, hepatoprotective, nephroprotective and cytotoxic effects. *Retama* species have been reported to contain flavonoids and alkaloids [14].

However, there are no reported studies on the adsorption of cationic dyes by *Retama raetam*. This work aims to understand the potential of *Retama raetam* for removal of methylene blue dye from simulated aqueous solution in batch mode. The adsorption efficiency of methylene blue was investigated in order to optimize the experimental parameters. The statistical functions were used to estimate the error deviations between experimental and theoretically predicted adsorption values, including linear and non-linear method. The optimization procedure required a defined error function in order to evaluate the fit of equation to the experimental data.