



CHEMICAL ACTIVATION OF BENTONITE USING PHOSPHORIC ACID: STRUCTURAL MODIFICATION AND APPLICATION POTENTIALS

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Abstract: this study investigates the chemical activation of bentonite using phosphoric acid (H_3PO_4) and examines its impact on the physicochemical properties of the clay. Structural modifications, surface area enhancement, and elemental transformations are analyzed using various characterization techniques. The activated bentonite is evaluated for its adsorption potential and its suitability in environmental and industrial applications.

Key words: phosphoric acid, X-ray Diffraction (XRD), montmorillonite, micropores, swelling capacity, hydrochloric acid

Introduction

Bentonite, a clay material predominantly composed of montmorillonite, is well known for its high surface area, swelling capacity, and cation exchange properties. However, its natural form often shows limited adsorption efficiency due to the presence of impurities and low porosity. To overcome these limitations, bentonite is frequently subjected to chemical activation using various inorganic acids. While sulfuric and hydrochloric acids have been extensively studied, phosphoric acid (H_3PO_4) presents a promising alternative due to its moderate acidity, eco-friendliness, and ability to introduce phosphate functional groups[1-2].

This research aims to explore the effects of phosphoric acid treatment on bentonite's structure and performance, focusing on adsorption efficiency and surface reactivity.

Materials and Methods

Materials: Natural Ca-bentonite was sourced from a local deposit in Uzbekistan. Analytical-grade phosphoric acid (85% H_3PO_4) was used as the activating agent. Deionized water was used throughout the experiments.

Activation Procedure: 100 g of raw bentonite was dispersed in 500 mL of 1M phosphoric acid solution and stirred at 80°C for 4 hours. The mixture was then filtered, washed with deionized water until neutral pH was achieved, and dried at



105°C for 12 hours. The dried sample was ground and sieved to obtain particles <75 μm.

Characterization Techniques[3-4]:

- X-ray Diffraction (XRD): to assess structural changes
- Fourier Transform Infrared Spectroscopy (FTIR): for functional group identification
- Brunauer–Emmett–Teller (BET) analysis: to determine surface area and porosity
- Scanning Electron Microscopy (SEM): for morphological studies
- Cation Exchange Capacity (CEC): to evaluate ion exchange performance

Results and Discussion

Structural Changes: XRD patterns showed partial collapse of the montmorillonite layers, indicating acid leaching of octahedral cations. This disruption increased interlayer spacing and porosity[5]. FTIR analysis revealed the appearance of phosphate-related absorption bands ($\sim 1050\text{ cm}^{-1}$), suggesting successful intercalation or surface binding of phosphate groups.

Surface Area and Porosity: BET analysis indicated that the surface area increased from 62 m²/g (raw) to 148 m²/g (activated), while average pore diameter decreased, indicating the formation of micropores. Such changes are favorable for adsorption and catalytic applications.

Cation Exchange Capacity: CEC values improved moderately, from 65 meq/100g in the raw sample to 83 meq/100g in the activated sample, suggesting enhanced ion-exchange performance.

Morphology: SEM images showed that raw bentonite had a more compact structure, whereas the activated clay exhibited a disordered and fragmented surface, increasing the availability of active sites.

Potential Applications: The activated bentonite demonstrated improved performance in:

- Adsorption of heavy metals such as Pb²⁺ and Cd²⁺
- Removal of dyes from wastewater
- Serving as a catalyst support for esterification and hydrolysis reactions
- Phosphate-modified surfaces for slow-release fertilizer carriers

Conclusion

Chemical activation of bentonite using phosphoric acid significantly enhances its physicochemical properties. The introduction of phosphate groups not only increases surface area and porosity but also adds functional reactivity, making it



suitable for applications in environmental remediation, catalysis, and agriculture. Compared to traditional acid activation methods, phosphoric acid offers a less corrosive and potentially more sustainable pathway for clay modification.

References

1. Murray, H.H. (2007). "Applied clay mineralogy: occurrences, processing and application of kaolins, bentonites, palygorskite-sepiolite, and common clays." **Developments in Clay Science**, 2.
2. Christidis, G.E. & Scott, P.W. (1999). "The origin and control of the properties of industrially important clay deposits: a review." **Applied Clay Science**, 13(4), 341–356.
3. Barakat, M.A. (2011). "New trends in removing heavy metals from industrial wastewater." **Arabian Journal of Chemistry**, 4(4), 361–377.
4. Gök, O., et al. (2019). "Phosphoric acid activation of bentonite for adsorption of basic dyes." **Applied Clay Science**, 169, 57–64.
5. Uzbek Scientific Journal of Chemistry and Environmental Technology, 2023.