ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26jul1834

Recovery of Oil from Spent Bleaching Earth and Regeneration of so Formed Deoiled Spent Clay to Activated Bleaching Earth

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Publication Date: 2026/08/06

Abstract: Spent Bleaching Earth (SBE) is a by-product generated during the refining of edible oils using activated bleaching clay. Depending on refinery operating conditions, SBE typically contains between 30 and 50 % entrained vegetable oil [1,2]. The residual oil retained within the porous clay structure represents a significant economic loss while simultaneously creating handling, storage, and environmental challenges. Recovery of the entrained oil followed by regeneration of the clay offers a sustainable approach to waste minimization and resource recovery [3,4].

This paper discusses the extraction of retained oil from SBE using solvent extraction technology and the subsequent regeneration of the de-oiled clay through thermal treatment and acid activation to produce regenerated bleaching earth suitable for reuse in edible oil refining operations.

How to Cite: Ashok Agarwal (2026) Recovery of Oil from Spent Bleaching Earth and Regeneration of so Formed Deoiled Spent Clay to Activated Bleaching Earth. *International Journal of Innovative Science and Research Technology*, 11(7), 3137-3139. https://doi.org/10.38124/ijisrt/26jul1834

I. INTRODUCTION

Activated bleaching earth is widely used during vegetable oil refining to remove pigments, oxidation products, phospholipids, trace metals, soaps, and other undesirable compounds [3,5]. During the bleaching process, a portion of the oil becomes adsorbed onto the clay surface and remains trapped within the pore structure.

The resulting spent bleaching earth typically contains 30–50 wt% residual oil, depending on the refining process and clay dosage [1,6]. Because this oil exists as a thin film distributed over a large internal surface area, oxidation occurs readily upon exposure to air, potentially resulting in self-heating and spontaneous combustion [7].

Traditionally, SBE has been disposed of in landfills. However, increasing environmental regulations and the economic value of the retained oil have encouraged the development of oil recovery and clay regeneration technologies [4,8].

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Traditionally, SBE has been disposed of in landfills. However, increasing environmental regulations and the economic value of the retained oil have encouraged the development of oil recovery and clay regeneration technologies [4,8]. The retained oil may be recovered and utilized as feedstock for biodiesel production, soap manufacturing, oleochemical processes, or industrial fuel applications [4,9

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II. RECOVERY OF ENTRAINED OIL BY SOLVENT EXTRACTION

➢ *Process Principle*

Solvent extraction is the most widely employed method for recovering oil from spent bleaching earth [4,10]. Solvents such as n-hexane or methanol penetrate the porous clay matrix and dissolve the retained oil, forming a liquid mixture commonly known as miscella.

Studies have shown that methanol may provide superior extraction efficiency and improved regeneration characteristics, whereas hexane often yields recovered oil more suitable for biodiesel production [4].

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IV. REGENERATION OF DE-OILED BLEACHING EARTH

Following oil extraction, the clay contains carbonaceous residues that reduce adsorption efficiency by blocking the pore structure [6].

Thermal regeneration is commonly performed in a rotary kiln or rotary furnace under an inert nitrogen atmosphere at temperatures between 500°C and 650°C [4,6,12].

Research has demonstrated that regeneration temperature is the most significant process variable affecting the final properties of the regenerated clay. Thermal treatment removes residual hydrocarbons and partially restores pore accessibility [6,12].

V. ACID ACTIVATION

Thermally regenerated clay generally exhibits lower surface area and pore volume than fresh bleaching earth [6].To improve adsorption performance, acid activation is commonly employed. The regenerated clay is treated with hydrochloric acid or sulfuric acid under controlled conditions to dissolve impurities and increase pore accessibility [13].

Following acid treatment, the material is washed, filtered, dried, milled, and classified to obtain the required particle size distribution. Several studies have reported that acid-activated regenerated clay can achieve bleaching performance comparable to or exceeding that of commercial bleaching earth products [4,13]

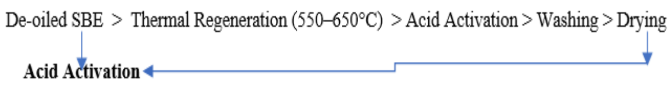
VI. PROPOSED INDUSTRIAL PROCESS

The proposed industrial process consists of two integrated sections:

Section A – Oil Recovery

Spent Bleaching Earth > Preparation > Solvent Extraction > Miscella Distillation > Recovered Oil > Solvent Recovery

Section B – Clay Regeneration



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Grinding and Classification > Regenerated Activated Bleaching Earth

VII. ENVIRONMENTAL AND ECONOMIC BENEFITS

The recovery of entrained oil and regeneration of bleaching clay provides several advantages:

- Reduction in landfill disposal requirements.
- Recovery of valuable vegetable oil.
- Reduction in fresh bleaching earth consumption.
- Lower environmental liability.
- Reduced risk of spontaneous combustion.
- Improved refinery sustainability [4,8,14].

For refineries generating significant quantities of SBE, the combined value of recovered oil and regenerated clay can substantially improve operating economics [14].

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VIII. CONCLUSION

Spent bleaching earth should be considered a valuable secondary resource rather than a waste material. Through solvent extraction, a substantial proportion of the retained oil can be recovered for beneficial use. Subsequent thermal regeneration and acid activation can restore the adsorption properties of the clay, enabling its reuse in edible oil refining operations.

The integration of oil recovery and clay regeneration technologies offers both economic and environmental benefits while supporting circular economy principles within the vegetable oil processing industry.

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