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«ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫ» РҚБ
«ХАЛЫҚ» ЖҚ

ХАБАРЛАРЫ

ИЗВЕСТИЯ

РОО «НАЦИОНАЛЬНОЙ
АКАДЕМИИ НАУК РЕСПУБЛИКИ
КАЗАХСТАН»
ЧФ «Халық»

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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы «ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы» ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

ЧФ «ХАЛЫҚ»

В 2016 году для развития и улучшения качества жизни казахстанцев был создан частный Благотворительный фонд «Халык». За годы своей деятельности на реализацию благотворительных проектов в областях образования и науки, социальной защиты, культуры, здравоохранения и спорта, Фонд выделил более 45 миллиардов тенге.

Особое внимание Благотворительный фонд «Халык» уделяет образовательным программам, считая это направление одним из ключевых в своей деятельности. Оказывая поддержку отечественному образованию, Фонд вносит свой посильный вклад в развитие качественного образования в Казахстане. Тем самым способствуя росту числа людей, способных менять жизнь в стране к лучшему – профессионалов в различных сферах, потенциальных лидеров и «великих умов». Одной из значимых инициатив фонда «Халык» в образовательной сфере стал проект Ozgeris powered by Halyk Fund – первый в стране бизнес-инкубатор для учащихся 9-11 классов, который помогает развивать необходимые в современном мире предпринимательские навыки. Так, на содействие малому бизнесу школьников было выделено более 200 грантов. Для поддержки талантливых и мотивированных детей Фонд неоднократно выделял гранты на обучение в Международной школе «Мирас» и в Astana IT University, а также помог казахстанским школьникам принять участие в престижном конкурсе «USTEM Robotics» в США. Авторские работы в рамках проекта «Тәлімгер», которому Фонд оказал поддержку, легли в основу учебной программы, учебников и учебно-методических книг по предмету «Основы предпринимательства и бизнеса», преподаваемого в 10-11 классах казахстанских школ и колледжей.

Помимо помощи школьникам, учащимся колледжей и студентам Фонд считает важным внести свой вклад в повышение квалификации педагогов, совершенствование их знаний и навыков, поскольку именно они являются проводниками знаний будущих поколений казахстанцев. При поддержке Фонда «Халык» в южной столице был организован ежегодный городской конкурс педагогов «Almaty Digital Ustaz.

Важной инициативой стал реализуемый проект по обучению основам финансовой грамотности преподавателей из восьми областей Казахстана, что должно оказать существенное влияние на воспитание финансовой грамотности и предпринимательского мышления у нового поколения граждан страны.

Необходимую помощь Фонд «Халык» оказывает и тем, кто особенно остро в ней нуждается. В рамках социальной защиты населения активно проводится

работа по поддержке детей, оставшихся без родителей, детей и взрослых из социально уязвимых слоев населения, людей с ограниченными возможностями, а также обеспечению нуждающихся социальным жильем, строительству социально важных объектов, таких как детские сады, детские площадки и физкультурно-оздоровительные комплексы.

В копилку добрых дел Фонда «Халык» можно добавить оказание помощи детскому спорту, куда относится поддержка в развитии детского футбола и карате в нашей стране. Жизненно важную помощь Благотворительный фонд «Халык» оказал нашим соотечественникам во время недавней пандемии COVID-19. Тогда, в разгар тяжелой борьбы с коронавирусной инфекцией Фонд выделил свыше 11 миллиардов тенге на приобретение необходимого медицинского оборудования и дорогостоящих медицинских препаратов, автомобилей скорой медицинской помощи и средств защиты, адресную материальную помощь социально уязвимым слоям населения и денежные выплаты медицинским работникам.

В 2023 году наряду с другими проектами, нацеленными на повышение благосостояния казахстанских граждан Фонд решил уделить особое внимание науке, поскольку она является частью общественной культуры, а уровень ее развития определяет уровень развития государства.

Поддержка Фондом выпуска журналов Национальной Академии наук Республики Казахстан, которые входят в международные фонды Scopus и Wos и в которых публикуются статьи отечественных ученых, докторантов и магистрантов, а также научных сотрудников высших учебных заведений и научно-исследовательских институтов нашей страны является не менее значимым вкладом Фонда в развитие казахстанского общества.

С уважением,
Благотворительный Фонд «Халык»!

