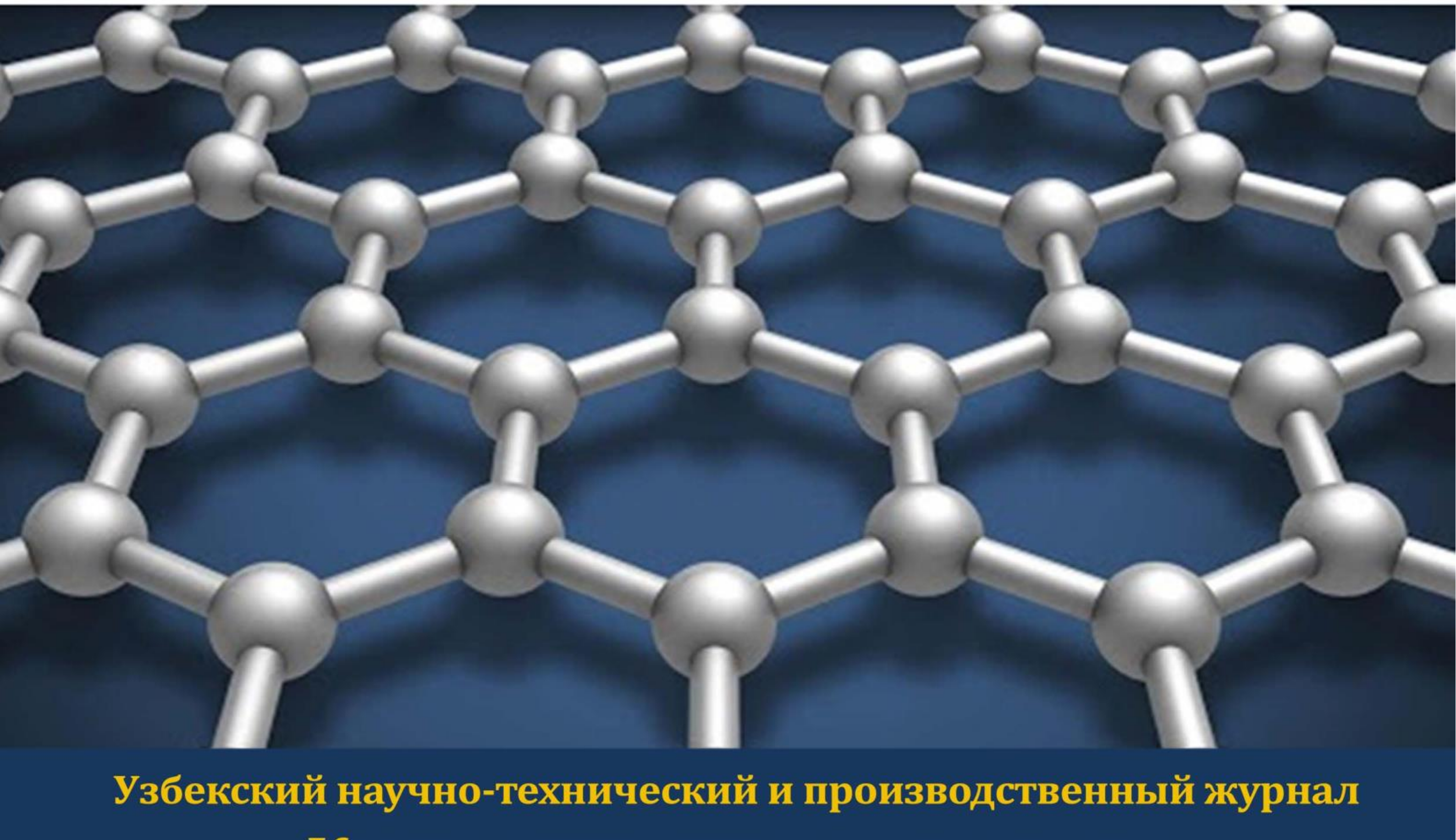
ISSN 2091-5527
№ 4/2024

O‘zbekiston

Kompozitsion Materiallar

Ilmiy-texnikaviy va amaliy jurnali



Узбекский научно-технический и производственный журнал

Композиционные материалы

UDC 544.478.02

NORDON GAZLARDAN OLTINGUGURT AJRATIB OLISH UCHUN TITAN ASOSLI SEOLIT ISHLAB CHIQISHNING ILMIY ASOSLARI

Sultonov S.B., Kucharov A.A., Yusupov F.M.

