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DEVELOPMENT OF COAL ENRICHMENT AND GAS EXTRACTION TECHNOLOGY FOR THE USE OF CONSTRUCTION MATERIALS INDUSTRIAL ENTERPRISES

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Abstract: This article presents information on how the enrichment of low-quality coal, amounting to 2.0 million tons with a high ash content, can lead to more efficient utilization. The aim of the study is to reduce the ash content by 20-35% and increase the calorific value to between 3600-5200 Kcal/kg. During the coal enrichment process, in-depth studies were conducted using potentiometric titration, FT-IR analysis, and scanning electron microscopy. The results indicate the potential for an economic benefit of 1.3 billion Uzbek soms. This involves producing alternative energy sources through waste recycling, reducing environmental impact, and enhancing economic efficiency by implementing new technologies. The analysis of the experimental-industrial trials conducted via a pilot facility is also included.

Keywords: coal, enrichment, ash content, calorific value, economic benefit, waste recycling, alternative energy, FT-IR analysis, scanning electron microscopy, energy sources, environment, pilot facility.

Introduction. Currently, many construction enterprises are transitioning from natural gas to coal as a fuel source, facing challenges due to the high ash content and low calorific value of coal. This article addresses this critical issue by proposing solutions through coal enrichment. By enriching low-quality coal with an ash content ranging from 48% to 65%, it is possible to reduce the ash levels by 20% to 35%. This process can lead to significant benefits, including an economic gain of 1.3 billion UZS by processing 4,000 tons of coal annually. The anticipated results enhance the importance of this article and improve the efficiency of coal as a fuel source.

The development of effective methods for enriching low-quality coal samples and creating gas production technologies from coal and industrial waste is considered a scientific challenge today. It is essential to enhance coal with high ash content and low calorific value, while also establishing technologies for gas production for construction materials. Research into the physical and chemical properties of coal aims to reduce ash content in accordance with GOST standards from 35% to 60% and achieve productivity rates of 75% to 80%. Furthermore, it is possible to increase the calorific value from 1,500-2,000 Kcal/kg to 3,600-5,200 Kcal/kg.

Technologies for enriching lignite and anthracite, as well as methods to accelerate gravity and flotation processes using new fluororeagents, are being developed. The proposed technologies will utilize enriched coal along with waste from the Ustyurt gas-chemical plant and the Shurtan gas-chemical complex to facilitate gas production.

The challenges presented by the limited reserves of oil and gas in the country, alongside the increasing demand for alternative energy sources, highlight the importance of addressing issues related to the processing of fuels and other industrial waste. One of the most effective approaches to resolving this issue is improving fuel production through waste recycling. This project focuses on developing green technologies based on coal and its by-products, aiming to solve energy-related problems.

In Uzbekistan, the Angren and Shargun coal mines possess 10 million tons of low-quality coal reserves that remain underutilized due to their low calorific value and high ash content. Enhancing the quality of lignite and anthracite, developing enrichment methods, and creating gas production techniques based on oil and gas industry waste are pressing issues today. Implementing this project aligns with the roadmap outlined in Appendix 3, clause 195 of the President of Uzbekistan's resolution PQ-307, dated July 6, 2022, aimed at developing cost-effective and highly efficient methods for enriching high-ash coal.

The project employs various methodologies and empirical analyses, including Fourier-transform infrared spectroscopy (FTIR), potentiometric titration, and thermal analysis. The FTIR analysis was performed using the BRUKER VERTEX70 FT-IR device, analyzing samples within the wavelength range of 400 to 4,000 cm-1. Potentiometric titration assessed the mineral composition of the coal ash, while thermal properties were determined using a STA TG-DTA/DSC "Start-1600" apparatus.

The quality improvement of unserviceable lignite from the Angren coal mine is crucial for enhancing the economic efficiency of coal utilization. A pilot facility has been created to implement the proposed technology, and positive results from trial operations have been achieved, reinforcing the economic viability of coal enrichment processes. This initiative represents a step toward sustainable energy solutions and effective waste management in the region.

Methodology & empirical analysis.

Potentiometric Titration Method. The potentiometric titration method was employed to analyze the mineral composition of the ash from lignite coal samples of grades 2BR-B2 and 2BOMSH-B2, specifically focusing on SiO2, Al2O3, CaO, and MgO. This titration method is based on oxidation-reduction reactions and serves as a means of characterizing solutions. In this method, no indicators are used; instead, the potential of the analyte, typically measured through an electrolyte solution, provides high accuracy and reliability.

