Development of technology for water concentration of brown coal without use and use of red waste in this process as a raw material for colored glass in the glass industry

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Abstract. The Angren coal mine has 2 billion tons of reserves of various grades of lignite that can be used as fuel, of which 2BR-B2 and 2BOMSSh-B2 lignite grades, which have 2 million tons of reserves, remain unusable due to poor quality and low combustion heat. [1]. To improve the quality of these coals, water treatment technology has been developed. Technological schemes, gravitational flotation methods were studied. The ash content of coal was reduced, and the heat of combustion was increased. Scientific results have been obtained to apply the mixture as a technological waste in the glass industry. In particular, the properties of raw materials for brown tara bottles were studied. The brown glass was obtained by adding the resulting mixture as a technological waste, and its properties were studied.

1 Introduction

Coal is the most polluted type of fossil fuel. Coal produces 70% more CO₂ than natural gas and 30% more CO₂ than oil. The main emissions of industrial enterprises using coal as fuel are nitrogen and sulfur oxides, which is several times higher than the number of harmful gases emitted from natural gas. But because more than a quarter of the world's energy balance is supplied by coal, this does not allow the fuel to be phased out. Unlike natural gas and oil reserves, coal reserves make up millions of hectares of the world's fuel reserves. This is of great interest in technologies that increase the environmental friendliness and efficiency of the use of solid energy fuels.

To develop the economy of Uzbekistan, it is necessary to increase the capacity of the energy and fuel industries. The coal industry plays a growing role in the global energy system [3]. There are objective grounds for explaining this. Given the role of coal in fuel and energy balances, regions, countries, and around the world, its dynamics and prospects, it is necessary to consider the current industrial reserves of various fuels [4-5]. According to experts, the geological reserves of coal account for 90 to 97% of all fossil fuel resources on the planet, and oil and gas only 3-10% [6-7].

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At a time when the demand for energy resources is growing, the processing of low-quality coal and coal waste remains a topical issue [8]. One of the main directions of improving the quality of coal is the enrichment of coal, i.e., purification from non-combustible mineral mixtures [9].

The country has small oil reserves, the volume of production does not meet the needs of all sectors of the economy. Therefore, there is a need to develop new methods of obtaining alternative fuels through the processing of coal resources located in the territory of the Republic. As a result, to meet the energy needs of society, in a short time, coal has become the most important source of energy needed for the development of industry and transport.

The resource base of the country's coal industry consists of the Angren coal basin and the Shargun and Boysun coal deposits. Uzbekkomir JSC, with a history of seventy-two years, is the largest and main enterprise in the industry, operating based on the Angren coal basin in the Tashkent region. Consequently, 85% of the coal mined in Uzbekistan comes from the Angren open pit owned by Uzbekcoal. The joint-stock company also mines coal at the Apartak open and underground mines in Angren. Coal is located at depth, between sedimentary rocks [2].

All coal mined from the Angren coal basin is used only for the needs of Uzbekistan. Currently, the company is working to meet the country's demand for solid fuels. It is estimated that the Republic needs 6 million tons of coal a year. This year, the Angren field will meet 3.7 million tons of this demand. The point is that to extract coal as needed, it is necessary to accelerate the opening of the coal seam in the open pit. This, of course, takes a lot of time and effort. Nevertheless, the management of Uzbekcoal JSC is using its potential and plans to produce 4.5 million tons of coal next year. Naturally, these figures are growing from year to year.

It is no secret that in the past, large, high-quality coal was mixed with low-quality raw materials (coal powder), and in this case, it was delivered to both power plants and the population. This was especially unsatisfactory for homeowners who heated their homes with coal in the winter. This is because coal dust does not burn well in home stoves and gives off much less heat than coal.

The company pays special attention to ensuring the quality of coal. The separation of the rocks reflects a belt conveyor on which the coal is conveyed. The task of the plant staff is to separate the coal from the rocks by hand. Currently, such raw materials are supplied to consumers.

2 Methods

Reagents used in the chemical processing of brown coal grades 2BR-B2 and 2BOMSSh-B2: Nitric acid k.t, GOST 4461-77, hydrochloric acid GOST 3118-77, fluoric acid GOST 10484, sulfuric acid GOST 2184-13.

The potentiometric titration method is used to check the mineral content of SiO_2 , Al_2O_3 , CaO , MgO in the ash content of brown coal grades 2BR-B2 and 2BOMSSh-B2.

