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Adsorption of Methyl Orange Dye by Modified Fly Ash-Based Geopolymer – Characterization, Performance, Kinetics and Isotherm Studies

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Abstract

Geopolymer has been widely used as adsorbent for heavy metals and dyes. Modification on geopolymer surface with cationic surfactant can improve the anion exchange capacity of geopolymer . In this paper, fly ash-based geopolymer had been modified with cetyltrimethylammonium bromide (CTAB) which is cationic surfactant and applied as adsorbent of methyl orange (MO) anionic dye . Modified geopolymer had shown better performance as MO dye adsorbent compared to unmodified geopolymer . The adsorption of MO dye showed the best result at low pH and reached equilibrium after 90 minutes. On the basis of kinetics and isotherm studies , MO dye adsorption by modified geopolymer followed pseudo-second-order model and Langmuir model with maximum adsorption capacity of 19.231 $mg \cdot g^{-1}$

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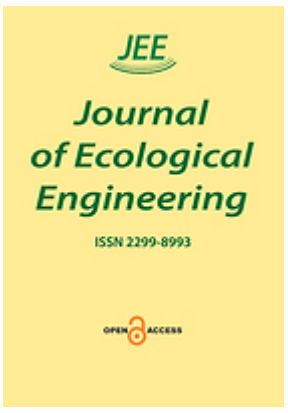

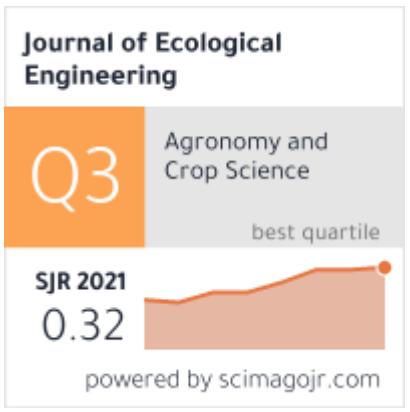

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Adsorption of Methyl Orange Dye by Modified Fly Ash-Based Geopolymer – Characterization, Performance, Kinetics and Isotherm Studies

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ABSTRACT

Geopolymer has been widely used as adsorbent for heavy metals and dyes. Modification on geopolymer surface with cationic surfactant can improve the anion exchange capacity of geopolymer. In this paper, fly ash-based geopolymer had been modified with cetyltrimethylammonium bromide (CTAB) which is cationic surfactant and applied as adsorbent of methyl orange (MO) anionic dye. Modified geopolymer had shown better performance as MO dye adsorbent compared to unmodified geopolymer. The adsorption of MO dye showed the best result at low pH and reached equilibrium after 90 minutes. On the basis of kinetics and isotherm studies, MO dye adsorption by modified geopolymer followed pseudo-second-order model and Langmuir model with maximum adsorption capacity of 19.231 $mg \cdot g^{-1}$.

Keywords: adsorption; methyl orange; modified fly ash-based geopolymer; CTAB surfactant.

INTRODUCTION

Geopolymer is inorganic polymer composed of tetrahedral silicate and aluminate units linked by sharing oxygen atoms. Geopolymer can be prepared from alumino-silicate materials, such as kaolin, fly ash, biomass ash, and slag (Davidovits, 2017; Samadhi et al., 2017). Geopolymer has amorphous to semi-crystalline three-dimensional structures and had been widely used as adsorbent. Many studies have reported that geopolymer can adsorb heavy metals and dyes. In geopolymer, tetrahedral aluminates have negative charge that can be balanced by exchangeable cations. Modification on geopolymer surface with cationic surfactant can improve the anion exchange capacity of geopolymer (Siyal et al., 2018; Selkala et al., 2020; Xu et al., 2022).

One of the most common dyes in textile industries is methyl orange (MO) dye. MO dye is also widely used as pH indicator in titration. MO dye is anionic azo dye that toxic and carcinogenic. Removal of MO dye in wastewater can be carried out by adsorption. Adsorption is a preferred method to remove MO dye because of its simplicity, high efficiency, and low cost in operation. Adsorbents used for MO dye removal include activated carbon, biochar, biosorbent, clays and minerals, polymers and resins, nanoparticles, and composites (Iwuozor et al., 2021; Wu et al., 2021).

In this paper, fly ash-based geopolymer was modified with cetyltrimethylammonium bromide (CTAB) which is cationic surfactant and applied as MO dye adsorbent. The characterization of modified fly ash-based geopolymer was studied in addition to its performance as MO dye adsorbent with variable of pH, time, and initial concentration. Furthermore, the studies of adsorption kinetics model and adsorption isotherm model had also been conducted.

