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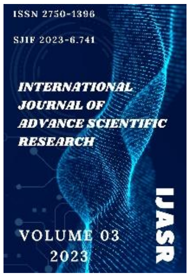

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Research Article

CHARACTERISTIC OF BINDERS IN BRIQUETTING BROWN COAL (LIGNITE)

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Akmaljon Khakimov
PhD, Docent, Fergana Polytechnic Institute, Fergana, Republic Of Uzbekistan

Nasiba Vokhidova
PhD Student, Fergana Polytechnic Institute, Fergana, Republic Of Uzbekistan

ABSTRACT

The results of briquetting technology and composition development of low-quality lignite waste using tars modified with mechanically activated organo-mineral binders as binders are presented. The procedure for using natural and household waste in the production of briquettes with a high burning rate was considered.

KEYWORDS

Lignite, mining deposits, lignite powder, fuel briquette, mechanical activation, ash content, the heat of combustion.

INTRODUCTION

One of the main sectors of the economy of our republic is the coal industry. Even though new types of heat sources are being developed today, coal remains one of the main natural resources used as fuel for both domestic and industrial needs [1].

Angren coal mine takes the leading place in our republic in terms of coal mining, 85% of the coal mined in our republic is Angren coal mine, and the remaining 15% comes from Boysun and Shargun coal mines [2].

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Today, several new projects on the construction of new mines and modernization of production are being implemented. The entry of new large companies is of great importance for the modern development of coal mining in the republic [3].

Angren coal mine is considered the largest coal mine in Uzbekistan. In addition, all conditions have been created for the transportation of mined coal products. The problem of rational use of these coals is primarily due to the high amount of small fractions in the natural state, mining and transportation, the amount of which reaches 50-60% of the total amount of mined coal [4].

THE MAIN PART

The currently produced briquettes do not fully meet the technical requirements for the affordable price of consumers and for use on cold days. According to the composition of coal, the Angren is characterized by a low content of humic acids, resins and substances used for good binding of coal particles, which is one of the main reasons for the technological complexity of their briquetting [5].

One of the most effective ways to use and store coal is briquetting of coal dust, which solves the problem of converting low-grade fuel that is unsuitable for use into briquetted fuel that is convenient for transportation, long-term storage and burning. The feasibility of briquetting lignite powder is that it avoids the huge need for cheap fuel for household needs, as well as the accumulation of coal powder with millions of tons of energy, which occupies large areas in coal mines, and at the same time, serves as a raw material for the production of fuel briquettes. does [6.7].

The waste of production enterprises, natural and household waste was chosen as a binder that further improves the quality and heat level of fuel. Its use is economically beneficial due to its low cost and availability. To improve the quality of briquettes, it is most effective to modify them with structurally active additives, which are used as natural sorbents [8.9].

In lignite briquetting technology, binders are accepted as a variable factor, a necessary condition for binding dispersed substances using organic and mineral substances, in addition to a wide base of raw materials and low cost, their specific surface area, area, porosity, as well as high adsorption properties are achieved [10].

The general technological scheme for obtaining lignite briquettes consists of several operations: preparation of the charge, pressing, heat treatment and cooling. To achieve high efficiency, before adding the binder, the powder is dried at 90 °C and sieved in mills to remove moisture. In the process of mechanical activation, at the same time as the dispersion and the specific surface area of the particles increase, they are transferred to a highly dispersed state, which is characterized by increased values of the surface energy, the level of the order of the crystal structure is disturbed, defects appear, and a transition to the metastable, non-equilibrium state of the particles occurs [11.12].

The study of the textural properties of the fillers shows that the fillers in the activated state are characterized by smaller particle size, specific geometric surface area and increased pores, which can be determined by the increase in pore volume compared to the fillers in the non-activated state [13].

Table 1. The main physicochemical properties of tar

Indicators	GUdron				
	without addition	SP with the addition	With active addiction.	With addition.	BU with the active
Density at 20 °C, kg/m3	955.10	930.10	924.52	953.68	942.54
Conditional viscosity at 80°, enh. degree	22.95	16.07	14.01	16.98	15.87
Mass fraction of silica gel resin, %	17.81	18.94	19.95	17.98	18.76
Mass fraction of asphaltenes, %	5.76	6.94	8.01	8.98	7.99
Fats, %	74.85	72.55	70.97	73.98	72.85
Mass fraction of paraffin, %	8.50	9.01	9.02	6.99	6.87
Coking, %	11.01	13.99	15.03	12.30	12.98
According to Kish, the softening temperature is not	55	53	51	50	49
Needle penetration depth at 25 °C, 0.1 mm	270	203	185	207	195

Data on the assessment of the effect of fillers on the main physicochemical properties and the chemical composition of the binding material in the group are presented in Table 1. Shows a significant effect on the rheological parameters of the fillers, as well as the group composition of the binder [14].

