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TREATMENT OF INDUSTRIAL WASTEWATER WITH ACTIVATED SAMPLES BASED ON DEFECATE AND BENTONITE

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Abstract: This article presents a detailed analysis of the quantitative and qualitative parameters of industrial wastewater from the "Navoielektrokimyo" Joint Stock Company. The analysis revealed that the wastewater contains a high concentration of dissolved salts, suspended solids, and other pollutants that exceed permissible environmental standards. In order to address this issue, laboratory experiments were conducted using activated samples prepared by thermal treatment of defecate and bentonite. The performance of these samples was evaluated based on changes in pH, turbidity reduction, sorption capacity, and overall purification efficiency. Special attention was paid to the modification techniques and roasting temperatures used in the activation process. The research demonstrated that thermally activated sorbents based on defecate and bentonite are cost-effective, environmentally friendly, and technically efficient for reducing the pollutant load in industrial effluents. These findings suggest that such modified natural materials hold significant promise for application in sustainable wastewater treatment technologies.

Keywords: Defecate, bentonite, wastewater, purification, pH, turbidity, sorption, modification, roasting, efficiency, salt concentration, ecological treatment, active material, thermal activation, industrial effluents.

DEFEKAT VA BENTONIT ASOSIDA TAYYORLANGAN FAOLLASHTIRILGAN NAMUNALARDAN FOYDALANIB SANOAT OQOVA SUVLARINI TOZALASH

Annotatsiya: Mazkur maqolada "Navoielektrokimyo" AJ sanoat korxonasining oqova suvlarining sifat va miqdor ko'rsatkichlari tahlil qilingan. Tadqiqot natijalari oqova suv tarkibida eritilgan tuzlar va qattiq moddalarning yuqori konsentratsiyasini ko'rsatdi. Oqova suvlarni tozalash uchun defekat va bentonit asosida yuqori haroratda faollashtirilgan namunalar ishlatilgan. Laboratoriya sharoitida o'tkazilgan sinovlar namunalarning fizik-kimyoviy xossalari, pH darajasi, loyqalik (turbidlik), adsorbsiyalovchi xususiyatlari va tozalash samaradorligi bo'yicha baholandi. Tadqiqot davomida faollashtirilgan sorbentlarning tarkibi, ularni modifikatsiya qilish usullari va qovurish (termik ishlov) jarayonining ta'siri o'rganildi. Olingan natijalar defekat va bentonit asosida tayyorlangan sorbentlar sanoat oqova suvlarini ekologik tozalashda samarali vosita bo'lishi mumkinligini ko'rsatdi.

Kalit so'zlar: Defekat, bentonit, oqova suv, tozalash, pH, loyqalik, sorbsiya, modifikatsiya, qovurish, samaradorlik, tuz konsentratsiyasi, ekologik tozalash, faol modda.

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ОЧИСТКА ПРОМЫШЛЕННЫХ СТОЧНЫХ ВОД С ИСПОЛЬЗОВАНИЕМ АКТИВИРОВАННЫХ ОБРАЗЦОВ НА ОСНОВЕ ДЕФЕКАТА И БЕНТОНИТА

Аннотация: В данной статье представлены результаты анализа количественных и качественных показателей сточных вод промышленного предприятия АО "Навоийэлектрохимия". Исследуемые сточные воды характеризуются высоким содержанием растворённых солей и твёрдых веществ. Для очистки сточных вод использовались активированные при высокотемпературной термической обработке образцы на основе дефеката и бентонита. В лабораторных условиях были проведены испытания с целью изучения физико-химических свойств образцов, уровня pH, мутности, сорбционной способности и степени очистки. В ходе исследования также были рассмотрены состав активированных сорбентов, методы их модификации и влияние термической обработки. Полученные результаты подтверждают эффективность сорбентов на основе дефеката и бентонита при экологической очистке промышленных сточных вод.

Ключевые слова: Дефекат, бентонит, сточные воды, очистка, pH, мутность, сорбция, модификация, обжиг, эффективность, концентрация солей, экологическая очистка, активное вещество.

INTRODUCTION. The problem of industrial wastewater contamination is a pressing environmental issue due to the continuous discharge of hazardous substances, including heavy metals, salts, and organic compounds, into aquatic ecosystems. These pollutants pose severe risks to both environmental and human health, making their removal a priority for industrial facilities worldwide. Traditional treatment methods such as coagulation, precipitation, and biological treatments often fall short in effectively removing diverse and persistent contaminants, especially at low concentrations and varying pH levels.

Among emerging solutions, adsorption has gained significant interest due to its operational simplicity, cost-effectiveness, and adaptability across various wastewater types. Adsorbents can selectively remove a broad spectrum of contaminants, including heavy metals, ammonia, phosphates, and organic dyes. The performance of adsorption systems heavily depends on the nature of the sorbent material used.