Institute of General and Inorganic Chemistry of the Academy of Sciences

Abstract. This research focuses on the utilization of titan-based zeolites for the processing of sulfur compounds, offering a solution to a significant environmental challenge associated with the emission of hydrogen sulfide and other harmful gases in the chemical, petrochemical, metallurgy, and gas processing industries. The study emphasizes the high adsorption capacity and chemical stability of titan-based zeolites, which allow for the efficient separation and extraction of sulfur from waste gases. The results obtained demonstrate that titan-based zeolites effectively reduce harmful components in waste, enabling the safe and environmentally friendly extraction of sulfur. Furthermore, the research highlights the importance of developing and implementing titan-based zeolites in industrial applications, which can lead to innovative technologies that address ecological issues. Additionally, the study presents the X-ray phase spectrum of waste from the ShGKMM process. The phase composition diagram obtained from X-ray analysis of the granule sample is scientifically analyzed. The results also include images of the sample taken after calcination at 250 µm.

Key words: titanium oxide catalyst, aluminum oxide, zeolite, SEM analysis, technological waste, gas processing, technological waste, sulfur compounds, adsorption capacity, environmental problems.

Introduction. Currently, the chemical, petrochemical, metallurgy, and gas processing industries produce waste gases containing hydrogen sulfide and other sour components (SO_2, CO_2, and organic sulfur compounds) as a widespread issue. These waste products, especially sulfur compounds, pose a significant risk due to their high corrosive properties and their potential to cause serious harm to the environment, making their utilization of vital importance. One of the widely used methods for processing sulfur compounds is to convert them into a safe product—sulfur itself. This process is not only environmentally protective but also economically effective [1]. The increase in sulfur content in natural gas and oil highlights the necessity for the rational and effective use of these resources. The fivefold increase in natural sulfur reserves demonstrates how to effectively utilize these resources [2]. The development of titan-based zeolites in these processes is urgent and of great importance. Titan-based zeolites stand out due to their high adsorption properties and chemical stability. They help in effectively processing sulfur compounds into elemental sulfur. The structure and properties of titan zeolites allow their use under specific conditions, which reduces the harmful components of waste gases [3].

Titan-based zeolites enable high-level separation of sulfur with minimal environmental damage. This process not only protects the environment but also enhances efficiency in industrial production. Zeolites are economically beneficial in waste processing while also safeguarding the environment. Furthermore, titan-based zeolites are significant in the development of new technologies. Their unique properties expand the possibilities for creating new methods and applying them in practice. Titan-based zeolites aid in making waste processing in industry efficient, thereby contributing to environmental protection [4].

In summary, the development of titan-based zeolites is crucial not only for reducing waste but also for ensuring the safe and effective use of sulfur compounds. This process facilitates economic development without harming nature. Consequently, the relevance and importance of developing titan-based zeolites align with the growing demands of any industry and open up opportunities for innovations in this field [6].

A new phosphorus fertilizer plant is being completed in Samarkand, Uzbekistan. The plant has a capacity of 910 thousand tons per year, of which 370 thousand tons will be monoammonium phosphate and 540 thousand tons will be nitrogen-phosphorus-potassium fertilizers. The required natural gas consumption for the plant is 90 million cubic meters per year. Phosphorus fertilizers play an important role in agricultural production as they provide the necessary phosphorus source for plant growth and development. Additionally, monoammonium phosphate helps plants better absorb nutrients. The establishment of the plant in Samarkand will enhance Uzbekistan's self-sufficiency in agriculture and reduce the need for imports. The implementation of this project is significant not only for agriculture but also for ensuring economic stability. The production of phosphorus fertilizers creates opportunities for improving the quality of agricultural products and expanding arable land. The natural gas consumption of the plant also addresses issues of energy efficiency and environmental protection. Rational use of energy resources will be a crucial factor in ensuring the sustainable operation of the plant in the future. Furthermore, the plant's production processes are designed based on modern technologies, making it competitive [7]. This project will greatly contribute to Uzbekistan's economic development and create new jobs.

