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## DEVELOPMENT OF ALTERNATIVE FUEL GENERATION TECHNOLOGY UNDER THE INFLUENCE OF MAGNETIC FIELDS FROM OIL COKE

**Abstract:** Oil refining and petrochemical enterprises have all the necessary prerequisites in order to become the basic industry for the processing of all types of waste within the framework of the concept of global recycling of industrial materials. This is especially important to emphasize, since this technology is developed in the framework of the most priority areas.

The relevance of this topic arose at the junction of two opposing trends arising in the oil refining industry: On the one hand, oil reserves are steadily decreasing, their price is constantly growing, their resources are decreasing, the costs of developing new fields are increasing, and tariffs for energy and rail transportation are constantly growing. On the other hand, waste from oil refining, petrochemical, mining, engineering, metallurgical and chemical industries, as well as the fuel and energy complex, accumulated over decades.

Today, in terms of volume and content of useful components, technogenic deposits can be equated to natural deposits. The location of waste near production facilities, as well as the fact that huge expenditures for their development are not required, are positive factors.

An analysis of these phenomena made it possible to formulate a scientific problem, the solution of which is possible in two directions: on the one hand, recycling and disposal of waste with the subsequent receipt of relatively cheap fuel raw materials. On the other hand, cleaning up entire regions where huge deposits of waste have accumulated. The result is a solution to one of the global environmental problems. One of such solutions is briquetting of heavy oil waste to obtain an alternative type of fuel, both industrial and domestic.

**Key words:** oil coke briquettes, mechanical force, compound, stable magnetic field, agglomeration, penetration.

**Language:** English

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### Introduction

This work is devoted to the urgent problem of obtaining an additional type of fuel as petroleum coke briquettes. Studies have been carried out to improve the physicochemical properties, environmental requirements and optimal use both in the domestic environment and in industry.

The objective of this work is to obtain petroleum coke briquettes with high mechanical strength and low

flash point. The study was based on coke breeze containing a mixture of petroleum bitumen and pitch as a binder, which additionally contains an extract for the selective purification of oils, asphaltite and paraffin, in the following ratio of components, mass% coke breeze (85-90%), oil bitumen (6-8%), pitch (1-2%), selective oil purification extract (1-2%) asphaltite (1.5-2), paraffin (0.5-1%).

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The novelty of this work is that a binder additionally containing an extract of selective purification of oils, asphaltite and paraffin in the declared amounts, the effect of the mixture in a stationary mode of a stable magnetic field on its dispersed and paramagnetic characteristics was investigated.[1-6].

As raw materials for the preparation of briquettes used: coke grade KZ,  $\pm 0-8$  mm; bitumen obtained from the tar of the Azerneftlyag Refinery by oxidation at 250°-260°C; pitch obtained by thermal oxidative compaction (TSP) of heavy pyrolysis resin; extract obtained by selective purification of oils; asphaltite is a product of deasphalting with tar gasoline; paraffin waste hydrogenation of vegetable oils of the Azersun Holding enterprise.

The invention is illustrated by the following example. Example: The briquette is prepared as follows. The binder mixture of petroleum bitumen, pitch, selective oil purification extract, asphaltite and paraffin is heated to 130-150°C, then mixed in a laboratory mixer with coke breeze for 5-10 minutes, at 160-200°C. Then the resulting homogeneous mass is cooled to 60-90°C and pressed under a pressure of 25 kg/cm<sup>2</sup> (PPa). A briquette with a diameter of 50 mm and a height of 20 mm is obtained.

A decrease or increase in the amount of coke, petroleum bitumen, pitch, asphaltite, an extract for the selective purification of oils and paraffin below and above the stated limits is impractical, since the best performance is achieved in the declared limits of the content of components in the composition of petroleum coke briquettes.

The physicochemical properties of the resources for the binder were studied. With the rising cost of oil, the decrease in its reserves, alternative resources are becoming more widespread. Therefore, the possibilities of supplementing the oil coke briquette with vegetable oils were investigated.