Flame Photometry Method. The flame photometry technique was utilized to determine the presence of sodium and potassium oxides (Na2O, K2O). A PFP-7 model photometer was used for these measurements. A 0.1 g aliquot of the ground ash was prepared in accordance with ISO 26427-85 standards and placed in the photometer (ISO 26148) for separate analysis of each oxide. The PFP-7 is a low-temperature, single-channel flame photometer designed for the continuous determination of concentrations of sodium, potassium, calcium, barium, and lithium. For the analysis, 0.10 g of coal ash was dissolved in hydrochloric acid and sulfuric acid. The solution was prepared in a 250 ml flask, and 10 ml aliquots were taken, with the analysis performed in parallel twice to ensure a maximum error of 0.5%.

Thermal Analysis. The thermal properties of the samples were analyzed using the STA TG-DTA / DSC "Start-1600" device (Linseis, Germany). A sample of 5 mg was heated at a rate of 10 K/min until reaching a temperature of 1073 K. Based on the thermal analysis results, the percentage of crystallinity (χ, %) and the activation energy of the thermo-oxidation process (Ea, kJ/mol) were determined.

Results. The rapid growth of the global population, along with the development of entrepreneurship and business, is leading to an increasing demand for energy. The diminishing reserves of oil and gas, coupled with the rising need for alternative energy sources, have made the recycling of solid fuels, resins, and other industrial waste a pressing issue today.

One of the most effective solutions to this problem is to enhance the recycling process of industrial waste, converting it into fuel products to maximize resource utilization. Developing and implementing environmentally friendly and sustainable technologies for obtaining fuel products from industrial waste can significantly reduce environmental impact.

Utilizing industrial waste to create new chemical raw materials helps lessen the dependency on natural resources. Furthermore, recycling waste can improve energy production efficiency, reduce energy consumption, and achieve economic viability through the introduction of new technologies. This research initiative will be carried out based on the following technological scheme (Figure 1).

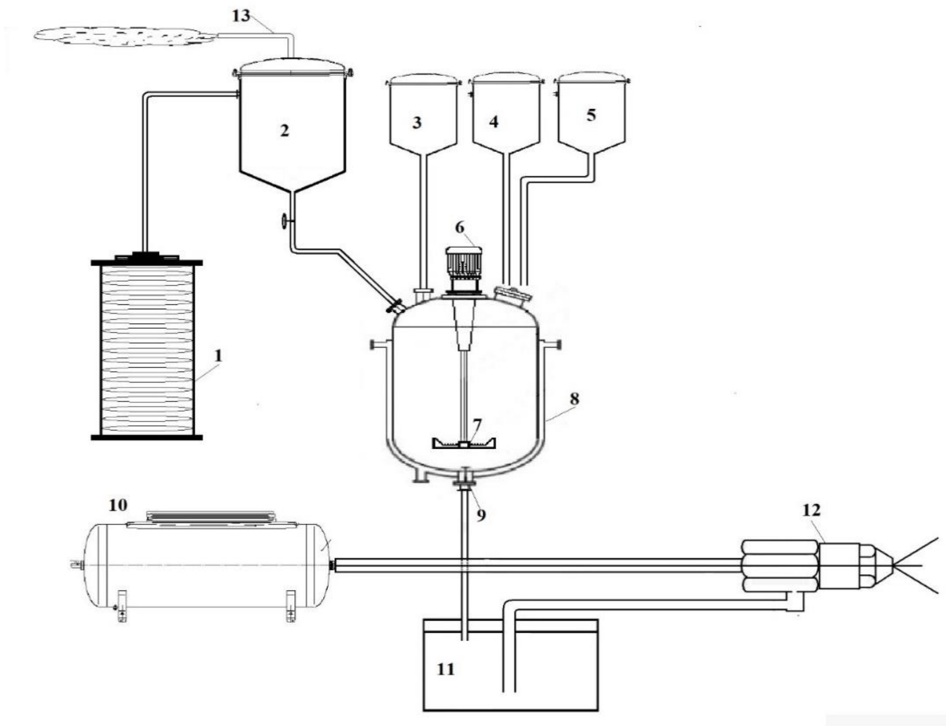


Figure 1. Technology for producing fuel products from industrial waste

1. Device for Producing Fuel Products: This system utilizes waste and developed catalysts to generate fuel products. 2. Storage Container for Liquid Fuel Products: A tank designed for holding the liquid fuel obtained from the process. 3-5. Raw Material Storage

