

A Review: Utilization of Spent Bleaching Earth in Various Industries

Review: Pemanfaatan Spent Bleaching Earth Pada Berbagai Industri

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ABSTRACT

The use of Spent Bleaching Earth (SBE) is very diverse and has potential in various applications. The use of SBE as an adsorbent has been proven to be effective in removing dyes from textile industry wastewater, with significant adsorption capacity at varying pH, adsorbent mass, and stirring time. SBE shows high efficiency in reducing dye concentrations, making it an economical and environmentally friendly choice for industrial wastewater treatment. Modified SBE is more effective than unmodified carbon SBE. In addition to adsorption, SBE can be used as a catalyst in the ozonation process to decompose long-lasting organic compounds, increase reaction rates, and reduce the time required for wastewater treatment. SBE has also been explored as an additional material in making concrete, with the addition of SBE to concrete mixes showing potential in improving the mechanical properties of concrete, such as compressive strength and durability.

Keywords: Spent Bleaching Earth; Adsorption, Composite, Utilization

ABSTRAK

Pemanfaatan Spent Bleaching Earth (SBE) sangat beragam dan potensial dalam berbagai aplikasi. Penggunaan SBE sebagai adsorben telah terbukti efektif dalam menghilangkan zat warna dari air limbah industri tekstil, dengan kapasitas adsorpsi yang signifikan pada variasi pH, massa adsorben, dan waktu pengadukan. SBE menunjukkan efisiensi tinggi dalam pengurangan konsentrasi zat warna, menjadikannya pilihan ekonomis dan ramah lingkungan untuk pengolahan limbah cair industri. SBE yang dimodifikasi lebih efektif dibandingkan karbon SBE tanpa modifikasi. Selain untuk adsorpsi, SBE dapat digunakan sebagai katalis dalam proses ozonisasi untuk menguraikan senyawa organik tahan lama, meningkatkan laju reaksi, dan mengurangi waktu yang diperlukan untuk pengolahan air limbah. SBE juga telah dieksplorasi sebagai bahan tambahan dalam pembuatan beton, dengan penambahan SBE dalam campuran beton menunjukkan potensi dalam meningkatkan sifat mekanis beton, seperti kekuatan tekan dan daya tahan.

Kata Kunci: Spent Bleaching Earth; Adsorpsi, Komposit, Pemanfaatan

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1. INTRODUCTION

Spent Bleaching Earth (SBE) is a waste produced by crude palm oil (CPO) refineries. Bleaching Earth from CPO refining is a mixture of Bleaching Earth (BE) and organic compounds derived from CPO. SBE is a sand-like solid waste containing color, gum or sap, metals, namely silica (47-52%), aluminum oxide (10.6-11.9%), ferrous oxide (4-4.5%), magnesium (3.2-3.6%), other metals and water (5.4-6%), and palm oil residue (22-30%). Spent Bleaching Earth is classified as waste from the processing of animal/vegetable fats and their derivatives. This waste, based on PP No. 22 of 2021, is included as hazardous and toxic waste from specific sources if the oil content in SBE is more than 3% (Amelia *et al.*, 2023).

SBE consists of two main components: residual oil (about 20-40% by weight) and montmorillonitic clay; thus, each ton of fresh BE used in the refining process generates about 1.2-1.6 tons of SBE for disposal without treatment or utilization. To reduce operational costs and associated environmental safety, various attempts have been made to regenerate SBE.