In Bukhara region, the construction of a new nitrogen plant is planned. This plant will have a capacity of 500 thousand tons of ammonia and 600 thousand tons of urea per year. Such high-capacity plants will expand the supply of fertilizers in agriculture. Nitrogen fertilizers are crucial for increasing crop yields as they contain nitrogen, an essential nutrient for plants. The natural gas consumption of the plant is expected to be 1.2 billion cubic meters, which is necessary for the energy supply of the plant. Natural gas is used as a primary raw material in fertilizer production [8]. Additionally, a gas-chemical complex is also planned in Bukhara, with a capacity of 300 thousand tons of polyethylene terephthalate (PET), 100 thousand tons of low-density polyethylene (LDPE), and 80 thousand tons of ethylene vinyl acetate (EVA). The natural gas consumption of this complex is estimated to be 1.3 billion cubic meters. Such production will aid in the development of Uzbekistan's gas chemical industry and contribute to the diversification of the country's economy. As Uzbekistan is rich in gas resources, rational use of these resources is essential.

These projects will help in the effective utilization and renewal of Uzbekistan's energy resources. The planned natural gas consumption reaching 15 billion cubic meters indicates further growth of the country's economy. This not only ensures economic stability but also increases the potential for creating new jobs. Thus, the plants being constructed in Samarkand and Bukhara regions will create significant innovations in Uzbekistan's agriculture and industry. This project plays a crucial role in achieving goals such as rational use of natural resources, ensuring economic stability, and creating new jobs for our people.

Material and methods. The zeolite is dried at a temperature of (110 ± 10) °C for 1.5 hours, then cooled in an exsiccator to room temperature and weighed. The measured sample is placed in a glass beaker, filled with distilled water, and boiled for 15 minutes. This process allows air to escape from the sample's pores. The sample is then transferred to a funnel, and water is passed through the sample for 10 minutes. Excess moisture is removed by filtering under vacuum (with a residual pressure of 8 kPa (60 ± 5 mm mercury column)) for 3 minutes, after which the sample is weighed again. The increase in the sample mass and the volume of water filling pores larger than 0.35 nm in diameter are calculated:

$$V_{£} = \frac{m_2 - m_1}{\rho_{H2O} \cdot m_1}$$

In this context:

m_1 - Mass of the product before hydration, g;

m_2- Mass of the product after hydration, g;

ρ_{H2O} – Density of water at the temperature at which the experiment is conducted

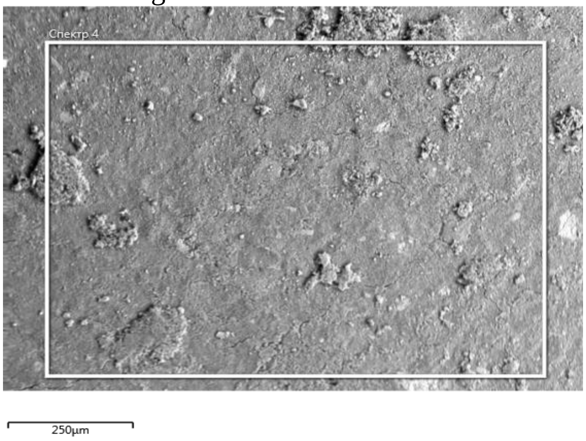
Results and discussions. Waste samples were burned at different temperatures in order to clean the waste of Shortangaz chemical complex (ShGKM) from various organic substances.