The essence of the work lies in the fact that the use of asphaltite in addition to the binder, an extract of selective oil purification, using constant MP, improves mechanical strength and abrasion resistance of petroleum coke briquettes, and the waste of hydrogenation of vegetable oils in the process of which uses a catalyst consisting of paramagnetic, metallic nickel (22%) deposited on the surface of high molecular weight paraffin can reduce the ignition temperature, and increase adhesion communication ability.

The proposed work allows to increase the mechanical strength, abrasion resistance and lower the ignition temperature of petroleum coke briquettes. In addition, the proposed petroleum coke briquette due to its high calorific value can be used as fuel, both in industry and in everyday life, instead of coal, coal briquettes and wood.

Enterprises of oil refining and petrochemical industry have all necessary prerequisites to become

the primary industry for the processing of all types of waste within the framework of implementation of concept of the global recycling of technogenic materials. It is especially important to stress it, since this technology has been developed within the framework of the top priorities.

The topicality of this topic arose at the junction of two contrasting trends emerging in the oil refining industry. On the one hand, oil reserves are steadily decreasing, their price is constantly growing, their resources are decreasing, the costs for developing new oilfields are increasing, and tariffs for energy and rail transportation are constantly growing. On the other hand, wastes accumulated over decades from oil refining, petrochemical, mining, machine-building, metallurgical and chemical production, as well as the fuel and power complex, are increasing.

Today, technogenic fields can be equated to deposits of natural resources in terms of their volume and content of useful components. The location of wastes in the vicinity of production, as well as the fact that huge costs for their development are not required, are positive factors.

The analysis of these phenomena made it possible to formulate a scientific task the solution of which is possible in two directions. On the one hand, recycling and utilization of wastes with the subsequent production of fuel raw materials at relatively low cost. On the other hand, cleaning of the whole region where huge deposits of waste have accumulated. As a result, the solution of one of the global environmental problems. One of such solutions is briquetting of heavy petroleum waste to obtain both industrial and domestic alternatives[7-9].

## II. RESULTS AND DISCUSSIONS

With the help of briquetting, energy-bearing waste, for example, waste from forest processing, coal processing, oil refining, agricultural products processing, waste from chemical productions, waste from the food and textile industries, waste from sewage treatment can be converted into high-quality fuel and sorbents.

In Russia, a huge amount of these wastes has already been accumulated and is still accumulating, they occupy large areas and pollute the air, water facilities, land and thereby they worsen the quality of the human environment, for example, huge quantities of sawdust, lignin, lignosulfonates have been accumulated in places of forest processing, millions tons of coal sludge have been accumulated in coal regions, and large amounts of precipitation from sewage treatment and other waste have been accumulated near cities. While this energy-bearing waste can serve as raw material for the production of fuel briquettes. At the same time, deficit of cheap high-grade fuel for communal and household needs is experienced in Russia.

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Briquetting is constantly given the highest priority in developed countries. Significant funds are invested in scientific and technological developments, in the construction of new and improvement of existing briquette productions, especially using waste or low-grade raw materials.

Briquettes on various technologies are produced based on coal fines in large volumes in England, France, Germany, Czechia, Poland, Turkey, the USA, Australia and other countries. This is due to the fact that when burning coal briquettes, as compared to burning ordinary coal, the efficiency of furnace devices increases by 25-35%, emissions of sulfur dioxide are reduced by 15-20%, emissions of solids with flue gases are more than halved, as well as

burning of combustible components decreases by 15 - 20% [2].

Agglomeration is the transformation of fine-grained natural resources into a lumpy product due to mechanical and (or) thermal effects using special additives or without them. One of the agglomeration varieties is briquetting, a physico-chemical process of producing a mechanically and thermally durable high-grade product-briquette which has a certain geometrical shape, size and weight. Briquetting differs from other known agglomeration methods (agglomerating and pelletizing) by simplicity of process and its low cost. This is confirmed by comparative data (in percent) of three ways of iron ore agglomeration.