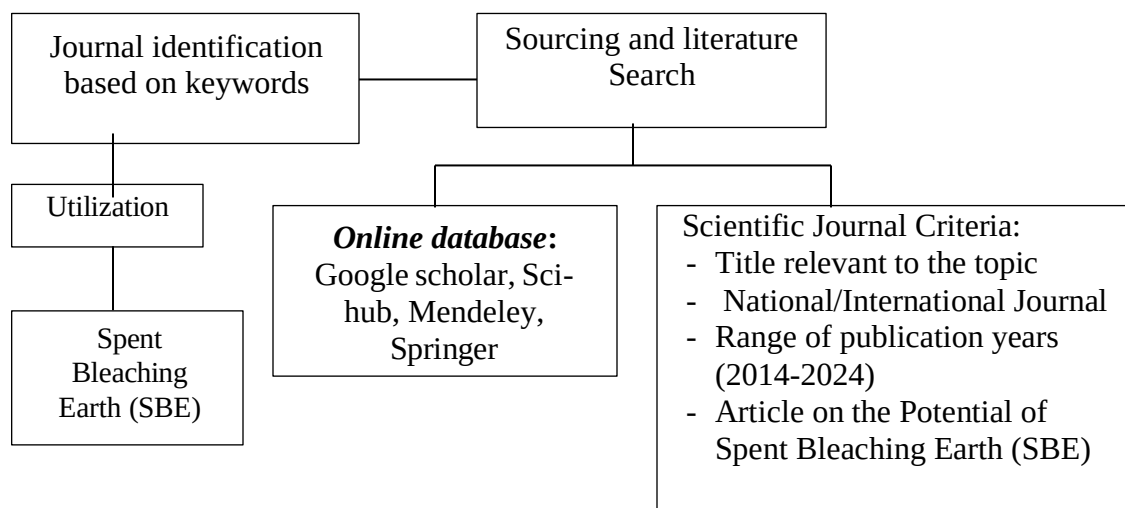
SBE is a waste that poses great challenges in handling and management, both in terms of physicochemical characteristics and the volume generated. To date, there is no effective alternative utilization for such waste. The conventional method is to send it to a landfill. However, this approach is considered unfeasible as it has the potential to cause negative impacts on the environment. SBE can be utilized as biodiesel (Naser *et al.*, 2021; Low *et al.*, 2022; (Pasaribu & Sukandar, 2017), concrete additive (Nababan *et al.*, 2023), and regenerated SBE is widely used in adsorption fields, including vegetable oil refining, adsorbents, wastewater treatment, CO₂ capture, and others (Phey *et al.*, 2022).

Therefore, SBE waste needs to be managed

through recovery, reuse, and recycle practices to produce new resources such as as a filler for NPK fertilizer (Purba *et al.*, 2019) cement substitute (Sharom, 2016) and as landfill material (Utama, 2020). SBE is a porous material in the bentonite clay category. Bentonite clays are very useful for adsorption (color pigments or metal ions), but activation is necessary so that it will produce adsorbents with higher adsorption capabilities than before activation. The use of SBE as an adsorbent is considered cheaper because it is a natural waste that is easily obtained (Rezki *et al.*, 2021). Spent bleaching earth is categorized as hazardous waste because SBE has a large quantity and has the potential for “self-combustion” because it contains a mixture of clay and oil.

SBE is a porous material categorized as bentonite clay that produces clay with higher adsorption ability. Bentonite clays are very useful for adsorption of color pigments or metal ions, but activation is necessary so that it will produce adsorbents with higher adsorption ability than before activation. The use of SBE as an adsorbent is considered cheaper because it is a natural waste that is easily obtained (Rezki *et al.*, 2021). Another advantage of SBE is that the more the concentration of adsorbate increases, the absorption capacity of the adsorbent will increase because the collision between particles between the adsorbent and the adsorbate increases when absorption occurs at high adsorbate concentrations (Kurniawan *et al.*, 2015). SBE can be utilized as an adsorbent through thermal, physical and chemical reactivation and pyrolysis, raw materials for cement and brick making (Loh *et al.*, 2017).

2. METHODS



Gambar 1. Skema Review Artikel

3. RESULTS AND DISCUSSION

Spent Bleaching earth (SBE) is derived from bentonite clay material and is commonly used as an adsorbent in the vegetable oil production process. Spent bleaching earth (SBE) is a used adsorbent produced from the CPO refining process. The process is one of the process units in the cooking oil industry. In principle, SBE has a low adsorption ability, but if regenerated by heating, and the addition of media its adsorption power will increase. The regeneration process on SBE can be done physically and chemically. The physical recycling process can be done by activating the SBE with a heating method and the chemical recycling process can be done with the help of activator media, such as phosphate acid (H_3PO_4), hydrogen peroxide (H_2O_2) SBE can be used as a substitute for fine aggregates (Ashari et al., 2017), raw material for making

briquettes (Abdelbasir et al., 2023) and adsorbents to remove pollutants in wastewater (Belhaine et al., 2016; Slamet et al., 2021; Yulikasari et al., 2022).

Research on Spent Bleaching Earth has been conducted with various variations because SBE is a waste material that has the potential to be reused either with or without composites. SBE has received the attention of many researchers. Many studies have been conducted on its regeneration and reuse in various important applications such as oil refining and biodiesel production. Water treatment to remove pollutants (either heavy metal ions, dyes, or organic compounds) accounted for most of these studies, which amounted to about 75 studies while biodiesel production accounted for only 10 studies. The utilization of Spent Bleaching Earth (SBE) that has been researched over the past few years can be seen in Table 1.