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TECHNOLOGY OF PREPARATION OF BRIQUETTED FUEL BASED ON PRODUCTION WASTE

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Abstract. The development and efficient use of mineral resources is the main direction of the development of production and industry namely oil and gas production have its own special place. This scientific work, on the basis of reducing the environmental impact from waste released in the process of oil and gas production, conducting an examination on their origin, as well as considering the waste formed in production centers as secondary raw materials and using them in various industries, the project is considered. Coal briquettes are used for their intended purpose in the domestic and industrial industries. The proposed scientific article analyzes the new scientifically substantiated results of research that ensure the solution of environmental problems at production sites, important for industrial use, and the development of approaches to the use of asphalt resin paraffin deposits (ARPD). Large-scale physico-chemical analyzes of solid oil residues formed in oil fields, various varieties of coal, as well as rice husk were carried out in a special

laboratory and scientific experiments were carried out in the areas of its use as a source of raw materials in the fuel industry. In the experimental work, several tests were carried out to determine the humidity, temperature of each added mixture and their strength by pressing them under different pressures in special standard containers. At the same time, to carry out calculations for the heat of combustion of the briquette, changing the concentrations of the impurities included in the briquette in the possible range and determining the concentration of each. All calculations were carried out by creating a computer program. As a result of the conducted scientific research, innovative technologies for the effective use of industrial waste are proposed.

Keywords: oil, coal, production waste, technologies, briquettes, ARPD, rice husks

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ӨНДІРІС ҚАЛДЫҚТАРЫ НЕГІЗІНДЕ БРИКЕТТЕЛГЕН ОТЫН ДАЙЫНДАУ ТЕХНОЛОГИЯСЫ

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Аннотация. Жер қойнауындағы шикізат пен қазба байлықтарды игеру мен тиімді пайдалану өндіріс пен өнеркәсіптің дамуының басты бағыты болып табылады. Соның ішінде мұнай және газ өндірісінің өзіндік ерекше орны бар. Бұл ғылыми еңбекте мұнай және газ өндірісі үдерісінде бөлінген қалдықтардан қоршаған ортаға бөлінетін зардапты азайту негізінде, олардың бөлініп шығу тегіне байланысты сараптама жүргізе отырып, сонымен қатар өндіріс ошақтарында түзілген қалдықтарды екінші ресурсты шикізат

ретінде қарастырып, оларды әртүрлі өндіріс саласында пайдалану жобасы қарастырылған. Көмір брикеттері мақсаты бойынша тұрмыстық және өнеркәсіптік салаларда қолданылады. Ұсынылып отырған ғылыми мақалада өндірістік пайдалануы маңызды, өндіріс орындарындағы экологиялық міндеттерді шешуді қамтамасыз ететін зерттеулердің жаңа ғылыми негізделген нәтижелері және асфальтты шайырлы парафинді шөгінділерді (АШПШ) пайдалану тәсілдерінің зерттемелері талданған. Мұнай кен орындарында түзілетін қатты мұнай қалдықтарына, көмірдің әртүрлі сорттарына сонымен бірге күріш қауызына арнайы зертханада кең бағытта физика-химиялық талдаулар жасалып, оны отын өнеркәсібінде шикізат көзі ретінде пайдалану бағыттарына ғылыми эксперименттер жасалған. Тәжірибе жұмыстарында әрбір қосылатын қоспалардың ылғалдылығы, температурасы және оларды арнайы стандартты ыдыстарға салып әртүрлі қысымдарда престеу арқылы олардың беріктіктері бірнеше сынақтардан өткізілген. Сонымен бірге брикеттің жану жылуына есептеулерді жүргізу үшін брикет құрамына кіретін қоспалардың концентрацияларын мүмкін болатын диапазонда өзгерте отырып және әрқайсысының концентрациясы анықталды. Барлық есептеулер компьютерлік бағдарлама құру арқылы жүргізілген. Жүргізілген ғылыми зерттеулердің нәтижесінде өндірістік қалдықтарды тиімді пайдаланудың жаңашыл технологиялары ұсынылған.