Sodium and potassium oxides (Na_2O , K_2O) were detected using flame photometry. A photometer PFP-7 was used for this purpose. To do this, an aliquot is prepared from 0.1 g of crushed ash following the requirements of GOST, passed through a photometer (GOST 26148), and each oxide is tested separately.

Low and high combustion temperatures of coal were determined using the colorimetric method.

Fe_2O_3 in coal ash was checked by optical method, for which an aliquot was prepared using KSt 19330-17490735-05: 2005, and the photocolorimeter was checked by KFK-3.

3 Results and Discussion

To enrich the brown coal grades 2BR-B2 and 2BOMSSh-B2, it is first passed through a vibrosieve, and the fine coal that passes through the sieve is passed to a gravity drum. Large pieces are crushed in a grinder. The gravity drum is chemically treated and cleaned of the original mineral content. The coal that passes through this drum is recycled in a flotation reactor and transferred to a coal dryer. The enriched and dried coal is transferred to the briquette-making machine through the envelope, and the finished product is obtained in the form of briquettes (Figure 1).

Fig. 1. Technological scheme for the enrichment of lignite: 1 is poor quality brown coal, 2 is vibrosieve, 3 is grinder, 4 is gravity drum, 5 is flotation reactor, 6 is air compressor, 7 is drying drum, 8 is briquette machine, 9- is finished product, 10 is technological waste, 11 is wastewater

The ash of the burning of brown coal grades 2BR-B2 and 2BOMSSh-B2 was studied in the experiment, their high mineral content (35-60%) was determined, and the ash content was checked. Coal ash contains large amounts of silicon, aluminum, and calcium oxides. As a result of the study of its chemical composition, it was concluded that the extracted ash is suitable as a raw material for the glass industry (Table 1).

Table 1. 2BR-B2 and 2BOMSSh-B2 lignite grade and mineral content

Name	Ash content%	SiO ₂ %	Fe ₂ O ₃ %	Al ₂ O ₃ %	CaO %	MgO %	Na ₂ O %	K ₂ O %
2BR-B2	48-55	58.1	2.1	27.6	8.4	1.8	0.6	1.2
2BOMSSh-B2	52-61	66.9	1.6	18.2	7.9	2.3	0.9	0.7

Without knowing the melting point of coal ash, it cannot be used for the tara glass industry. Because the chemical composition of similar substances is equal to the melting point balance, those suitable for glass baking are selected. The results show that the

liquefaction point of the process waste meets the requirements of GOST glass baking (Table 2).

Table 2. Melting point of brown coal mineral composition 2BR-B2 and 2BOMSSh-B2

Name	Before Enrichment			After Enrichment		
	t_A °C	t_B °C	t_C °C	t_A °C	t_B °C	t_C °C
2BR-B2	1080	1150	1150	1115	1170	1250
2BOMSSh-B2	1108	1140	1195	1110	1165	1280

The following table shows that the main parameters of enriched coal with semi-industrial equipment meet the requirements of GOST (Table 3)

Table 3. The main indicators of brown coal 2BR-B2 and 2BOMSSh-B2 before and after enrichment

Indicator Name	Character	Unit of Measur ement	Before Enrichment		After Enrichment	
			2BR-B2	2BOMSSh-B2	2BR-B2	2BOMSSh-B2
moisture	W_t	%	20-40	20-40	15-40	15-40
Ash content%	A_d	%	35-60	35-60	20-35	20-35
Size	d	mm	1-100	1-100	Briket	Briket
Formation of volatiles	V^{daf}	%	32-50	35-45	44-55	40-55
High combustion heat	Q_s^{daf}	MD Dj/KG	15.5-25.4	15.4-23.8	28.6	29.7
Low combustion heat	Q_i^{daf}	MD Dj/KG	6.9-12.8	8.9-13.6	15.9	15.7

The wastes generated during the enrichment of brown coals of 2BR-B2 and 2BOMSSh-B2 brands were compared with the coal used for KT brand tara bottles. As a result, it was concluded that technological waste is suitable for use in packaging bottles. Because the chemical composition of the technological waste partially replaces the quartz sand and dolomite used for CT brand brown Glass. In addition, the high content of aluminum in technological waste is an import-substituting raw material. Due to the presence of iron oxides, it is considered unsuitable for colorless packaging (Table 4).