**Table 1. Comparative data.**

	Briquetting	Agglomeration	Pelletization with burning
Prime cost	100	120-170	110-150
Expenses for 1 t.processing	100	130-160	90-140
Specific capital expenses	100	110-200	120-180

Briquettes are used in coal, coke-chemical, metallurgical, chemical and other industries, as well as household fuel. Depending on the properties of natural resources and technological purposes, briquettes must satisfy the following requirements: 1) to have atmospheric constancy, not to collapse from temperature effects and precipitation. 2) to have mechanical strength i.e. to withstand fairly high resistance to shock, abrasion and bending. 3) to have sufficient porosity, providing good gas permeability at high temperatures of burning and melting. 4) to contain a minimum amount of moisture, the availability of which requires additional heat consumption for evaporation and complicates the gas permeability of briquettes. 5) to have temperature resistance, not to collapse from the impact of high temperatures of burning and melting. Briquetting as a single technological process of agglomeration of natural resources, consists primarily of the following production operations:

1. Operations providing the preparation of raw materials for pressing: crushing, sifting, grinding and drying; preparation of binders; dosage of the components of the briquette charge, their displacement, heating and cooling of the briquette charge before the pressing procedure.

2. The operation of pressing the briquette charge with the application of the required efforts determined depending on the physicochemical properties and petrographic composition of the briquetted material.

3. Processing operations of "raw briquettes" with the purpose of their quickest solidification (cooling,

steaming, carbonization, drying, regenerative firing, etc.).

4. The operations of warehousing and loading of ready briquettes [1].

Due to the availability of a number of shortcomings in the provision of fuel to various regions of the Republic of Azerbaijan and in providing the environmental safety of the country as a whole, the search and creation of alternative fuel sources is one of the actual problems of our time.

The significance of solving this problem was confirmed by a decree of the President of the Republic of Azerbaijan dated 21 October 2004 and was reflected in the State Program on the "Use of Alternative and Renewable Energy Sources of the Republic of Azerbaijan".

Pursuant to the paragraphs of the State Program, we performed research operations in this direction. In the course of the research conducted, the possibility of briquette production from heavy oil residues as an alternative fuel was studied.

Coke fraction KZ-0 obtained at the oil refining plant named after H.Aliyev, and heavy oil residues from the refining processes obtained at the "Azerneftiyagh" oil refining plant were used as the main raw material for the production of fuel briquettes.

The main parameters of coke used as raw material are given in table 2.

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**Table 2.**

Raw materials	Density, kg/m <sup>3</sup> 25°C	Amount of light volatile hydrocarbons, mass %	Sulfur content, mass%	Ash formation, %
KZ-0-8 mm	2060-2080	13,5	0,12	0,2

As shown in Table 2, the raw materials for the briquette production contains a minimum amount of sulfur-containing compounds and forms a smaller amount of ash, which makes the briquettes obtained from this fraction of coke, completely suitable for use in everyday life and on public and social facilities.

In the process of briquette production, bitumen obtained in the process of tar oxidation at the “Azerneftyagh” oil refining plant, was used as a binder-other main raw material. The main quality parameters of bitumen used as a binder are shown in Table 3.

**Table 3. Physico-mechanical parameters of oil bitumen.**

Parameters	Values
Softening temperature, ° C	55-65
Penetration 25° C; 0,1 mm	60-70
Ductility, cm	45-50
Flash-point, ° C	220

Bitumen used in briquettes as a binder was obtained in the process of tar oxidation at a temperature of 250-260 ° C. Pursuant to studies conducted, the use of bitumen with the mentioned parameters in the production of fuel briquettes is more targeted. Approbation of various types of modifiers was conducted during studies in order to increase the bonding properties of bitumen.

A literature review showed that the use of bitumen of pitch, asphaltite, pitch distillate, heavy distillate of catalytic cracking, heavy pyrolysis resin, etc., as a binder, is more profitable from an economic point of view [1-12].