Түйін сөздер: мұнай, көмір, өндіріс қалдықтары, технология, брикет, АШПШ, күріш қауызы

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ТЕХНОЛОГИЯ ИЗГОТОВЛЕНИЯ БРИКЕТИРОВАННОГО ТОПЛИВА НА ОСНОВЕ ОТХОДОВ ПРОИЗВОДСТВА

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Аннотация. Освоение и эффективное использование недр сырья и ископаемых ресурсов является основным направлением развития производства и промышленности. В том числе добыча нефти и газа имеет свое особое место. В статье описывается проект по использованию отходов, образующихся в очагах производства, в различных отраслях производства, в качестве вторичного ресурсного сырья с проведением экспертизы, связанной с их выделением, на основе снижения потерь в окружающую среду от отходов, выделяемых в процессе добычи нефти и газа. Угольные брикеты по назначению используются в бытовой и промышленной сферах. В предлагаемой научной статье проанализированы новые научно обоснованные результаты исследований, обеспечивающие решение экологических задач на производственных объектах, имеющих значение для промышленного использования, и разработки способов использования асфальтовых смолистых парафиновых отложений (АСПО). Для твердых нефтяных отходов, образующихся на нефтяных месторождениях, различных сортов угля, а также рисовой шелухи в специальной лаборатории были проведены обширные физико-химические анализы и научные эксперименты по направлениям их использования в качестве источника сырья в топливной промышленности. В экспериментальных работах влажность, температура каждого добавляемого соединения и их прочность подвергались нескольким испытаниям путем их прессования в специальные стандартные емкости при различных давлениях. При этом для проведения расчетов теплоты сгорания брикета определяли концентрацию каждого из них, изменяя концентрации примесей, входящих в состав брикета, в пределах возможного диапазона. Все расчеты производились путем создания компьютерной программы. В результате проведенных научных исследований предложены инновационные технологии эффективного использования промышленных отходов.

Ключевые слова: нефть, уголь, отходы производства, технология, брикет, АСПО, рисовая шелуха

Introduction

It is known that the Republic of Kazakhstan is one of the top ten countries in the world in terms of the volume of fossil resources and reserves of oil raw materials. Along with the benefits, the harmful effects of oil and gas production on the environment are not small. The consequences of natural or man-made disasters occurring during oil production, transportation and processing operations, in turn, contribute to the deterioration of the ecological situation of oil regions. It is clear that oil and oil residues spilled on the ground, the area of flares for burning associated gases, not only pollute water, soil and harm the flora and fauna, the health of people, but also cause the extinction of some living things.

The increase in anthropogenic impacts associated with the development of Science and technology today is the reason for the deterioration of the environmental situation. Today, one of the most important issues is the monitoring of the state of extremely polluted areas, the disposal of production waste, the assessment of the quality of the environment, the forecast for the future and the implementation of environmental measures.

Therefore, reducing the harmful effects of oil and gas production on the natural environment is an urgent problem today and it is necessary to create a new model that will resist the impending environmental stagnation.

Thousands of tons of production waste are generated annually in Kazakhstan. The bulk of the waste in the fields is oil waste accumulated in open tanks. In turn, oil residues accumulated in open places are absorbed into the bowels of the Earth, destroying groundwater, soil fertility, some species of rare plants in this area, spreading into the air under the influence of sunlight and negatively affecting the environment. Therefore, the disposal and processing of oil waste in oil producing regions is considered one of the main goals in protecting the natural environment. The main directions of protection of oil-producing enterprises from harmful effects are to reduce the area of oil-damaged land, reduce air pollution, as well as to consider liquid and solid oil waste spilled during oil production, transportation and repair work as secondary raw materials and reuse them in various industrial fields. As long as it is cost-effective, it protects the environment from pollution from an ecological point of view and ensures its sustainability. The use of solid oil waste in the technology of manufacturing various building materials, which makes it possible to turn it into a category of marketable products, is one of the methods of solving environmental and economic problems (Ruchkinova et al., 2004; Ruchkinova et al., 2022). For example, scientists have proven that solid oil residues in the form of asphalt-resin paraffin deposits can be used in the production of briquette fuel; in the field of road construction; in the construction of waterproof screens; in the development of roofing materials; for the production of hydrocarbon lubricants. Currently, many private enterprises have established a solution to the problem of disposal of oil waste by various methods (incineration or burial in the ground) (Abilbek et al., 2021). However, these methods do not benefit enterprises from an environmental and economic point of view, but rather harm the environment. The main direction of reducing the formation of oil waste is their use for obtaining materials and products necessary for the consumer, as a second raw material that stores reserves in terms of physical and chemical properties. Solving these problems will not only improve the environment, but also make a huge contribution to the development of many industrial and agricultural sectors. Therefore, through the use of truly environmentally friendly and cost-effective technologies, it will be possible to radically solve environmental problems (Zhabagiev et al., 2023).