Bentonite, a naturally occurring clay composed primarily of montmorillonite, has proven to be a promising adsorbent owing to its high surface area, cation exchange capacity, and unique swelling behavior. Its efficacy can be significantly enhanced through thermal and chemical modifications, which increase porosity, activate surface sites, and improve binding capacity.

Defecate, a byproduct of the sugar industry, contains calcium carbonate and organic residues and is often discarded as waste. Its combination with bentonite may yield a composite material with synergistic adsorption properties. However, little research has explored the potential of this combination, particularly under thermal treatment, for the removal of complex pollutant mixtures from industrial effluents.

This study seeks to fill this gap by investigating the use of thermally activated composites based on defecate and bentonite for the treatment of industrial wastewater from the Navoi electrochemical enterprise. The goal is to develop a low-cost, sustainable, and effective sorbent material that can meet

stringent environmental regulations while promoting waste valorization and resource recovery.

MATERIALS AND METHODS. Samples of industrial wastewater were collected from the Navoi Electrochemical Enterprise. Raw bentonite was sourced from Krantaus (KR) and Navbakhor (NAB) deposits. Defecate, a sugar industry byproduct, was used as a secondary component. The chemical compositions of the clays were determined and are shown in Table 1.

Sample Activation Mixtures of defecate and bentonite were prepared in various mass ratios (1:1, 2:1, 3:1) and subjected to controlled heat treatment at 400–650°C in a muffle furnace. The samples were held at peak temperature for 2 hours to ensure consistent thermal activation. This process aimed to eliminate organic content and enhance the specific surface area and porosity of the resulting adsorbents.

Characterization Techniques The structural and morphological properties of the activated samples were analyzed using:

- **X-ray Diffraction (XRD)** to determine phase composition and crystalline structure changes.
- **Thermogravimetric Analysis (TGA)** to monitor weight loss and thermal stability during activation.
- **Scanning Electron Microscopy (SEM)** to observe surface morphology and porosity.
- **BET surface area analysis** (where applicable) to quantify specific surface area and pore volume.

Wastewater Treatment Tests Laboratory-scale batch experiments were performed to evaluate the sorption efficiency of activated samples. Known volumes of wastewater were treated with pre-weighed amounts of activated adsorbent under constant stirring. Samples were filtered and analyzed after specified contact times (1–6 hours). Measured parameters included:

- Cation and anion concentrations (Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+, Cl^-, SO_4^{2-}, NO_3^-, NO_2^-)
- pH
- Electrical conductivity
- Turbidity (NTU)
- Total dissolved solids (TDS)
- Residual heavy metals (Fe, Cu, Ni, As, Se, Sr)
- Organoleptic properties (color, odor, taste)

Repeatability tests were conducted in triplicate, and average values were reported. Statistical analysis was performed to determine the significance of changes in pollutant concentrations pre- and post-treatment.

RESULTS AND DISCUSSION

Initial Wastewater Composition The untreated wastewater had a complex chemical composition with high levels of Ca2+ (220 mg/l), Mg2+ (152 mg/l), NH4+ (60 mg/l), Cu (26 mg/l), Fe (116 mg/l), Ni (58 mg/l), and others. Total dry residue was measured at 3700 mg/l.

Adsorption Efficiency Tables 2 and 3 summarize the reduction in pollutants after treatment. Activated samples showed significant improvements in water quality, including reductions in hardness, ammonium, sulfate, chloride, and heavy metal ions. For instance, samples activated at 650°C resulted in water suitable for reuse in technical processes.

Structural Changes Post-Treatment SEM images showed increased porosity and surface area after heat treatment. TGA confirmed the breakdown of organic matter and formation of carbon particles that enhanced the adsorption process. XRD patterns confirmed the formation of new crystalline phases conducive to metal ion capture.

The findings confirm that defecate and bentonite-based sorbents, when thermally activated, exhibit enhanced physicochemical properties for adsorption. The selection of activation temperature and mass ratio plays a

crucial role in determining sorption performance. The removal of heavy metals and reduction in dry residue indicates the potential for these materials in practical wastewater treatment. Furthermore, the use of local raw materials like bentonite and defecate adds to the sustainability and economic feasibility of the method.

CONCLUSION. The present study has clearly demonstrated the potential of thermally activated defecate and bentonite composites as effective adsorbents for industrial wastewater treatment. By optimizing the activation temperature—particularly at 650°C—high-performance sorbents were synthesized that significantly improved the removal of various contaminants, including heavy metals, ammonium, and sulfates. The treated wastewater met or exceeded the maximum permissible concentration (MPC) standards, rendering it suitable for reuse in technical applications such as cooling systems or industrial rinsing processes.

This approach leverages low-cost, locally available materials and transforms industrial byproducts into value-added resources, thereby contributing to waste minimization and environmental sustainability. Moreover, the application of these sorbents supports the principles of the circular economy by reducing the environmental burden associated with both wastewater discharge and solid waste disposal. Further research could explore the regeneration and reuse of the adsorbents, as well as scaling up the treatment process for continuous-flow industrial operations

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