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The synthesization of activated carbon from electrocoagulated palm oil mill effluent sludge for wastewater treatment

Farah Amalina [a], Abdul Syukor Abd Razak [a], Santhana Krishnan [b], A.W. Zularisam [a], Mohd Nasrullah [a,*]

[a] Faculty of Civil Engineering Technology, Universiti Malaysia Pahang (UMP), Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang, Malaysia
[b] Department of Civil and Environmental Engineering, Faculty of Engineering, Prince of Songkla University, Songkhla 90110, Thailand

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ABSTRACT

The oil palm industry in Malaysia is certainly the one of economic and agricultural drives for the country. Nevertheless, despite the obvious benefits that it possesses, oil palm mill also significantly contributes to environmental degradation. It generates massive amounts of solid waste, wastewater, and air pollution from its production and processing processes. Activated carbon (AC) as an adsorbent has been used widely to remove pollutants in wastewater. Many attempts have been made to produce economically accessible AC. This paper explores the idea of producing an AC, a value-added product, sludge produced from the electrocoagulation process of palm oil mill effluents (POME) through chemical activation. AC has different applications after its discovery as a solid and reliable adsorbent. Its microporous structure, high surface reactivity, and surface area make it versatile and viable for removing pollutants from aqueous solutions. The electrocoagulated sludge-based AC is characterized by its surface characteristics, elemental compositions, surface morphology, and available functional group. To validate the adsorption capacity of electrocoagulated sludge-based AC, textile dye wastewater treatment was carried out to test the efficiency of AC. Results indicate that TSS in textile dye wastewater decreased as the adsorbent dosage increased. The values of TSS removal by AC from H_3PO_4 activation decreased steadily compared to KOH activation. Meanwhile, the color removal percentage decreased when the dye concentration increased. AC from H_3PO_4 activation has higher color removal percentage. This shows that AC from H_3PO_4 activation has better adsorption due to its more extensive surface area. From BET analysis, AC by H_3PO_4 activation offers a higher surface area, 36.1017 m^2/g, compared than KOH activation, 8.9460 m^2/g. Extensive surface area has a higher tendency to adsorb contaminations. The findings of this work confirmed the potential use of electrocoagulated sludge-based AC as an alternative and economically adsorbent for effective dye pollution removal in wastewater.

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1. Introduction

The palm oil sector has been one of the most significant contributors to the economy of Malaysia [1]. It is the second largest commodity producer in the world after Indonesia [2]. However, a substantial waste, known as palm oil mill effluent (POME), is produced abundantly due to the expanding production and processing of oil palm and its derivatives, affecting human and aquatic life [3]. Approximately 65 million tonnes of POME is generated yearly and constitutes severe environmental pollution by releasing it into the environment, especially in waterways [4]. The release of either untreated or inadequately treated POME into the ecology can prompt severe perils ranging from groundwater contamination, the release of methane, and unpleasant smell into the environment [4–6]. Due to this issue, many technologies have been introduced to encounter it; one of them is the electrocoagulation process [7–9].

Electrocoagulation (EC) is comprehensive spectrum treatment technology combined with coagulation, floatation, and electrochemistry process that removes or destabilizes suspended, emulsified, or dissolved contaminants from wastewater [10,11]. It produces in-situ coagulant in water through electrolytic oxidation by introducing a minimal amount of electrical current through one or more submerged and sacrificial electrodes [12]. The three

* Corresponding author.

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