Containers: These are containers for storing various raw materials used in the production process. 6. High-Speed Stirring Motor: A motor that provides the necessary agitation for the reaction. 7. Screw: A component involved in the process, likely for material movement or mixing. 8. Reactor: The primary vessel where the conversion of waste into fuel occurs. 9. Reactor Outlet: The section of the reactor where the processed materials exit. 10. Air Compressor: A device used to supply air to the system as needed. 11. Storage Container for Finished Liquid Products: This tank is designated for holding the finished liquid fuel. 12. Burner for Liquid Fuel: A device specifically designed to combust the liquid fuel for energy. 13. Initial Gas Product: The gaseous byproducts generated during the fuel production process.

The goal of the scientific concept is to develop new, environmentally friendly energy sources through the recycling of oil and gas industrial waste, while also protecting the environment and creating economically efficient technologies.

Understanding the liquids point of coal ash is essential for its application in the glass industry. This is because suitable raw materials for glass melting are selected based on their high liquidus points, typically above 1500-1600°C. The results indicate that the liquids point of the technological waste aligns with the requirements for glass melting according to O'zDSt standards (see Table 1). The presence of partially fusible components in the technological waste, including certain oxides and organic compounds, contributes to its ease of liquefaction. This phenomenon is explained by the formation of physical-chemical bonds with more challenging-to-melt components like aluminum and silicon.

Table 1. Pour point of mineral content of different brands of Angren lignite

Coal stamps	One lamchi mineral content			Secondary mineral composition		
	t_A ºC	**t_B ºC**	**t_C ºC**	**t_A ºC**	**t_B ºC**	**t_C ºC**
2BR-B2	1080	1150	1150	1115	1170	1250
2BOMSSh-B2	1108	1140	1195	1110	1165	1280

The main indicators of enriched coal samples at a semi-industrial scale must meet the requirements outlined in O'zDSt standards. These specifications are detailed in Table 2 below.

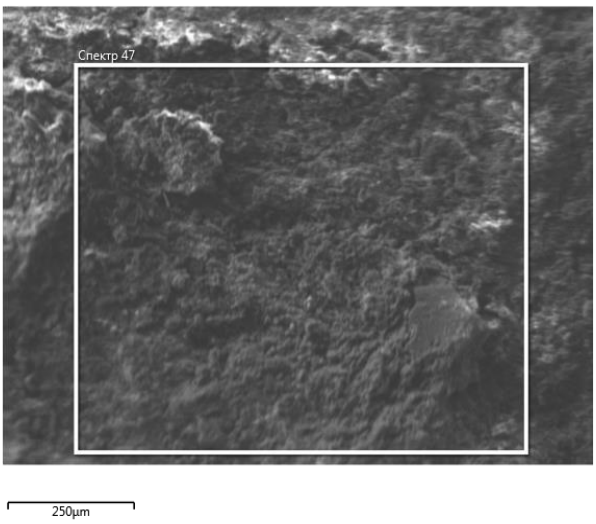
It is essential for the characteristics of the coal to align with these standards to ensure quality and efficiency in their application. The table provides a comprehensive overview of the necessary parameters, which include aspects such as ash content, calorific value, and other critical properties. Meeting these standards is vital for the effective utilization of the enriched coal in various industrial applications, enhancing both performance and sustainability.

By adhering to the O'zDSt requirements, the coal samples can achieve the desired outcomes in terms of energy production and environmental impact. This alignment not only supports compliance with regulatory frameworks but also promotes advancements in energy technologies and resource management. Therefore, the significance of these indicators cannot be overstated in the context of modern industrial practices.

Table 2. The main indicators of lignite brands 2BR-B2 and 2BOMSSh-B2 before and after enrichment.