As a result of research conducted in the direction of the rational use of heavy oil residues, the possibility

of obtaining pitch from them was revealed. The pitch applied in the production of fuel briquettes was obtained from heavy pyrolysis resin and heavy catalytic cracking distillate. The heavy pyrolysis resin (HPR) and the heavy catalytic cracking distillate (HCCD) were heated to a temperature of 250 ° C and they were purged with nitrogen gas for 2 hours. Then, the resulting mass was heated up to 380–385 ° C under conditions of a constant increase in the heating rate and was oxidized by atmospheric oxygen for 1 hour. The quality parameters of the pitch obtained as a result of the thermopolycondensation reaction are shown in Table 4.

**Table 4. The quality parameters of the pitch obtained as a result of the thermopolycondensation**

Raw materials	Softening temperature, ° C	Fractional composition, mass %			Oxidation state, %
		α	β	γ	
HCCD	75-80	19,2	27,9	52,2	40,8
HPR	75-80	28,5	30,5	41,0	48

As shown in Table, the physico-chemical parameters of the pitch obtained from heavy pyrolysis resin are higher as compared with the pitch obtained from heavy catalytic cracking distillate. Higher values of the rate of coking and fractions providing the stickiness properties of the pitch, can be explained by the chemical group composition.

In order to increase the operational performance of the pitch, the various modifiers were added to their

composition. As modifiers, we used extract obtained as a result of oil purification by selective solvents and the wide petrol fraction of tar with asphaltite which is a product of deasphalting, proposed by us and obtained from the action of a magnetic field. The parameters of extract and asphaltite quality are shown in Tables 5 and 6.

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**Table 5. Physico-mechanical parameters of the extract**

Parameters	Values
Density, kg/m <sup>3</sup>	969
Coking rate, %	16,9
Ash formation, mass %	0,035
Sulfur content, mass %	0,95

**Table 6. Physico-mechanical parameters of the asphaltite**

Parameters	Values
Density 20°C	1045
Softening temperature, °C	90-95
Ash formation, mass %	0,9
Coking rate, %	36,9

Composition of chemical group, %	Values
Oils	16,4
Resin	21,7
Asphaltenes	61,9

The preparation of fuel briquettes was studied with a laboratory facility.

The amount of binder added to petroleum coke, amounted 10% of the total mass during all experiments. Coke particles used for the preparation of fuel briquettes were dried at 60 °C and then heated to 80-90 °C. The binder in the mixer at 180-200 °C to a liquid state and then for 10-15 minutes. Intensively mixed with dried coke particles till obtaining of homogeneous mass.

After cooling to 70 °C, the obtained homogeneous mass was squeezed with a hydraulic press under a pressure of 20 kg /m<sup>3</sup>. The squeeze pressure was individually regulated for each sample depending on the desired need.

The obtained briquettes were tested for their resistance to compression and friction for ash formation and burning duration. Resistance to compression was determined by the pressure on the whole surface of the cylindrical briquette in a hydraulic press. To determine the resistance to friction, briquettes were placed in a standard cylinder, and values of the parameters were measured according to GOST 6114-57 (state standard). Digital value of resistance to abrasion was determined as the ratio of the mass of particles remaining on the sieve with a size of holes 250x25 mm after the cylinder made 100 revolutions to the primary mass of the briquette.

Studies have shown that the mechanical strength of fuel briquettes depends on quality, quantity, softening temperature of the binder, humidity of coke particles before the beginning of mixing with binder, on squeeze pressure and etc. When adding modifier-asphaltite to the binder briquette, the mechanical strength of the briquette is increased approximately two times. The mechanical strength of briquettes also increases with the application of petroleum pitch obtained from tar. When applied as an extract modifier, the strength parameter remained virtually unchanged.

### III. CONCLUSIONS

Briquettes obtained as a result of application of binders made on the basis of petrochemical and oil refining industry residues, form less ash and the content of harmful substances in flue gases remains at a minimum level. Therefore, the use of binders is considered more targeted.

The proposed work allows to increase the mechanical strength, resistance to abrasion and to reduce the flash point of petroleum-coke briquettes. Besides, due to its high heating value, the proposed petroleum-coke briquette can be used as fuel instead of coal, coal briquettes and wood both in industry and at home.

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