Chapter 8
Betung Bamboo–Based Magnetic Biochar for Dye Removal

Widi Astuti
Universitas Negeri Semarang, Indonesia

Irene Nindita Pradnya
Universitas Negeri Semarang, Indonesia

Triastuti Sulistyaningsih
Universitas Negeri Semarang, Indonesia

Khoiriyah Rahmawati
Universitas Negeri Semarang, Indonesia

Dhoni Hartanto
Universitas Negeri Semarang, Indonesia

Kusnia Kusnia
Universitas Negeri Semarang, Indonesia

ABSTRACT

Water is one of the vital resources of human life. The rapid development of the industrial sector in developing countries is one of the main factors that contribute to water pollution, due to a lack of environmental awareness. Therefore, it is very important to remove the pollutants from industrial wastewater before being discharged into water bodies. Adsorption using inexpensive and high availability materials such as magnetic biochar is a promising alternative. Embedding magnetite (Fe3O4) into biochar not only aims to solve the separating problem, but also to strengthen the adsorption performance of the biochar. This book chapter introduces the preparation and characterization of magnetic biochar derived from betung bamboo. Furthermore, a discussion was conducted to provide a perspective on the use of magnetic biochar in adsorption technology, particularly in the removal of dyes in an aqueous solution. Finally, the isotherm models for the magnetic biochar-dye system are discussed at the end of this chapter.

INTRODUCTION

Water is one of the vital resources of human life. The availability of water on earth is very large, covering 70% of the earth of which 3% is available as freshwater. However, among these, only 0.06% are accessible. Unfortunately, most of the world's population lives in developing countries with the provision of clean water is still a serious problem. The rapid development of the industrial sector in developing countries is one of the main factors that contribute to water pollution due to a lack of environmental awareness. The discharge of wastewater into the stream without prior treatment has reduced the self-cleaning capacity of the water and increased the pollution of water bodies. It is further exacerbated by the fact that some synthetic dyes, heavy metals, and organic compounds contained in the wastewater are toxic, teratogenic, mutagenic, carcinogenic, and nonbiodegradable (Wang et al., 2022; Astuti et al., 2011). Therefore, it is very important to remove the pollutants from industrial wastewater before being discharged into the water bodies. Several researchers have developed biological and physicochemical methods to remove pollutants from wastewater, including electrocoagulation (Prasetyaningrum et al., 2018), coagulation-flocculation (Badrus, 2018), ultrafiltration membrane (Aryanti et al., 2015), UF membrane (Istirokhatun et al., 2015), micellar-enhanced ultrafiltration (MEUF) membrane (Aryanti et al., 2017), anaerobic sequencing batch reactor (Rahayu et al., 2015), biosorption (Hadiyanto et al., 2014), phytoremediation using microalgae (Soeprobowati and Hariyati, 2017), anaerobic baffled reactor (Sumantri et al., 2015), advanced oxidation processes (Azizah and Widiasa, 2018), and adsorption (Astuti et al., 2016). The adsorption process with the advantages of simple process, easy operation, high efficiency, and low cost is a great alternative (Chafidz et al., 2018). Coal fly ash (Astuti et al., 2017), coal bottom ash (Kusmiyati et al., 2017), zeolite (Imandiani et al., 2018), clay (Darmawan et al., 2019), composite (Chen and Tseng, 2022), chitosan (Wang et al., 2022), activated carbon (Al-Latief et al., 2015; Arnelli et al., 2018; Arnelli et al., 2019), and biochar (Meng et al., 2022) have been used as adsorbents. Among these materials, biochar is an environmentally friendly adsorbent and has high economic value for removing organic and inorganic pollutants in aqueous solutions, including dye (Astuti et al., 2022).

Biochar, a black carbonaceous material, can be produced through the pyrolysis process under limited or no oxygen conditions (Medeiros et al., 2022) at a temperature of 300-1000 °C from various types of biomass such as sludge (Liu et al., 2022), organic waste (Zhang et al., 2022), agricultural waste (Ajeng et al., 2022; Murad et al., 2022), algae (Sun et al., 2021), forest residue (Aghababaei et al., 2017), and animal manure (Hossain et al., 2021). Besides biochar, pyrolysis of biomass also produces bio-oil and syngas. Therefore, the operation condition needs to be considered to obtain high-yield biochar. As a carbon-rich material and highly aromatic solid

Related Content

Airborne Particulate Matter: Source Scenario and Their Impact on Human Health and Environment

Bhawna Dubey, Asim Kumar Paland Gurdeep Singh (2017). *Environmental Issues Surrounding Human Overpopulation (pp. 202-223).*

www.irma-international.org/chapter/airborne-particulate-matter/173314

Farming Adaptations to the Impacts of Climate Change and Extreme Events in Pacific Island Countries: Case Study of Bellona Atoll, Solomon Islands

Viliamu Iese, Joseph Maeke, Elisabeth Holland, Morgan Wairiuand Sumeet Naidu (2015). *Impacts of Climate Change on Food Security in Small Island Developing States (pp. 166-194).*

www.irma-international.org/chapter/farming-adaptations-to-the-impacts-of-climate-change-and-extreme-events-in-pacific-island-countries/118024

Long Term Modeling and Predictive Assessment of Climate Change of Ukraine Polesie Zone

Petro Kovalenko, Nataliia Prykhodko, Vasyl Turcheniukand Jerzy Jeznach (2023). *Handbook of Research on Improving the Natural and Ecological Conditions of the Polesie Zone (pp. 123-133).*

www.irma-international.org/chapter/long-term-modeling-and-predictive-assessment-of-climate-change-of-ukraine-polesie-zone/324034

Computational Tools and Techniques to Predict Aquatic Toxicity of Some Halogenated Pollutants

Raghunath Satpathy (2019). *Handbook of Research on the Adverse Effects of Pesticide Pollution in Aquatic Ecosystems (pp. 318-337).*

www.irma-international.org/chapter/computational-tools-and-techniques-to-predict-aquatic-toxicity-of-some-halogenated-pollutants/213513

Chemical Treatment Technologies for Landfill Leachate

Salem S. Abu Amrand Noor Ainee Binti Zainol (2016). *Control and Treatment of Landfill Leachate for Sanitary Waste Disposal (pp. 286-314).*

www.irma-international.org/chapter/chemical-treatment-technologies-for-landfill-leachate/141856