Journal of Environmental Chemical Engineering 4 (2016) 1274–1294

Contents lists available at ScienceDirect

Journal of Environmental Chemical Engineering

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

Adsorption of dyes onto palygorskite and its composites: A review

Bin Mu[a,b], Aiqin Wang[a,b,*]

[a] Center of Eco-material and Green Chemistry, State Key Laboratory of Solid Lubrication, Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences, Lanzhou 730000, PR China
[b] Center of Xuyi palygorskite Applied Technology, Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences, Xuyi 211700, PR China

ARTICLE INFO

Article history:
Received 26 November 2015
Received in revised form 7 January 2016
Accepted 25 January 2016
Available online 28 January 2016

Keywords:
Palygorskite
Activaition
Modification
Composite
Dye adsorption

ABSTRACT

With the continuous increase in the demand of dyes, the dye wastewater is becoming a major environmental threat. Adsorption techniques are widely used to remove dyes from wastewater using clay minerals, especially a naturally available one-dimensional palygorskite due to high surface area, moderate cation exchange capacity, excellent salt resistance compared with other clay minerals. Although the maximum adsorption of natural palygorskite toward dyes far exceeded the cation exchange capacity of palygorskite, it is difficult to completely release the adsorption capacity of palygorskite toward dyes due to the existence of the bulk crystal bundles or aggregates originated from the interparticle Van der Waals' and hydrogen bonding interactions. Therefore, it is indispensible to disaggregate palygorskite crystal bundles and introduce functional groups to improve the microscopic structure of palygorskite and increase the adsorption sites via various physical and chemical modifications. This review article summarizes the development on the modified palygorskite with different physical or chemical methods and palygorskite-based composite used as adsorbents for the adsorption of dyes from aqueous solution by reviewing a comprehensive literature combined with our group's research achievements. In addition, few conclusions and suggestions have been proposed for future research.

Contents

* Corresponding author at: Center of Eco-material and Green Chemistry, State Key Laboratory of Solid Lubrication, Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences, Lanzhou 730000, PR China. Fax: +86 931 8277088.
E-mail addresses: aqwang@licp.cas.cn, aqwang@lzb.ac.cn (A. Wang).

http://dx.doi.org/10.1016/j.jece.2016.01.036
2213-3437/

1. Introduction

The dye effluent is one of the most serious water pollution sources related to various industries such as textile, paper, plastic, leather, etc. It is difficult to exactly estimate the amount of dyes discharged from various processes in the environment. However, it is reported that approximately 100 tonnes/year of dyes is discharged into water streams with a consumption of more than 10,000 tonnes/year in the textile industry worldwide [1]. Due to the growing use of dyes, the dye wastewater is becoming a major environmental threat, even very small amounts of dyes in water (less than 1 ppm for some dyes) is highly visible and undesirable. However, it remains a difficult challenge to remove these dyes from wastewater, especially the removal of the low concentration of dyes. In recent decades, several physical, chemical and biological techniques have been reported to remove dyes from wastewater including adsorption, coagulation, membrane separation, chemical oxidation, photocatalytic degradation, electrochemical and aerobic and anaerobic microbial degradation, etc [2–8]. By contrast, adsorption is one of the most effective and feasible methods for the wastewater treatment owing to high efficiency, ease of operation and insensitivity to toxic pollutants. Adsorption as technique for dye adsorption can be traced back in 1912, which was employed to separate particular dye molecules [9]. In recent years, many efforts have been spent in developing the low-cost and high-effective adsorbents, such as natural materials, biosorbents, and solid wastes from agriculture and industry, as shown in Fig. 1. Among them, natural clay minerals (Fig. 2) are familiar to mankind from the earliest days of civilization, and they are acknowledged to be exceptionally promising candidates as low-cost, sustainable,

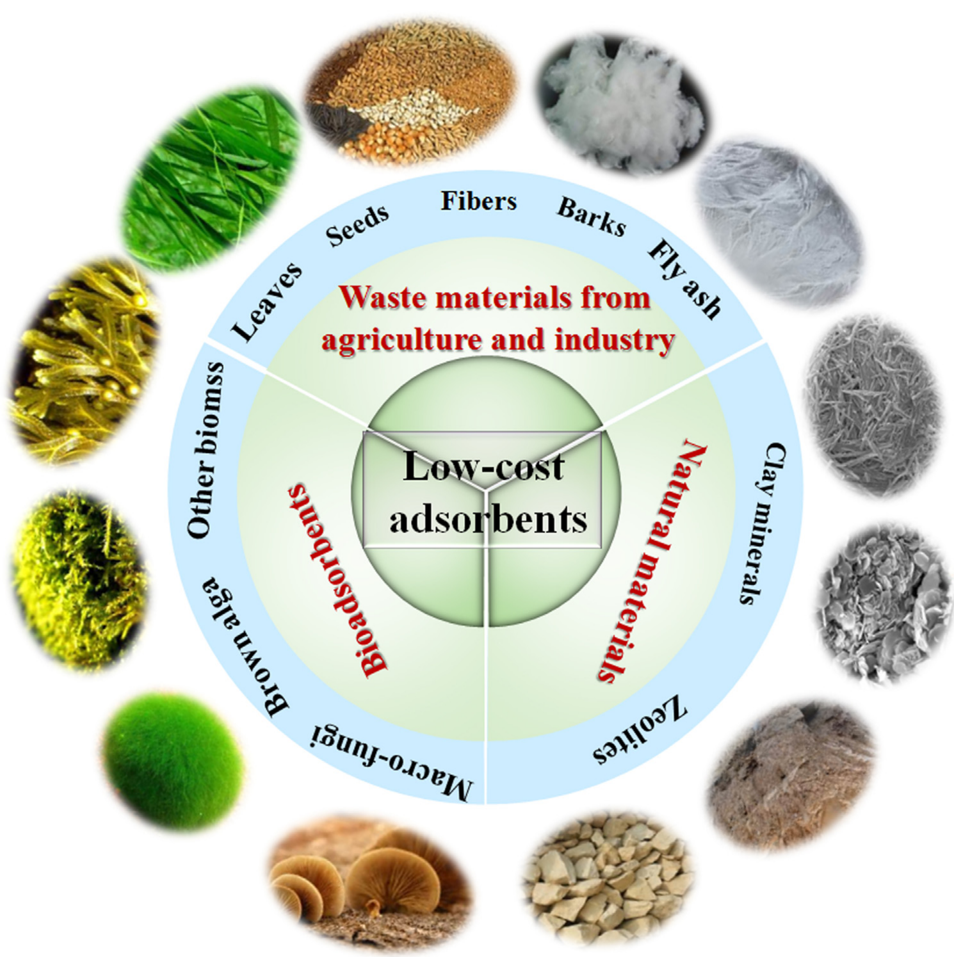

Fig 1. The common low-cost adsorbents for the removal of dyes from aqueous solution.