It follows from the comparison of the given data that the introduction of activated fillers allows to maintenance the technological parameters of the resin and to significantly improve it in some aspects. As a result of high porosity, fillers have a high sorption capacity compared to tar oils. Immobilization of oils helps to reduce the mobile dispersion medium, which reduces the softening point and tar penetration [15.16].

It was found that after the modification of the resin, the amount of oils decreases by 1.2-9.5%, the viscosity decreases by 20-41%, but the amount of resins increases by 1.76-22.82%, and oxygen increased by 2.5-4.6 times [17].

Asphaltenes are one of the main carriers of sintering and rheological properties of binders obtained from petroleum. The number of asphaltenes in tar with additives was from 6.98 to 9.75%, with activated additives - 7.12-9.97% [18].

The filling has a positive effect on penetration and coking value, which ensures the thermal stability of briquettes. The penetration of tar samples determined at 25 °C was 280 units [19].

The introduction of fillers causes this indicator to decrease to 170-200, with activated fillers - to 160-190 units. The change in penetration of sapropel-filled resin is similar to that of resin with coal and zeolite fillers. The coking value of binder without additive is 12.54%, with additive - 12.05-15.12%, and with activated additive - 13.12-16.01% [20].

Table 2. Main technical specifications of brown coal briquettes

Content	ssh, MPa	*A*d, %	*V*tambourine, %	S_{etc}, %	*W*, %	*W*rt, %	*Q*daf, MDj/kg	*Q*r, MDj/ kg
Coal + tar	5.99	15.98	44.95	0.32	2.09	5.74	27.95	18.98
Coal + tar + sapropel	11.99	17.97	48.94	0.52	1.99	3.97	28.97	21.15
Coal + tar + act. sapropel	24.99	13,14	47.95	0.41	2.36	4.55	28.95	20.91
Coal + tar + coal samples.	11.01	17.3	52.99	0.27	1.96	3.99	27.9	20,41
Coal + tar + activated carbon	13.99	15.78	55,86	0.27	2.3	3.97	28.97	21.98
Indicators GOST 7299–84	6.9	24.99	64.84	3.75	2.82	–	28.98	–

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ssh – compressive strength, MPa; Ad – dry ash content of the fuel, %; Vdaf - yield of volatile substances, %; Std – total sulfur content in dry fuel, %; W - water absorption, %; Qdaf s - gross calorific value of fuel for the state without dry ash, MDj/kg; Qri - the low calorific value of fuel in working condition, MDj/kg.

The analysis of the change in the properties of the binder composition shows that for any binder, pre-activation in the mill leads to an improvement in physical and mechanical properties compared to the binder containing the same concentration of non-activated filler [21].

Preliminary results show that the following parameters are acceptable for obtaining high-quality fuel briquettes: coal size 0-2.5 mm; analytical humidity of coal - 10-11%; processing temperature -230 °C; heat treatment time -180 min [22].

One of the requirements for lignite briquettes is to maintain sufficient strength to transport the material over long distances. Data obtained on physical-mechanical studies of composites with different compositions show an increase in strength indicators when using a composite consisting of 15% tar, 10% filler and 75% coal by weight, which is associated with better briquetting. Interactions at the "coal-binder" interface are associated with an increase in the content of asphaltenes and resins and a decrease in the amount of low polar oils in the binder [23].

The incorporation of activated filler into the binder as a structurally active additive resulted in a significant change in the compressive strength of the specimens compared to specimens with untreated filler.

It was found that the optimal time of activation of sapropel, and lignite in the mill is 2 minutes, which allows for achievement of the best value in terms of strength of briquettes. Compared to briquettes containing the same concentration of non-activated filler, the strength increases by 1.5-2.0 times [24].

The results of the study of a set of physical and mechanical tests of lignite briquettes presented in Table 2 show that the introduction of activated structurally active fillers (sapropel, lignite) into the pitch leads to a significant improvement in technical characteristics. As can be seen from the developed briquettes, the biggest contribution to increasing the strength of the briquettes is made by the activation of the filler substance. Thus, the value of the compressive strength is 1.5-2 times higher than the normalized value, with the activation of additives - 1.8-3.2 times, depending on the nature of the filler, and 1.7-4.0 times higher compared to the samples containing the original resin [25].