Table 1. Utilization of Spent Bleaching Earth

Materials	Utilization	Research	References
Clay/SBE Carbon	adsorption of toxic dye Eosin Y from aqueous solution	Eosin Y adsorption was tested on SBE and SBE/C. The effects of factors such as temperature, pH, and ion coexistence were also evaluated and characterized by BET analysis, SEM, XRD, and FTIR analysis.	(Liu <i>et al.</i> , 2020)
C-SBE	Methylen Blue Adsorption	on the adsorption process was carried out with methylene blue dye parameters, namely pH, adsorbent mass, and time.	(Yulandi <i>et al.</i> , 2016)
C-SBE/Clay	Ozonation process in wastewater treatment	The performance of the catalyst was tested in the ozonation process of benzoic acid, a common long-lasting organic compound found in wastewater.	(Liu <i>et al.</i> , 2020)
C-SBE	Rhodamine B Adsorption	The experiment to determine the kinetics of adsorption was conducted on rhodamine B with a concentration of 60 mg/L. Adsorbent material added as much as 0.5 gram	(Rahayu & Nurhayati, 2023)
Clay/C-Spent Bleaching Earth (SBE)	Adsorption of Pb (II) ions	SBE carbon activated with KOH for Pb (II) adsorption	(Liu <i>et al.</i> , 2020)
C-Spent Bleaching Earth (SBE)	Adsorption of Tetracycline Hydrochloride	Comparison of adsorption ability of SBE and SBE Carbon	(Wan <i>et al.</i> , 2019)
Spent Bleaching Earth (SBE)	Agregate of Concrete mix	SBE as a concrete mixture with analysis of concrete compressive strength compressive strength analysis and TCLP test	(Dermawan & Ashari, 2018)

3.1 Adsorption of Eosin Y

This article is research on the adsorption of toxic dye Eosin Y from aqueous solution using clay/carbon composite derived from SBE. Water pollution by dyes is a serious environmental problem. Eosin Y, a toxic anionic dye, is often used in the textile and medical industries. This dye can harm aquatic organisms and human health. Conventional methods for removing dyes from water, such as membrane filtration and chemical oxidation, are often expensive and less efficient. Adsorption using inexpensive

materials such as spent bleached soil (SBE) is considered an efficient and economical alternative. This article concludes that SBE/C is an effective and economical adsorbent for toxic dye removal from wastewater. SBE/C has about three times higher adsorption capacity than SBE, showing significant efficiency in the removal of Eosin Y. This process offers an environmentally friendly and low-cost solution for dye effluent treatment, while utilizing industrial waste (SBE) (Liu *et al.*, 2020).

3.2 Methylene Blue Adsorption

The textile industry produces wastewater containing dyes such as methylene blue, which can pollute the environment and negatively affect human health and aquatic organisms. Adsorption was chosen as an effluent treatment method because it is simple, efficient, and does not produce toxic by-products. This article evaluates the use of spent bleaching earth (SBE) as an adsorbent to remove methylene blue from wastewater. This article shows that SBE can be used as an effective adsorbent for the removal of methylene blue from textile wastewater. The results showed that the best adsorption occurred at lower pH, with the highest adsorption capacity at pH variation of 0.5035 mg/g. This method offers an efficient and economical solution for textile industry wastewater treatment (Yulandi *et al.*, 2016).

3.3 Ozonation Process with SBE

The ozonation process discussed in this journal is a water treatment method that uses ozone (O_3) as an oxidant to decompose long-lasting organic contaminants (recalcitrant organics) in wastewater. Ozonation is a very effective technology for removing various types of organic pollutants because ozone is a strong oxidizer. Ozonation is used to decompose complex and long-lasting organic compounds into simpler and less harmful compounds. In this journal, the target compound tested is benzoic acid, which is an example of a long-lasting organic contaminant. In a nitrogen atmosphere (SBE-N2-650) had the highest catalytic activity, increasing the contaminant mineralization rate by 36% compared to ozonation without a catalyst. This approach shows great potential in effectively and sustainably treating wastewater, while providing solutions for industrial waste management (Liu *et al.*, 2020).