Name of physical chemical properties	Symbol	Unit of measure	Before enrichment		After enrichment	
			2BR-B2	2BOMSSh-B2	2BR-B2	2BOMSSh-B2
Moisture	W_t	%	20-40	20-40	15-40	15-40
Ash level	A_d	%	35-60	35-60	20-35	20-35
Size	d	mm	1-100	1-100	Briquette	Briquette
Volatile of substances fruit to be	^{Part}V	%	32-50	35-45	44-55	40-55
High combustion heat	Q_S^{daf}	J / kg	15.5-25.4	15.4-23.8	28.6	29.7
Low combustion heat	Q_i^{daf}	J / kg	6.9-12.8	8.9 - 13.6	15.9	15.7

The waste generated during the enrichment process of the 2БР-Б2 and 2БОМСШ-Б2 grades of brown coal was compared with the coal used for KT grade glass production. The results indicated that the technological waste is suitable for use in glass manufacturing.



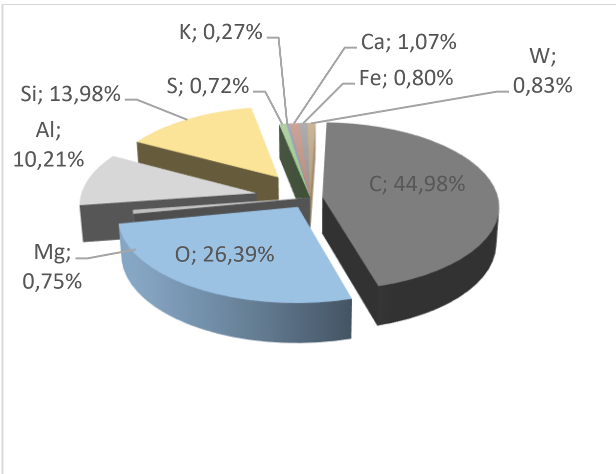


Figure 2. Electron microscope image of the Angren low-quality coal of the 2BR-B2 grade before enrichment and its elemental composition

The surface condition of the Angren low-quality coal of the 2BR-B2 grade was examined using an electron microscope before and after the enrichment process. The electron microscope images obtained during the study indicated that the surface of the Angren coal prior to enrichment was smooth, as the pores on the surface were not opened (see Figure 2).

SEM analysis shows that the coal surface of the Angren 2BR-B2 grade, prior to enrichment, appears unclear due to the presence of impurities. The elemental composition indicates that carbon constitutes 45%, aluminum 10%, and silicon 14%. It can be observed that the amounts of silicon and aluminum are high, while the carbon content is low.

In the research, various physical, mechanical, and chemical methods were applied to the Angren low-quality coal, and the coal samples were examined using an electron microscope.

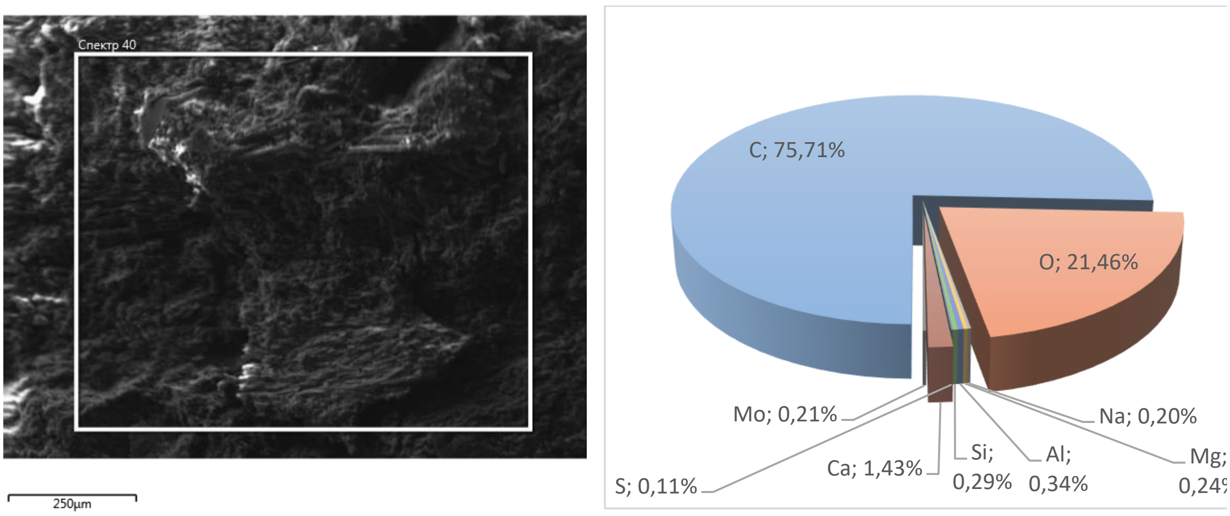


Figure 3. Electron microscope image of the Angren low-quality coal of the 2BR-B2 grade after enrichment and its elemental composition