Table 4. Properties of coal and technological waste used for the glass industry

Type of analysis	Analysis name	BT brand coal for KT container glass	Technological waste
Technical analysis	moisture	13.49%	25.11%
	Ash	24.71%	91.29%
Chemical composition of ash	SiO ₂	66.9	58.5
	Al ₂ O ₃	1.6	14.2
	Fe ₂ O ₃	18.2	12.8
	CaO	7.9	8.6
	MgO	2.3	3.5
	Na ₂ O	0.9	0.3
	K ₂ O	0.7	1.1
	SO ₃	1.2	-
Granulometric composition	1.25	68.8	0.1
	0.63	8.0	0.2
	0.36	5.3	80.7
	0.16	5.1	16.9
	Dust	12.8	2.1

The optimal condition was the mixing of technological waste in the process of enrichment of brown coal 2BR-B2 and 2BOMSSh-B2 with coal used as a raw material for brown Glass in a ratio of 40/60. It was difficult to obtain Glass of the expected color when 100% technological waste was used (Table 5).

Table 5. Properties of brown Glass derived from coal used to obtain technological waste and tare glass obtained in different proportions

Technological waste / used coal ratio	100% Technological waste	20/80	40/60	50/50	40/60	80/20	90/10
Properties							
Glass density GOST 32131-2013	2.4956	2.5005	2.5055	2.5049	2.5040	2.4988	2.4997
Temperature resistance GOST 32131-2013	+	+	+	+	+	+	+
Water resistance	0.18	0.2	0.19	0.20	0.17	0.18	0.19
Color for CT brand	-	-	+	+	+	+	+
Glass molding temperature	1020	1023	1025	1027	1020	1025	1026

In the semi-industrial method, brown Glass of the CT brand was obtained using raw materials from the technological waste generated during the enrichment of lignite grades 2BR-B2 and 2BOMSSh-B2. This glass was obtained from UzDsT and KT brand brown glass produced in the Republic, which is not inferior to other glass (Table 6).

Table 6. Properties of KT brand brown Glass produced when the technological waste from the process of enrichment of brown coal 2BR-B2 and 2BOMSSh-B2 is used in the glass industry

Technological indicators of Glass		Glass brands			
		KT	KT	KT	KT
		O'zDsT	Campalia	Asl oyna	Technological waste / used coal ratio 40/60
Chemical composition	SiO ₂	71.1(±2.5)	72.09	72.2	70.9
	Al ₂ O ₃	3.3±1.5	2.8	3.1	3.3
	Fe ₂ O ₃	0	0.278		0.29
	CaO	11.0(±1.5)	6.8	11.0	6.9
	MgO		3.4		3.7
	Na ₂ O	14.3 ± 0.9	14.1	14.2	14.4
	K ₂ O		0.09		0.2
	SO ₃	0,3	0.1	0.2	0.1
Density GOST 32131-2013		2.47-2.51	2.5023	2.4955	2.5049
Water resistance GOST 32131-2013		0≥0.35	0.21	0.18	0.19
Chemical stability GOST 32131-2013		0≥0.35	0.17	0.21	0.17
Temperature resistance GOST 32131-2013		+	+	+	+

4 Conclusions

The area of Angren and Shargun coal deposits has been fully explored, so it is not possible to increase the area of their coal reserves. Sanjar Square in Boysun; It is possible to increase the number of coal reserves of the Republic by studying the coal reserves of Fangard and Gugud fields in Surkhandarya region, Vuadil field in Fergana region. An important indicator for brown coal used as a solid fuel is the heat of combustion and the level of ash. Therefore, quality coal is obtained by reducing the level of ash and increasing the heat of combustion [10]. The Angren coal deposit has more than 2 million tons of unusable brown coal reserves of 2BR-B2 and 2BOMSSh-B2. By enriching these coals, it is possible to obtain coal used for the national economy and industry. To do this, the use of the above method is one of the most optimal options. This method consists of three stages, purifying coal from 10-15% of minerals. It also provides cost-effectiveness for enrichment costs when brown waste from industrial waste is used to obtain Glass. The properties of brown Glass and the raw materials needed to obtain it were studied. Glass was obtained using industrial waste. This prevents pollution of the environment. The properties of Glass were studied and compared with the products of industrial enterprises of the Republic. According to laboratory tests, it was concluded that industrial waste is suitable for use on a semi-industrial scale.

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