1 table

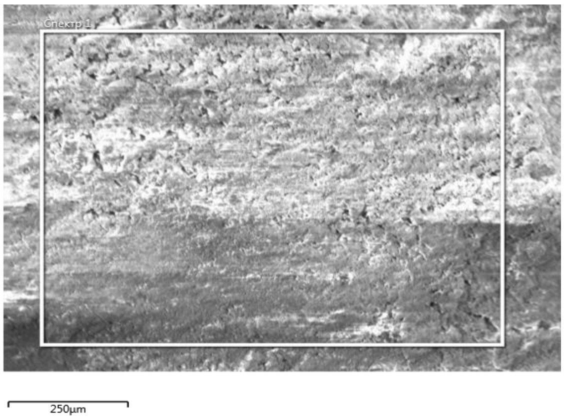
ShGKM change in waste composition depending on the incineration temperature

Burning temperature, °C / Chemical Content, %	It burned did not	400	500	600	700	800
Al	39,3	40,3	40,8	41,3	41,3	41.5
Na	0.5	0, 7	0, 7	0.75	0, 7 5	0.85
Si	0.03	0.0 7	0.0 7	0.0 7	0.08	0.08
S	16.50	3.50	1 , 5	1, 0 5	0.50	0.50
Cl	0.60	1, 00	1, 2 0	1, 3 0	1.30	1.35
K	0.03	0.03	0.03	0.03	0.03	0.03
Ca	0.025	0.025	0.025	0.025	0.025	0.08
Ti	0.0042	0, 10	0, 10	0, 1 2	0, 1 2	0.14
V	0.0015	0.15	0, 2	0, 2	0, 2	0.22
Mr	0.0040	0.0040	0.0040	0.0040	0.0040	-
Fe	0.035	0.035	0.035	0.035	0.035	0.01
Zn	0.0006	0.0006	0.0006	0.0006	0.0006	-
Zr	0.00001	0.00001	0.00001	0.00001	0.00001	0.0002
Mo	0.00001	0.00001	0.00001	0.00001	0.00001	0.0002
C	11.44	1	1	1	1	0.8

The chemical composition of the samples burned at different temperatures was determined using the X-ray fluorescence method. According to it, it can be seen that the amount of S in the sample has decreased and the amount of metals has increased. SEM images of the samples before and after annealing were also taken.



1 picture. Image taken at 250 µ of the sample before annealing



2 pictures. Image taken at 250 µ of the sample after annealing

As a result of the comparison of the chemical composition and SEM images of the initial and incinerated samples, it can be seen that various sulfur and other organic compounds settled on the surface of ShGKM waste granules during incineration and, as a result, the pores on the granule surface are opened.

