Development of Technologies for Processing Large-Tonnage Accumulations of Oil Sludge and Wood Waste with Obtaining Binders to Improve the Quality of Household Briquetted Fuel Based on Brown Coal

Development of Technologies for Processing Large-Tonnage Accumulations of Oil Sludge and Wood Waste with Obtaining Binders to Improve the Quality of Household Briquetted Fuel Based on Brown Coal

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Abstract: Despite the ongoing state policy in the field of energy conservation and the use of renewable energy sources, the actuality and availability of raw materials, the fuel briquettes are not manufactured on the territory of the Republic of Sakha (Yakutia). The main obstacle in maintaining briquette production is the high cost of oil binders. The most expedient way for briquetting brown coal in conditions of the Republic of Sakha (Yakutia) is the use of alternative types of binder and new less expensive methods of briquetting based on oil sludge and wood waste from logging.
The paper presents the results of development of the technology for processing oil sludges and wood waste to obtain binders that enable production of briquettes from brown coal with significantly improved technical and calorific characteristics. The organization of briquette production will meet the needs of its production facilities, the local population and boiler plants in regions with no other sources of fuel.

1. Introduction

The problem of agglomeration of coal screenings is extremely urgent for all coal regions of Russia. The thermal energy is provided through imported fuel for the northern and Arctic regions of Yakutia, despite the difficulties and high cost of delivery. According to the socio-economic development strategy of the Republic of Sakha (Yakutia) for the period up to 2030, the organization of briquette production will meet the needs of its production facilities, the local population and boiler plants in regions with no other sources of fuel.

The Kangalassky brown coal deposit of the Lena basin is the main fuel base that supplies the central regions of Yakutia with household and industrial fuels. The brown coals of the Republic of Sakha (Yakutia) deposits have a very low yield of humic acids, low content of their own bituminous substances and a small yield of coal tar. Due to these properties, they are briquetted only with the use of binding additives and application of high pressure [1-3]. The implementation of brown coal of the Kangalassky deposit is associated with loss of quality due to spontaneous dispersion and spontaneous combustion, which complicate its transportation and storage.

Traditional methods of coal briquetting require about 10% of the over-oxidized solid bitumen with a softening temperature generally higher than 60 ° C. This leads to a high cost of briquettes, since the costs for bitumen, heating and mixing of high viscosity compounds, pressing briquettes on expensive

and fast-wearing equipment (press) are high due to high pressure [4-10].

As a result of many years of systematic research conducted at the Institute of Oil and Gas Problems of the SB RAS, a set of experimental and theoretical information on the physical and mechanical properties and methods of manufacturing fuel briquettes based on local organic and mineral raw materials was obtained and generalized. Technologies have been developed for obtaining high-quality and inexpensive grade fuel from brown coals of Yakutia with an improved set of physicochemical and calorific properties protected by copyright. Almost in all cases, an unambiguous conclusion was made on the possibility of obtaining strong briquettes from the coals of the Kangalassky deposit, but with the obligatory addition of oil binding agents [11-21].

At present, about 35% of the volume of harvested wood is lost in the form of irretrievable technological waste - chips, sawdust and bark, a fine-tile in the volume of more than 600.0 thousand cubic meters annually. At the same time, during storage of petroleum products large-tonnage waste of oil sludge to be disposed are formed at JSC "Sahaneftegazsbyt" and JSC PC "Tuymaada-neft", the largest oil depots of the Republic of Sakha (Yakutia). Bottom oil sludge and oil waste with a high content of mechanical impurities are practically not subjected to recycling because of the technological complexity of their processing.

The present paper proposes the technology of using oil sludge accumulated in oil storages and wood waste from logging and timber processing to obtain cheap high-quality binder for the production of composite fuel briquettes. It will lead to significant reduction of the cost of briquettes, will enhance their technical and calorific qualities, improve the ecological situation and solve the fuel problem of the regions of the Republic of Sakha (Yakutia). The wood contains an active binder - lignin, which is an amorphous polyfunctional polymer of aromatic nature of a complex structure. Due to its branched, mesh structure, lignin has a high adhesive capacity under the influence of pressure, temperature, and moisture.

Table 1. Group composition of oil sludge of JSC PC "Tuymaada-neft".

Component	Oils (HC)	Tar		Asphaltenes	Water
		Benzene	Alcohol-benzene		
Content, %	52,59	13,78	23,30	2,33	8

Table 1 presents the analysis of the group composition of oil sludge, which shows a high content of asphalt-tar-paraffin components that provide gluing and cohesive properties, characteristic for oil-binders. The low content of water and mechanical impurities, the presence of adhesive capacity and adhesion properties suggested the possibility of using oil sludge in the binder to ensure the hydrophobic properties of coal briquettes.

The technological process of briquetting using wood-sludge waste includes preparation of brown coal and binder composition, heating of the mixture, pressing, and cooling. The preparation of the starting components (coal and wood waste) for briquetting consists in drying them for 3 hours at a temperature of 110°C and grinding. Brown coal fractionated to 2.5 mm and sawdust of up to 1.25 mm are used for briquetting. Then, briquetting compositions are compounded with the content of sawdust of 45, 50, 55 % by weight and the content of oil sludge being 10, 15, and 20 % by weight. Pressing is performed on a hydraulic press at a pressure of 120 MPa with the mixture preheating to 60 ° C. Five cylindrical samples with a diameter of 25 mm are manufactured for each series.