MATERIALS AND METHODS

The fly ash waste used in this research was obtained from a power plant in East Java, Indonesia, and contained main oxides: SiO_2 (32.4%), Al_2O_3

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Potential Application of Used Coffee Grounds in Leather Tanning

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ABSTRACT

Safety of environment and human health is an essential requirement of modern industrial techniques. Therefore, using natural agents in tanning industry may emerge as a trusted method to avoid the chemical contamination caused by using traditional chromium salts in tanning process. This study aimed to evaluate the hot water extract of used coffee grounds (UCGs) as a vegetable tanning agent. The collected UCGs were dried and extracted with hot water at 90 °C for 2h. The phytochemical screening properties of UCGs extract were determined. Sufficient amount of extract was prepared to be used in leather tanning. Three groups were tanned with UCGs extract solely at concentrations of 20, 30 or 40% of pelts' weight, while another three groups were tanned with the same concentrations and then re-tanned with 10% of a synthetic tanning agent "Phenol sulfonates". On tanned leathers, organoleptic, physical and chemical properties were determined; scanning electron micrographs were depicted to examine the leather surface and collagen fiber bundles. Analysis of UCGs extract revealed that it has good tanning properties, as it contained tannins (14.92%), tannins/non tannins ratio (2.06), hide powder (39.57) and Stiasny number (21.16). The results of leather properties showed that using UCGs extract alone at concentration of 40% achieved the best results for the vegetable tanning where the tanned leather had higher ($P<0.05$) tensile strength, tearing strength and shrinking temperature than that treated with the lower level of 20% UCGs extract. However, 40% of UCGs extract is highly recommended to be used to accomplish the required shrinkage temperature that should be ≥ 70 °C. UCGs extract could be successfully used as tanning agent in vegetable tanning to produce durable leathers with good fullness; it may be used for different manufacturing products, such as footwear and bags. Moreover, using a combination of UCGs extract at any of the used concentrations with phenol sulfonates 10% led to significant improvement in all studied traits as compared with using UCGs extract alone.

Keywords: leather properties, tannins, vegetable tanning.

INTRODUCTION

Leather tanning converts animal skins or hides as a material susceptible to biodegradation into leathers as a non-degradable material, stable thermally and resistant to abrasion that can be used in the manufacture of various leather products [Covington, 2009]. For decades, vegetable tanning was the only known tanning method. With development of the industry, other tanning methods had been developed, such as mineral tanning, which is currently prevalent in the world. Although chrome tanning has various advantages compared to vegetable tanning [BASF, 2007], solid and liquid wastes of this industry showed many negative effects on plants, animals and human's health [Erdem & Ozverdi, 2008; Jia, et al., 2016] that promoted a return to vegetable tanning again as an eco-friendly tanning method [Alim, et al., 2019].

Vegetable tanning is based on the use of natural plant extracts with high content of tannin compounds having small particles enough to penetrate, react and crosslink with collagen fibers in raw skins or hides. Both of condensed and hydrolysable tannins with high concentrations in some famous plants (e.g. wattle, mangrove, quebracho and hemlock, myrobalan and chestnut) are being

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Pesticides in Small Agricultural Catchments in the Czech Republic

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ABSTRACT

Generally, pesticides are the products containing at least one chemical substance which should protect plant or plant products against pests/diseases. Among them, the most important ones are herbicides, followed by insecticides and fungicides. As a result of intensive agriculture techniques, large amounts of pesticides are applied on agricultural soil. They remain and degrade in soil, but they can enter water bodies and negatively affect water quality and the aquatic ecosystem. The article deals with the level of pesticide load in soil, bottom sediment and surface water in chosen agriculture catchments in the Czech Republic. Results revealed that the main general problem is glyphosate and its metabolite AMPA, although their application has been constrained for several years. Furthermore, the difference in contents of chosen parent pesticide substances and their metabolites in soils and waters were pointed out.

Keywords: soil, sediment, water, glyphosate, AMPA, parent pesticides, metabolites.

INTRODUCTION

Intensive farming in the Czech Republic brings a wide spectrum of pesticides into the arable land. They partly remain in soil, are degraded and partly transported to water bodies. Besides agricultural land, there are also point pesticide sources (e.g. municipalities) as a potential risk of surface waters pollution, but the study aims at agricultural non-point sources. In a catchment, there are two main ways of material transport: water erosion (surface runoff), infiltration and subsequent subsurface runoff. Transport by water erosion is an extensive problem in the Czech Republic. Due to large blocks of arable land, steep slopes and soil erodibility, about 50% of the agricultural land is threatened by the aforementioned soil degradation process. Subsurface runoff can be accelerated on leachy soils and with ameliorative drainage. Subsoil drainage was built in the Czech Republic in the last century to extend agricultural land and obtain higher yield and consequently, it extends to about 25% of arable land now (Kulhavý and Fučík 2015).

Although the currently used pesticides (CUPs) are not persistent in the environment, they can still accumulate in soil and water, as a result of their repeated use ("pseudo persistence"), since their degradation is slower than their input (Hvězdová et al. 2018). Moreover, the degradation products of CUPs can remain in the soil for a long time and can have similar negative effects on ecosystems as the original substance (Halešová et al. 2021). This happens despite the sophisticated process of risk assessment which must be done for each active substance and product as a part of authorization to ensure compliance with European rules (Regulation EC No. 1107/2009). Since groundwater contamination can pose a direct risk for humans and it is relatively better described (e.g. Kodeš et al. 2016, Syafrudin et al. 2021) than contamination coming in soil, a system of limit values for concentrations of selected CUPs in groundwater has been developed in many countries and also