Materials and methods

Analysis of technical solutions in the field of obtaining briquetted fuel in addition to improving the well-known composition and technology for obtaining

this fuel, new research is being carried out to replace the briquetted fuel binder with waste, as is the carbon-containing material. In particular, the compositions for replacing bitumen binder with oil residues were studied. According to published data, secondary products (oil waste) can replace commodity binders, but not 6–8 %, as in the case of the use of bitumen, but 15 % or more (up to 67 %). The second important condition for the possibility of using oil residues in briquetted fuel is the upper content of organic compounds in them (from 60 % to 90 %), lower humidity (10 %) and a small content of mechanical impurities (5÷14 %). So, the third condition for the use of oil waste in briquetting technologies is their high calorie content.

As we have noted, the group chemical composition of asphalt resin paraffin deposits (ARPD), the predominance of organic compounds in them, their rheological, adhesive, colloidal-chemical and structural-mechanical properties make it possible to evaluate sediments as binders with significant cohesion and heat-forming ability, which can be used to obtain solid briquetted fuel (Yelishevich, 1987; Nikishanin et al., 2016).

A very accessible, studied and technically prepared method for the use of coal chips is the cutting method. Cutting is the transformation of fine-grained minerals into a lump product due to mechanical or thermal exposure with or without the use of special additives. One of the most diverse types of cutting is briquetting – a physical and chemical process of obtaining mechanically and thermally durable grade products with a clear geometric shape, dimensions and mass.

For their intended purpose, coal briquettes are domestic and industrial. Industrial briquettes serve for partial coking of lignite and coking of hard coals, can perform the function of heat-insulating material, replacing scarce graphite, and are also used as the main material for obtaining a wide variety of types of electrodes. Industrial briquettes are of various shapes, such as round, brick, cube, etc. (Ismailova et al., 2018).

Briquettes must meet the following requirements (Bisenov et al., 2021):

1) have atmospheric tolerance-not disturbed by temperature effects and atmospheric precipitation;

2) have mechanical strength-must have a very high resistance to impact, friction and bending;

3)at high combustion and melting temperatures, it is necessary to ensure good passage of gases (the gap must be hollow);

4) there should be as little moisture as possible, which requires additional losses during heat evaporation and complicates the gas permeability of briquettes;

5) temperature tolerance – it is necessary that it does not break under the influence of the upper temperature of combustion and melting.

Briquetting is the transformation of coal powders into durable briquettes by squeezing them of a certain geometric shape (Zhalgasuly et al., 2022). Coal briquetting is widely developed in many European countries (Poland, Hungary, Romania, France, England, Holland, Germany), Asia (Japan, China) and the United

States. Briquetting objects are brown and hard coals, which have poor strength and, after their removal from the mine to the surface, easily break down during storage and transportation, as well as coal pellets that are not used rationally. In the process of industrial development, the theoretical foundations of briquetting were created. Despite all the diversity of Coal, their chemical and physico-mechanical properties, well-known researchers have developed the Basic Rules and prerequisites for the possibility of briquetting coal of different brands, during the suppression of which the physico-chemical interactions that occur in coal were revealed. At the present stage, research on briquetting of all new coal deposits does not stop, and each researcher contributes to the development of the theory and practice of this complex process (Nifonteyev, 2000; Tanzharykov, 2015).

The study of coal briquetting of the Kiyakty deposit was carried out sequentially. First of all, the possibility of briquetting dry coal according to the developed methodology was studied. For the experiments, dry coal was used, which was stored for a long time at room temperature, crushed to 5÷1mm. The granulometric composition of coal is presented in table 1.

Table 1. Granulometric composition of coal prepared for research

Sequence	Grain size, mm						Total	
	g	%	g	%	g	%	g	%
1	98,94	19,75	331,48	66,32	69,58	13,92	500	100
2	109,88	21,98	361,95	72,38	28,17	5,59	500	100
3	145,98	29,21	298,02	59,58	56,00	10,21	500	100
4	107,13	21,39	360,91	72,21	31,96	6,38	500	100
Average	115,48	23,08	338,16	67,62	46,36	9,02	500	100

In order to determine the optimal composition of the charge for conducting compression tests, 7 briquettes were made with each composition in accordance with GOST 21289-75 to determine the average value of the strength of briquettes during the testing process.

The briquettes compression load was 12; 15; 18 tons. Accordingly, the compression pressure was 80; 100; 130 MPa. The diameter of the resulting briquettes corresponded to the inner diameter of the Matrix - 42 mm.