It is established that the optimal parameters for obtaining high-quality fuel briquettes made of wood and charcoal in laboratory conditions are: 1) the coarse size of coal is 0-2.5 mm, the size of sawdust is 0-1.25 mm; 2) the content of sawdust in the mixture is 10 wt%; 3) the moisture content of the mixture is 10 -12%; 4) compacting pressure is 170 MPa; 5) heating temperature of the charge is 100°C; 6) holding time at the heating temperature of the charge is 180 min.

The research complex of samples of brown coal briquettes includes determination of the compressive strength, ash content, volatiles yield, and combustion heat. One of the main requirements for brown coal briquettes is the preservation of sufficient strength necessary for transporting the material over long distances and weather resistance. The results obtained during the study are presented in Table 2.

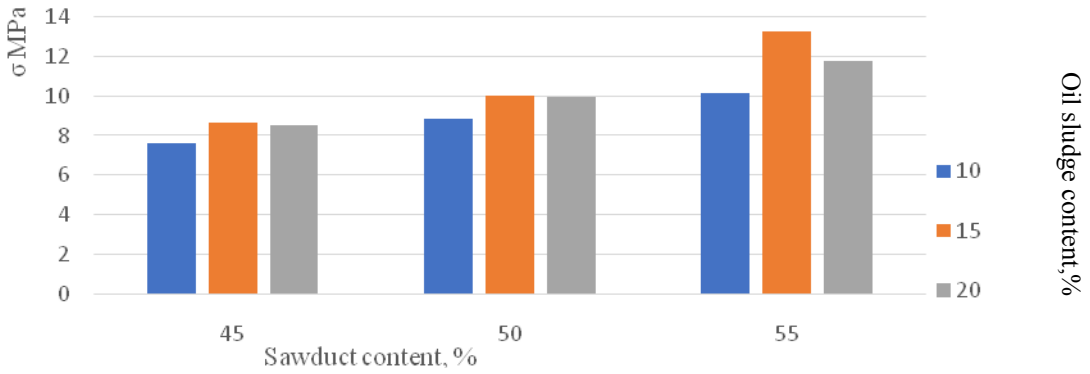

Figure 1. Influence of the wood-sludge binder content on the strength of the briquettes.

When the oil sludge content is increased to 15 wt% the strength increases by 1.5, which is explained by the formation of a film with optimum thickness on the surface of the carbon grains due to the adhesive interaction of the particles and adherence. The obtained data on compressive strength indicate an increase of this index with an increase of the content of sawdust and oil sludge. It is established that briquettes with an oil sludge content of 15 wt. % have increased compressive strength by 3 times as compared to the starting coal.

Table 2 shows that the improvement in water absorption indicators is accompanied by an increase in the amount of oil sludge. The water absorption of briquettes is 2.64-2.87%, which is lower by 30-35.6% of briquettes without oil sludge. Other parameters such as combustion heat, ash content, volatile yield meet the requirements of GOST 7299-84. The best results are obtained for briquettes of the composition: coal 30% + sawdust 55% + oil sludge 15%, since there is an increased level of technical indicators in comparison with the samples made with wood sawdust.

The expediency of using the obtained products is conditioned by the significant need for cheap grade fuel for domestic needs, especially for the northern regions of the Republic of Sakha (Yakutia), as well as by the accumulation of millions tons of energy-bearing coal slimes in the coal regions that occupy vast territories and at the same time can serve as raw materials for the production of fuel briquettes.

Table 2. Basic specifications of briquettes[1].

Composition, wt. %	W, %	A^d, %	V^{daf}, %	Q^{daf}_s, MJ / kg	Q^r_i, MJ / kg
Coal of Kangalas m / r	6,20	14,80	49,40	28,60	19,90
Coal 85% + sawdust 15%	4,10	14,7	55,90	27,1	20,40
Coal 35% + sawdust 55% + oil sludge 10%	3,28	14,0	64,70	30,0	24,30
Coal 30% + sawdust 55% + oil sludge 15%	2,87	13,9	69,00	29,8	22,10
Coal 25% + sawdust 55% + oil sludge 20%	2,64	12,8	74,90	26,10	21,80

Note[1]: W - water absorption; Ad - ash on dry condition of fuel; V^{daf} - the output of volatile substances; Q^{dafs} - the highest combustion heat for dry ashless state of fuel; Q^r_i - net calorific value for the working condition of the fuel.

2. Conclusion

The resulting composite briquettes can be used as an effective fuel for heating small and medium-sized facilities, social facilities, for household needs, mini boilers, stoves, boilers, municipal heating systems and private households (heating houses, cottages, baths, saunas, small farms, fireplaces, boxes, garages, etc.). Briquettes are non-toxic, economical in use, transportable, are characterized by convenience in storage due to their compactness, and constitute an environmentally safe type of fuel.

Maintaining the production of coal briquettes will allow obtaining high-grade and transportable fuel of improved quality, will lead to reduction of coal losses during storage, utilization of oil waste and waste from timber industry and woodworking enterprises. Moreover, it will increase the extraction of brown coals for their use for energy and technological processing, and consequently, intensify the industrial development of the adjacent territories.

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