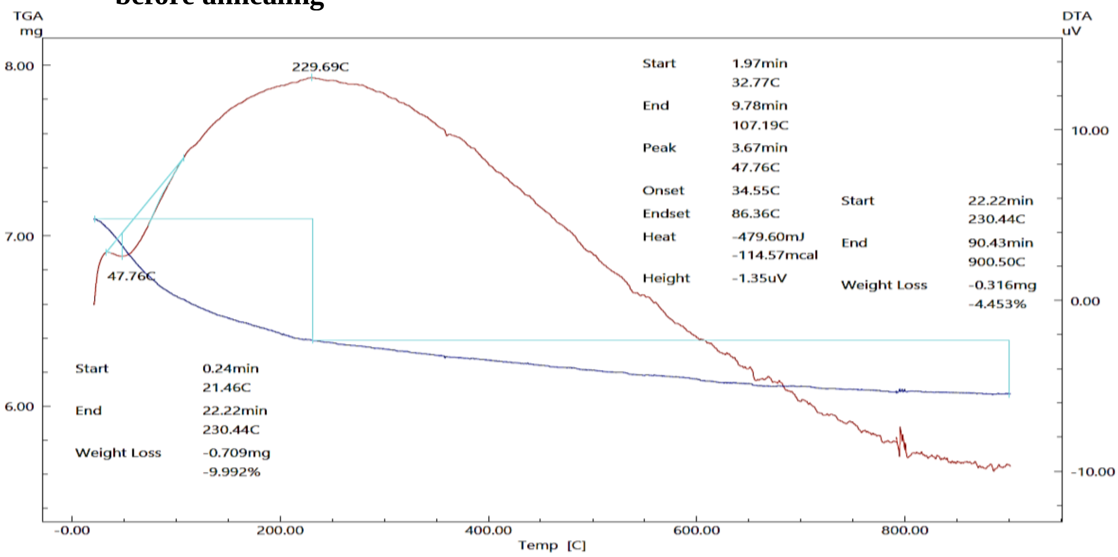


Figure 3. Results of thermal analysis of the waste sample of ShGKM

A slight decrease in mass was observed during heating of the waste of SCC as a result of two exothermic and two endothermic processes. An endothermic effect observed at 100-120 °C means that water and other volatile substances have been removed from the sample. Exothermic effects with maxima at 320°C and 490°C indicate the progress of oxidation processes. And endothermic processes at 560-850°C mean the presence of coke layers on the granule surface. Most of the mass loss was observed in the temperature range of 440-560°C.

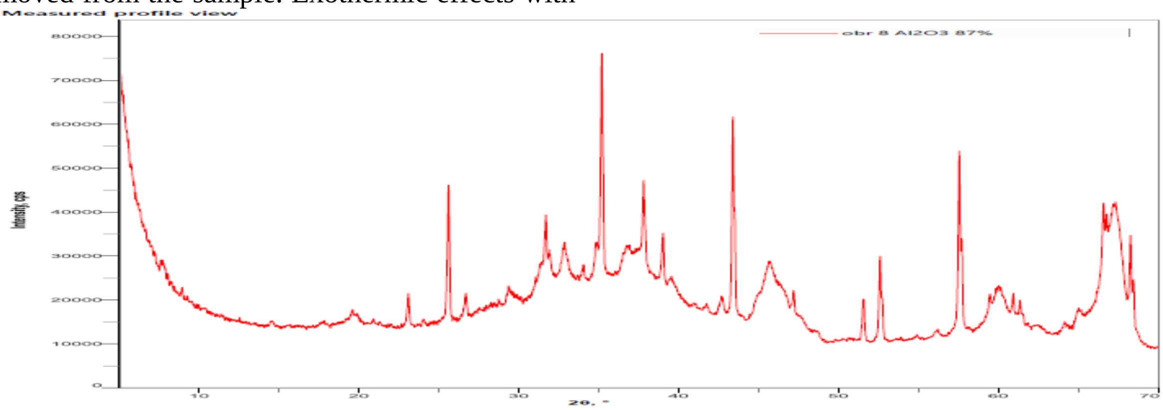


Figure 4. X-ray phase analysis spectrum of the pellet sample

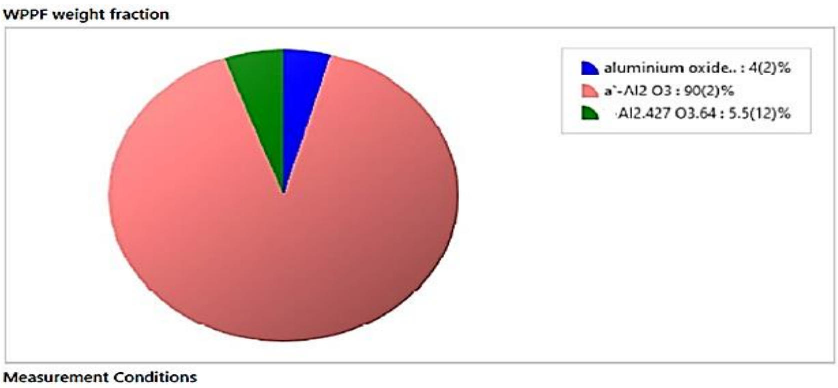


Figure 5. Phase composition diagram of a granule sample obtained from X-ray analysis

X-ray phase analyzes of the waste and the sample taken from it were carried out. The X-ray pattern of the samples was found to be consistent with X-ray diffraction of low-temperature oxides.