Coal was poured into the mold, the height, diameter and cross-section were measured. The press was placed under the form and the compression force was set. During the test, the following indicators were taken into account (height, weight, pressing force, destructive load temporary compression resistance). In the course of a preliminary study of dry coal pressing, the optimal pressing pressure from 60 to 130 MPA was determined. As preliminary experiments have shown, briquettes are crushed under pressure (Table 2).

Table 2. Results of the study of the dry coal briquetting process

Pressing force, t	Sample number	Height, mm	Weight, g	Breaking load, kg	Temporary compression resistance, kg/cm^2
12 tons	1	25,0	42,5	610,0	44,66
	2	25,0	42,5	570,0	41,68
	3	25,0	42,5	510,0	37,34
	4	25,0	42,5	560,0	41,26
	5	26,0	45,0	540,0	39,61
	6	26,0	46,5	510,0	36,20
	7	26,0	44,5	510,0	36,20
15 tons	1	27,5	46,5	560,0	41,68
	2	27,0	44,0	600,0	44,24
	3	29,0	48,5	560,0	41,82
	4	27,5	48,0	590,0	43,02
	5	29,0	48,5	550,0	40,96
	6	29,0	49,5	510,0	35,90
	7	28,0	48,5	540,5	36,40
18 tons	1	26,5	47,5	490,0	35,80
	2	25,5	44,5	560,0	40,86
	3	25,0	43,5	380,5	27,96
	4	25,5	44,5	490,0	35,06
	5	26,0	45,5	560,0	40,86
	6	25,5	44,5	550,0	40,96
	7	26,5	47,5	555,0	38,11

Experiments have shown that the moisture content of coal is up to 15 %, an increase in pressing pressure increases in compression pressure increases the strength of briquettes. In this case, the compression pressure of the presses (130MPa) ensures the greatest strength of the briquettes. However, when the compression pressure is higher than 130 MPa, the strength of the briquettes can be expected to increase even more.

Pressing pressure above 130 MPa can be provided by Ring presses. However, these presses are bulky, expensive, and cannot be used in modular briquette installations. Therefore, during the experiments, the compression pressure was limited to 130 MPa.

Further research was carried out on the production of briquettes from moistened coal. For this, 3 versions of the charge with the addition of 5 %, 15 % and 25 % water are made of dry coal. The wet charge was kept in a closed container for 3 days in order to equalize the humidity over the entire mass of coal. The resulting charge was also poured into a mold, placed under a press and compressed under a pressure of: 60; 80; 100; 130 MPa. The resulting 21 pieces of briquettes were left for storage at a temperature of 20÷25^{0}C for further tests and determination of the strength of the briquettes. Table 3, figure 1 shows the dependence of the strength of briquettes on the joint effect of coal moisture and pressing pressure.

Table 3. Results of a study of the strength of briquettes on the dependence of coal moisture and compression pressure

Coal moisture, %	Compression pressure, MPa	Temporary resistance to compression, MPa							
		Experience numbers							
		1	2	3	4	5	6	7	Average value
5	60	2,68	2,65	2,83	2,81	2,79	2,53	3	2,75
	80	3,06	3,45	3,5	3,3	3,16	3,21	3,24	3,27
	100	5,12	5,32	5,41	5,47	5,64	5,36	5,31	5,37
	130	6,12	6,34	6,29	6,41	6,45	6,17	6,41	6,31
15	60	3,34	4,21	3,08	3,16	2,64	3,12	3,14	3,24
	80	5,52	5,14	5,54	6,08	5,46	4,79	4,56	5,29
	100	7,68	6,24	5,82	5,58	5,12	6,45	5,65	6,07
	130	7,71	7,48	7,55	7,77	6,62	8,25	8,26	7,66
25	60	2,57	2,28	2,24	2,32	2,54	2,33	2,17	2,35
	80	4,49	4,17	3,73	4,18	3,92	3,58	3,63	3,95
	100	4,17	4,38	4,16	4,31	4,16	3,65	3,71	4,07
	130	3,63	4,15	2,79	3,46	4,17	4,11	3,75	3,72