The results indicate an improvement in the morphology of the Angren low-quality coal surface (Figure 3). This improvement is attributed to the formation of pores on the surface and the removal of excess substances. As a result, the combustion efficiency of Angren coal is enhanced. Key indicators for solid fuels, such as combustion heat and ash content, are crucial. Therefore, by reducing the ash content and increasing the combustion heat, it is possible to obtain higher quality coal.

Conclusions. At "Uzbek Coal" JSC, a pilot facility was established to implement the recommended technology aimed at improving the quality of non-usable 2БР-Б2 and 2БОМСШ-Б2 grades of brown coal extracted from the Angren coal field. An experimental-industrial trial was conducted for coal enrichment, resulting in positive conclusions. Economic efficiency indicators required for the selected coal grades were developed through a material balance approach.

References

1. Kucharov, Azizbek, Sanjar Xalilov, and Farxod Yusupov. "Koʻmirni Qayta Ishlash Va Koʻmirdan Metallarni Ajratishning Energiya Tejamkor Texnologiyasini Ilmiy Tadqiqi." Farg'ona davlat universiteti 4 (2024): 101-101.

2. Nimchik, A., Pulatov, G., Yusupov, F., Haydarov, B., & Kambarov, A. (2024). Use of acid gases in the production of sodium sulphide. In *E3S Web of Conferences* (Vol. 494, p. 02003). EDP Sciences.

3. Nuriddinova, D., Yusupov, F., & Xursandov, B. (2021). Study of the properties of sulfonic cation exchanger. In *E3S Web of Conferences* (Vol. 264, p. 01025). EDP Sciences.

4. Yaxshiyeva, Yulduzxon. "Oqova Suvlarni Tuzlardan Tozalash Qurilmasini Ishlab Chiqishning Ilmiy Tahlili." *Namangan Davlat Universiteti Ilmiy axborotnomasi* 11 (2023): 113-117.

5. Xursandov, Bobomurod, et al. "Study of changes in the physical and mechanical properties of sulfur asphalt concrete mixture based on polymer sulfur." *AIP Conference Proceedings*. Vol. 3045. No. 1. AIP Publishing, 2024.

6. Султонов, Садулла. "Нордон Газлардан Олтингугурт Ажратиб Олиш Учун Кўмирни Бойитиш Натижасида Ҳосил Бўладиган Технологик Чиқиндилар Асосида Катализатор Олиш Технологиясини Ишлаб Чиқишнинг Илмий Асослари." *The Journal Of Research And Development* 1.3 (2024): 29-34.

7. Yusupov, Farxod, et al. "Development and study of adsorption properties of a new sulfur polyvinyl chloride cation exchanger for water treatment." *IOP Conference Series: Earth and Environmental Science*. Vol. 1231. No. 1. IOP Publishing, 2023.

8. Саидмуродов, Рашид, And Фарход Юсупов. "Ишлатилган Цеолитларни Термик Ишлаш Орқали Табиий Газни Қуритиш Жараёнига Боғлиқлигини Таҳлили Натижалари." *Journal of Experimental Studies* 1.4 (2023): 1-9.

9. Юсупов, Фарход Махкамович, et al. "Улучшение качества бурых углей марки 2бр-в2 и 2бомсш-б2 с помощью химической обработки." *Universum: технические науки* 3-2 (72) (2020): 43-46.

10. Юсупов, Фарход Махкамович, et al. "Свойства сферических гранул на основе оксида алюминия." *Universum: химия и биология* 3-1 (69) (2020): 59-63.

11. Ko'charov A., Yusupov , F., & Yaxshieva, Y. (2023). Ishlab Chiqilgan Polimer Holatidagi Adsorbentni Fizik Kimyoviy Tahlil Natijalari. *Journal of Research and Innovation*, *1*(8), 39–46. Retrieved from https://imfaktor.com/index.php/jorai/article/view/616

12. Kocharov, A. A., et al. "Scientific Analysis of the Ecological Condition of the Soils Around the Angren Coal Mine." *International Congress on Biological, Physical And Chemical Studies*. 2024.

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