Chemical Engineering Journal 218 (2013) 89–98

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

Dye anionic sorption in aqueous solution onto a cellulose surface chemically modified with aminoethanethiol

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HIGHLIGHTS

- Cellulose was modified with aminoethanethiol.
- The kinetic sorption occurs in pseudo-second-order model.
- The excellent pH's for interaction was 2 and 9.
- The experimental data was adjusted to Langmuir model.
- New material could be employed as low-cost material for the removal of anionic dye.

ARTICLE INFO

Article history:
Received 2 October 2012
Received in revised form 27 November 2012
Accepted 28 November 2012
Available online 8 December 2012

Keywords:
Cellulose
Modification
Characterization
Adsorption
Anionic dye

ABSTRACT

The natural biopolymer cellulose was initially chlorinated at the 6 carbon with a degree of substitution (DS) 0.99 ± 0.01 and then reacted with aminoethanethiol to form a modified compound with different basic centers, and this material was characterized by elemental analysis, XRD, TG, FTIR and ^{13}C NMR. The matrix obtained was effective in removing red reactive anionic dye in an aqueous medium at pH values of 2 and 9. The equilibrium time of adsorption obtained was approximately 100 min (pH 2) and 160 min (pH 9), and the kinetics for both systems followed a pseudo-second-order model. The adsorption isotherms at different pH levels at three different temperatures obeyed the Langmuir model, and the maximum adsorption capacities were 78 mg g^{-1} (pH 2) and 26 mg g^{-1} (pH 9), and the interaction was electrostatic and hydrogen bonds and/or covalent, respectively.

1. Introduction

In recent years, environmental pollution caused by the indiscriminate discharge of dyes has been a concern of the worldwide community [1,2]. Many industries, such as the textile industry, produce wastewater that contains strongly colored cationic and anionic dyes. Many of these dyes in wastewaters may affect peoples' lives in various ways by, for example, contaminating water used for washing, bathing and drinking. Furthermore, the dyes are not biodegradable and can cause a variety of diseases and disorders in living organisms, even at low concentrations [3,4]. Therefore, many techniques for the removal of these pollutants have attracted the attention of chemists, and many of these techniques, which include precipitation, ion exchange, flocculation, adsorption, filtration and electrodeposition, are still experimental [5–7].

Among the previously mentioned techniques, adsorption is an important method for removing dyes from aqueous media [8]. This technique offers more flexibility than and a significant advantage over the other techniques because, in many cases, the treated effluent can be reused. In addition, adsorption is most often a reversible process, and the regeneration of the adsorbent is possible, which therefore allows the possibility of a large operating economy. However, some materials are limited with respect to their adsorption ability, economic aspects, and reactivity [9,10].

With the development of field of materials chemistry, constant searches have ensued for new, low-cost and renewable materials that exhibit low toxicity and for improvements in existing materials [11,12]. The currently most explored materials include cellulose, chitin, clay, and lignin, among other [13–16]. Among these materials, cellulose can be highlighted for being the most abundant

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http://dx.doi.org/10.1016/j.cej.2012.11.118