The low-temperature phases of alumina belong to the spinel structural type, in which oxygen forms centered cubic packings with the highest density.

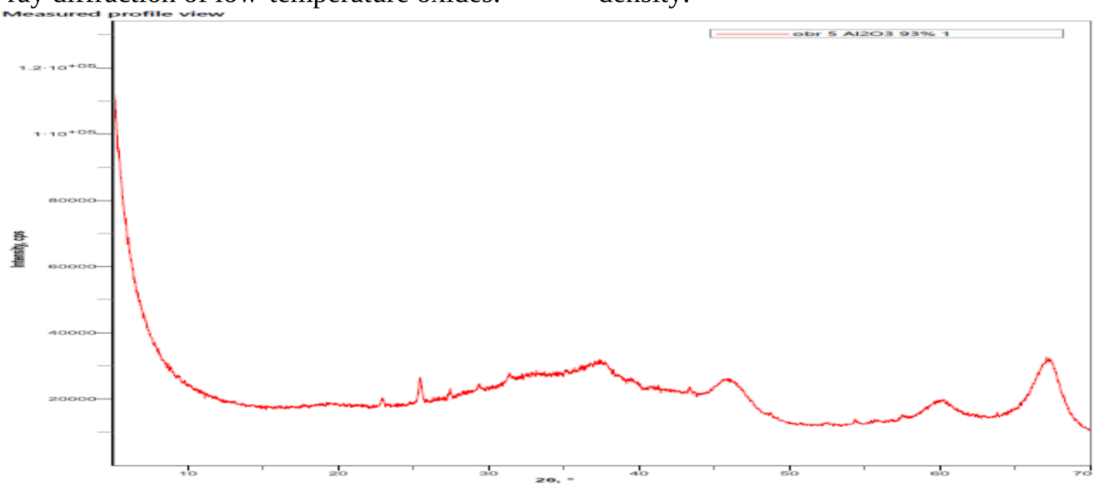


Figure 7. X-ray spectrum of ShGKM waste

$CaAl_2O_4$ spinel, calcium ions occupy 8 of the 64 oxygen tetrahedral shells, and aluminum ions occupy 16 of the 32 octahedral shells. Thus there are 24 cations for 32 anions. Spaces filled with cations are called spinel. Like oxygen anions, calcium and aluminum cations form simple centered cubic packings with their coordinates shifted relative to each other.

Conclusions: The primary aim of this research is to study the process of processing sulfur compounds using titan-based zeolites. Currently, the waste gases emitted in the chemical, petrochemical, metallurgy, and gas processing industries contain hydrogen sulfide, organic sulfur compounds, and other harmful gases. Since these waste products can significantly impact the environment, their effective utilization is of great importance. Throughout the research, the high adsorption properties and chemical stability of titan-based zeolites have been taken into account. Zeolites are very effective in separating and processing sulfur compounds, helping to reduce harmful components in waste. Moreover, titan zeolites allow for the safe and efficient extraction of sulfur, which is crucial for environmental protection. The study involved measuring the physical-chemical properties of titan-based zeolites, such as water density, and the mass of the samples before and after hydration. Through these processes, the composition of the hydrated zeolites and their filling with water were investigated. The structure and properties of the zeolites during the hydration process, as well as their effect on sulfur compounds, were examined in depth. The results obtained indicate that titan-based zeolites not only facilitate the separation of sulfur compounds but also enable the identification of the mass difference before and after hydration. All these processes can be economically beneficial while not harming the environment. Consequently, the processes of extracting sulfur using titan zeolites allow for the effective use of available resources. Another significant aspect of this research is the importance of developing titan-based zeolites and implementing them in industry. Research related to titan-based zeolites may lead to the creation of new technologies, which can help address ecological issues.

6. Проблемные обзоры