

Comparative Assessment of Activated Carbon from Oil Palm Kernel Shell versus Coconut Shell for POME Purification

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ABSTRACT

The conversion of oil palm waste to activated carbon (AC) has attracted significant attention due to its lignocellulose chemistry and abundance. Therefore, this research aimed to evaluate the performance of activated carbon oil palm kernel shell (AC-OPKS) as bio-adsorbent to remove organic and inorganic pollutants present in palm oil mill effluent (POME) final discharge. The effectiveness of AC-OPKS as a bio-adsorbent was compared to AC-COCONUT in this study. The batch adsorption system was tested using AC-OPKS and AC-COCONUT dosages of 5–25 g at a constant pH of 8.03 with different treatment times of 0–12 h to determine the optimal adsorbent capacity. In comparison with AC-COCONUT, AC-OPKS had performed effectively on the reduction of biological oxygen demand (BOD), colour, and suspended solids (SS) at 84.72%, 98.90%, and 91.85%, respectively compared to 78.61%, 90.12%, and 77.41% when using AC-COCONUT. The POME final discharge treated with AC-OPKS had BOD and SS values of 14.90 mg L⁻¹ and 56.00 mg L⁻¹, respectively, which is below the standard limit (BOD, 20 mg L⁻¹ and SS, 200 mg L⁻¹) set by the Department of Environment Malaysia (DOE) under the Environmental Quality Act 1974. It is also suggested that spent AC be reactivated or used as an organic fertilizer for vegetative plants because it contains beneficial enriching nutrients such as nitrogen, phosphorus, and potassium adsorbed from POME final discharge.

Keywords: Oil palm kernel shell; Coconut shell, Palm oil mill effluent, Activated carbon, Colour removal

INTRODUCTION

Activated carbon from biomass is an alternative adsorbent for the industrial sector. It is popular because of its well known efficiency for the removal of pollutants and heavy metals in wastewater treatments, abundance of raw material, low price, and ease of use. Activated carbon from oil palm biomass is therefore considered as environmentally sustainable and economically viable.

Oil palm biomass is generated from the mill and is available at the mill site. Owing to these advantages, the raw material, transportation, and operating costs can be minimized. Oil palm kernel shell (OPKS) is a suitable precursor for AC production due to its high density, high carbon content, and low ash content. AC-OPKS can be produced by carbonizing the biomass at a temperature below 500°C and converting it to biochar activated at a high temperature of above 800°C through physical or chemical activation methods. The two-in-one carbonization activation system was developed to improve production efficiency by combining the separate processes of carbonization and activation into a single system. The AC-OPKS produced has a great surface area of 935 m² g⁻¹. The treatment of palm oil mill effluent (POME) final discharge using AC-OPKS has been tested on a continuous pilot-scale plant, resulting in a great reduction of pollutants in POME final discharge. The performance of the system and the effectiveness of AC-OPKS were compared with activated carbon coconut shell (AC-COCONUT) using a similar range of dosage and treatment times. In comparison with AC-COCONUT, the AC-OPKS had performed effectively in reducing biological oxygen demand (BOD), chemical oxygen demand (COD), colour, suspended solids (SS) and ammoniacal nitrogen by 84.72%, 94.55%, 98.90%, 91.85% and 99.90%, respectively compared to 78.61%, 71.00%, 89.80%, 77.41% and 64.20% when using AC-COCONUT.

METHODOLOGY



RESULTS

PROPERTY	AC-PALM KERNEL SHELL (% removal)	AC-COCONUT SHELL (% removal)
Biological oxygen demand (BOD ₃ , mg/L)	84.72 ± 11.50	78.61 ± 13.81
Chemical oxygen demand (COD, mg/L)	94.55 ± 19.00	71.00 ± 11.26
Suspended solids (SS, mg/L)	91.85 ± 16.50	77.41 ± 33.50
Colour (ADMI)	98.90 ± 17.00	89.80 ± 19.09
Ammoniacal nitrogen (AM, mg/L)	99.90 ± 13.50	64.20 ± 23.33

HIGHLIGHTS

- Activated carbon palm kernel shell (AC-OPKS) was used as adsorbing material
- Packed in a continuous adsorption system
- Superior performance of AC-OPKS compared to conventional packed material (coconut shell)
- Price of AC-OPKS (RM 6.70/kg) is 11.84% lower than AC-COCONUT price (RM 7.60/kg)

ADVANTAGES

- Cheaper and abundant adsorption material
- Better adsorption efficiency
- Home grown technology

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