3.4 Adsorption of Rhodamine B

The concentration of adsorbate, the amount

of adsorbent, temperature and pH of the substance (pollutant) to be treated are factors that affect the adsorption process (Adeyemo *et al.*, 2017; Kanawade, 2015). To determine the interaction between adsorbent and adsorbate, adsorption isotherm analysis can be performed. SBE is activated to improve the pore structure of the material so that it can be reused as an adsorbent to absorb Rhodamine dye. ASBE has a greater maximum adsorption capacity (q_{max}) than SBE. Adsorption takes place in monolayer, indicating that the chemisorption process occurs, where the adsorption process occurs due to electron transfer between rhodamine B (adsorbate) and SBE or ASBE material (adsorbent). The results of batch adsorption experiments prove that ASBE material has better adsorption ability than SBE material. This result is supported by the results of SEM analysis which shows the morphology of ASBE is better for the adsorption process (Rahayu & Nurhayati, 2023).

3.5 Adsorption of Pb (II) ions

In this study, clay/carbon adsorbent composites prepared by combining carbonization and activation can effectively remove Pb (II). This study focuses on the activation process of clay/carbon composites. The effect of KOH-activated samples on Pb (II) adsorption performance. BE/C-A750-1/1 was prepared by carbonizing SBE and then activated with KOH. BE/C-A750-1/1 has a good Pb (II) adsorption capacity, and the Pb (II) adsorption capacity is 206.65 mg/g. Adsorption studies showed that the adsorption capacity of BE/C-A750-1/1 on Pb (II) after adsorption and desorption for 3 times was 183.62 mg/g. The adsorption mechanisms mainly include electrostatic attraction, ion exchange, physical adsorption, and chemical complexation. This suggests that activated BE/C may be a promising candidate for removing Pb (II) from industrial wastewater.

3.6 Adsorption of Tetracycline Hydrochloride

In this study, spent bleaching earth (SBE) and pyrolysis SBE (SBE-C) were tested for their capacity to remove tetracycline hydrochloride (TCH) from aqueous solution. The maximum adsorption capacity obtained by Langmuir model was 0.114 mmol/g for SBE-C and 0.087 mmol/g for SBE. The results of various characterization methods show that the adsorption mechanism mainly includes π - π interaction, hydrogen bonding, electrostatic interaction, and changes in physical and chemical properties. After 3 repeated pyrolysis cycles, the adsorption capacity of SBE@C remained at 85.4%, with SBE-C potentially recycled 21 times before the adsorption capacity was completely lost. In addition, secondary pollution issues caused by SBE and residual oil were addressed using SBE-C. All results indicate that SBE@C is a likely candidate for TCH wastewater treatment in future practical applications. The important reason for the difference in adsorption capacity between SBE and SBE-C is that pyrolysis of carbon species improves the physical properties and chemical properties of SBE-C (specific surface area, pore volume, pore size, and hydrophobicity).

3.7 Concrete Mix Aggregate

This research uses SBE waste as a substitute for fine aggregate in concrete mixes. The parameters used to test the feasibility of SBE waste as a substitute for fine aggregate in the concrete making mixture in this study are the compressive strength test and the TCLP test. Concrete compressive strength testing is carried out after the concrete has undergone treatment at the age of 28 days. This is shown in Figure 1 in SNI 03-2834-2000. The compressive strength test aims to control the composition of the constituent materials, especially the addition of SBE waste, has met the planned quality at 28 days, namely concrete with a characteristic

compressive strength of 28.5 MPa. TCLP testing is carried out to determine the concentration of hazardous metal minerals contained in the test specimen after solidification of waste material into a concrete mixture. TCLP test results show that 10% SBE concrete can be declared environmentally safe.

4. CONCLUSIONS

The utilization of Spent Bleaching Earth is very diverse and has potential in various applications. The use of SBE as an adsorbent has proven effective in removing dyes from textile industry wastewater. Results from several research studies show that the adsorption capacity is significant upon variation of pH, adsorbent mass, and stirring time. SBE shows high efficiency in dye concentration reduction making it an economical and environmentally friendly option for industrial wastewater treatment. Modified SBE will be more effective than unmodified SBE carbon. In addition to adsorption, SBEs can be used as catalysts in the ozonization process to decompose long-lasting organic compounds and increase the reaction rate and reduce the time required for wastewater treatment. SBEs have also been explored as additives in concrete manufacturing. The addition of SBEs in concrete mixtures shows potential in improving the mechanical properties of concrete, such as compressive strength and durability.

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