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Comparative Study of Almond Shell Raw Activated Carbon, Chemically Activated and Adsorption of Anionic Dye from Wastewater

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ABSTRACT

This study aims to use a biomaterial based on almond shells to prepare two types of activated carbon **(AC)**, raw **(rAC)** and activated by 85% H_3PO_4 **(cAC)**. These activated carbons were employed as adsorbents to treat an aqueous solution containing the Methyl Orange **(MO)** dye through the adsorption process. The study examined the influence of various factors such as pH, contact time, temperature, adsorbent material quantity, and initial concentration of Methyl Orange on the adsorption phenomenon. Experimental results revealed a rapid elimination phase within the first few minutes for both types of carbon, raw and chemically activated. At an ambient temperature of 25°C, with a mass of 1 gram, a concentration of 20 mg/L, and an agitation speed of 250 rpm, the maximum adsorption efficiency for the dye reached 94.3%. Chemical activation significantly improved the efficiency, reaching 98.30% for all variables studied. These findings underscore the efficacy of the biomaterial used as an adsorbent for liquid effluent treatment.

Keywords: Almond shell, Methyl orange, activated carbon and Adsorption

1 Introduction

Environmental protection has become a major priority in our contemporary society. Dyes are chemical compounds widely used in many industries such as textiles, paper, leather, food, and cosmetics. However, the use of these dyes leads to serious environmental pollution, where waste containing dyes is discharged into wastewater, affecting water quality and the aquatic ecosystem. To address this issue, many techniques have been developed to remedy dye pollution in water. Among these, adsorption stands out as a particularly effective and widely used method. Indeed, adsorption involves using an adsorbent capable of capturing and removing dyes present in liquid effluents. Among the various adsorbents available in adsorption processes, activated carbon **(AC)** emerges as one of the most commonly used and effective options for eliminating dyes present in liquid effluents.

The objective of this study is to prepare two types of activated carbon, the first being raw activated carbon **(rAC)** and the second being activated carbon by chemical activation **(cAC)**, using almond shells as the base material. This research also aims to evaluate the effectiveness of these two types of activated carbon in removing the anionic dye Methyl Orange **(MO)**. With a focus on preserving the environment and water resources, which are of crucial importance, this study explores alternative and sustainable approaches to remediate pollution and ensure the preservation of the aquatic ecosystem.

2 Experimental

This study focuses on an experimental investigation into the adsorption of an anionic dye, Methyl Orange **(MO)**, from an aqueous solution using a natural support: raw activated carbon **(rAC)** and chemically activated carbon **(cAC)** derived from almond shells. The objective is to recover this dye using this specific adsorbent. The effects of operating conditions, such as the initial dye concentration, and the adsorbent mass, were studied.

Methyl Orange*:* Methyl Orange is an anionic dye widely used in various industrial applications due to its bright orange color and its ability to bind to positively charged substrates. It is commonly used as a color

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indicator in acid-base titrations and as a dye in food products, inks, and cosmetics. Its overall chemical formula is $C_{14}H_{14}N_3NaO_3S$.

Preparation of the raw material: The following diagram represents the process of preparing activated carbon and its chemical activation.

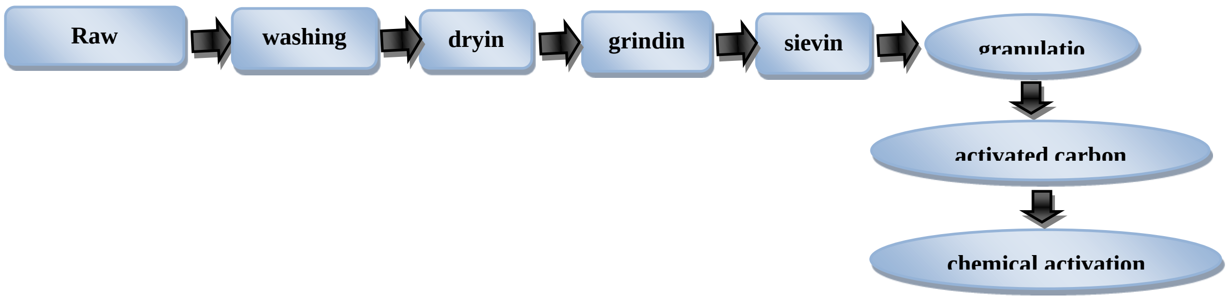

Figure 1: Process of preparing activated carbon and its chemical activation “Almond shells”.

In the context of this study, constant operating conditions were maintained to assess the adsorption of our organic pollutant before and after chemical activation. The results obtained are presented in Figure (2), which illustrates the evolution of adsorption efficiency over time.

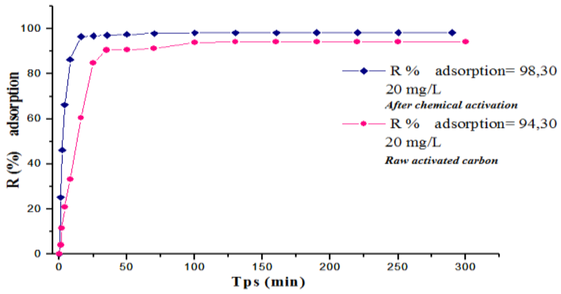

Figure 2. Evolution of the adsorption efficiency of MO by **(rAC)** and **(cAC)** as a function of time.

According to the data in Figure (2), the adsorption efficiency of methyl orange on activated carbon increases with contact time, reaching equilibrium after about 35 minutes. Two distinct phases are observed: an initial rapid phase followed by a slower phase. This can be explained by the initially high availability of free active sites on the adsorbent, which decreases gradually as adsorption progresses. The overall adsorption efficiency at equilibrium is approximately 94.3%, with an estimated equilibrium time of around 25 minutes and a removal efficiency of 98.30%. The shorter contact time can be attributed to increased pore size after activation of the activated carbon, improving the accessibility of dye molecules. The graph shows an initial rapid adsorption phase followed by a slower phase, which correlates with the gradual decrease in available active sites on the surface of activated carbon with increasing contact time.

3 Conclusions

The importance of chemical activation was highlighted by the yield results, showing a significant improvement in adsorption efficiency after activation.

References

[1] FARCH S., YAHOUM M.M. , TOUMI S., Application of Walnut Shell Biowaste as an Inexpensive Adsorbent for Methylene Blue Dye: Isotherms, Kinetics, Thermodynamics, and Modeling, Separations (2023), Vol. 10 (60), 1-19.

[2] Al-Hyali R.H., Alqazzaz W.A., Altamer D.H., Adsorptive Elimination of Methyl Orange Dye over the Activated Carbon Derived from Bitter Almond Shells: An Isothermal, Thermodynamic, and Kinetic Study, JOTCSA. (2023), Vol. 10(2), 339-358.

[3] Serban G.V., Iancu V.I., Dinu C., Removal Efficiency and Adsorption Kinetics of Methyl Orange from Wastewater by Commercial Activated Carbon, Sustainability (2023), Vol. 15, 12939

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