The ash content is in the range of 14.20-18.50%, which is significantly lower than the normal value; in briquettes with zeolite as a binder, the amount of ash slightly increases due to the large amount of mineral content in zeolites. The sulfur content of the obtained briquettes is 8-19 times less. The moisture content of the samples with the binder content is about 1.5 times lower than that of the original coal, which is due to some drying during the introduction of the additive and the preparation of the mixtures (heat treatment). The water absorption rate of the briquettes is 2.15-2.45%, which is 18-28% lower than the standard values, and the residual strength of the briquettes is reduced by 15-25%. It is also characterized by the fact that all samples do not stick to each other. The calorific value of briquettes increases up to 29.89 MJ/kg with the introduction of resin fillers [26].

According to the composition of volatile substances, briquettes obtained with optimized technological parameters and compositions belong to the category of smoky household solid fuels. However, with an increase in exposure time at processing temperatures from 230 °C to 360 minutes, the content of volatile substances can be reduced by 14-16%. Briquettes are subjected to secondary heat treatment to remove volatile substances introduced with binders and to reduce "smokiness". Combustion of the obtained fuel at a temperature of 850 °C showed that the briquettes burn in 110-113 seconds, and for briquette samples containing unmodified tar, little soot is observed during combustion and burning. The rest of the indicators meet the specified requirements.

Structural studies using X-ray diffraction were carried out to determine the influence of the composition and technological methods of lignite briquettes on the processes of structure formation and, accordingly, on the nature of changes in the properties of the compositions.

Table 3. X-ray analysis results

Sostav composition, ob. %			*T*, °C obr.	2nd degree	*d*, A°	a, %
ugol	tar	–	25	26.68	3,348	40.3
			230	26.62	3,348	42.6
ugol	tar	zeolite	25	26.67	3,342	34.4
			230	26.59	3,352	48.3
ugol	tar	act. zeolite	25	26.7	3,339	39.2
			230	26.59	3,352	53.7
ugol	tar	sapropel	25	26.61	3,352	32.5
			230	26.7	3,339	37.4
ugol	tar	act. sapropel	25	26.66	3,344	36.5
			230	26.59	3.36	38.8
ugol	tar	ugol	25	26.68	3,341	36
			230	26.61	3.35	46.2
ugol	tar	act. ugol	25	26.64	3,346	41.8
			230	26.5	3,363	43

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As can be seen from Table 3, the crystal peak of all samples is within 26° and the interplane distances of the crystal lattice are practically unchanged. Comparing them with the diffraction curve of the original resin-based briquette shows a slight shift of the amorphous brittle maximum in briquettes with activated additives to smaller diffraction angles (by 0.12°).

It was found that thermal treatment of all samples of briquettes leads to an increase in the level of crystallinity, and based on the obtained results, the intensity of the crystal peak also depends on the nature of the filler in the binder. Modifying the binder with activated fillers results in a slight increase in crystallinity. The nature of the change of α from the composition of the filler shows the complex nature of the influence of the filler on the crystallization processes of the resulting polymer substance.

When adding sapropel to the binderaThe decrease is probably due to a decrease in the percentage of crystalline regions due to agglomeration of filler particles and a decrease in the rate of polymer crystallization. Thus, when the resin is modified with organomineral fillers, their effect is mainly distributed in the amorphous zones.

In order to determine the permissible storage period of the briquette samples, to take into account the loss of mechanical strength, and possible damage to the surface of the briquettes during their wear, full-scale tests under the influence of climatic factors were conducted for 6 months. Every 2 months, compressive strength loss, and water absorption were evaluated and visual inspection of the samples was carried out.

From the data in Table 4, it can be seen that the briquettes containing the activated filler showed less weathering. For these compositions, the compressive strength remains in the traditional range, and good moisture resistance is observed, which does not change for a long time. All briquettes were found to retain their original shape. This is the basis for concluding that modified tar brown briquettes are less prone to disintegration in the atmosphere and can be stored in the open air for up to six months under natural conditions.

As a result of the research, fuel briquettes with an improved set of technical characteristics were obtained. In order to ensure the necessary technical quality of briquettes provided for in regulatory and technical documents, the technology of changing resin using mechanical activation methods was developed, which helps to increase compressive strength and maintain mechanical properties for a long time [27-29].

Conclusion

The results of the carried out scientific and research work can be used to conduct experimental tests and organize the production of brown briquettes from small pieces of coal based on lignite open mines.

Potential customers and consumers of briquetted coal can be industrial enterprises located on the territory of our Republic, enterprises under the jurisdiction of the Ministry of Housing, Communal Economy and Energy, and energy companies. In addition, social objects, private individuals who consume coal for domestic purposes (heating houses, cottages, baths, saunas, small farms, fireplaces, boxes, garages, etc.) can be used [29].

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