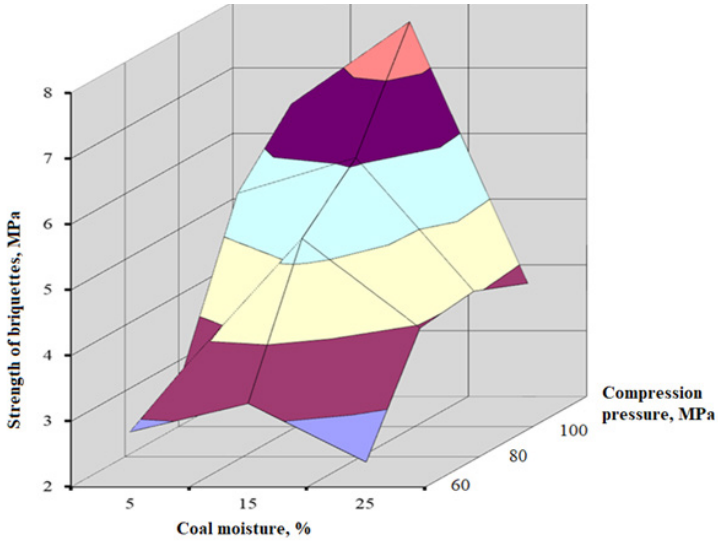

Figure 1. Dependence of briquettes strength on coal moisture and compression pressure

When using ARPD as a binder, the maximum strength of briquettes exceeds 5MPa at a residual oil content of 5÷7 and a maximum compression pressure (130MPa).

The dependence of the strength of briquettes on the joint effect of the composition of the ARPD and pressing pressure is presented in table 4 and figure 2. From the

graph it can be seen that the optimal amount of oil residue is 5 %. The optimal pressing pressure is 100÷130 MPa.

Table 4. Strength of briquettes containing ARPD

ARPD the composition, %	Compression pressure, MPa	Temporary resistance to compression, MPa							
		Experience numbers							
		1	2	3	4	5	6	7	Average value
2,5	60	1,72	1,94	1,81	1,86	2,09	1,92	1,88	1,88
	80	3,33	3,44	3,26	3,37	3,19	3,41	3,44	3,34
	100	4,32	4,18	4,42	4,37	4,29	4,31	4,46	4,33
	130	4,51	4,79	4,64	4,61	4,58	4,78	4,58	4,64
5,0	60	4,25	4,38	3,82	3,51	3,32	3,44	3,45	3,73
	80	3,88	4,45	4,14	4,46	4,76	4,54	4,92	4,45
	100	3,67	5,07	4,25	4,76	5,24	4,44	5,81	4,74
	130	4,78	5,21	5,07	4,81	5,07	4,89	5,15	4,99
10,0	60	3,66	3,77	3,84	3,98	3,68	3,78	3,85	3,79
	80	4,85	4,57	4,85	4,7	4,63	4,85	4,65	4,72
	100	3,95	4,31	5,37	5,55	4,48	5,82	4,91	4,91
	130	4,67	4,78	4,52	4,75	4,79	4,58	4,73	4,68

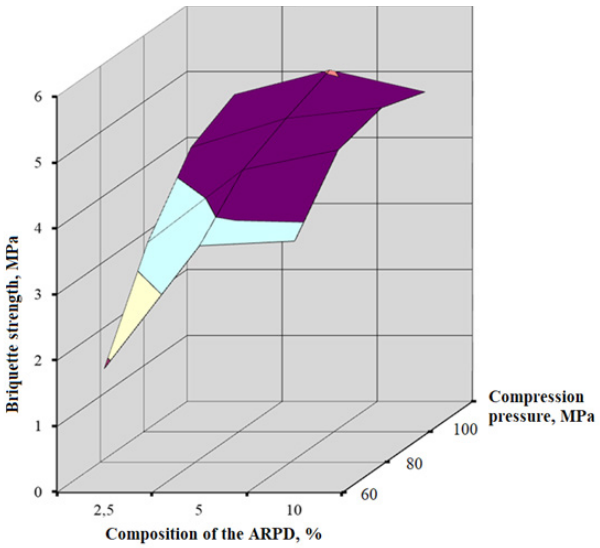

Figure 2. Dependence of the strength of briquettes on the composition and compressive strength of the ARPD

Table 5. figure 3 shows the dependence of the strength of briquettes on the joint effect of rice husk content and compression pressure. The table shows that the optimal amount of rice husk on the charge is 2,5÷5 %, and the compression pressure is 100÷130 MPa.

Table 5. Strength of briquettes containing rice husks

The composition of rice husk, %	Compression pressure, MPA	Temporary resistance to compression, MPa							
		Experience numbers							
		1	2	3	4	5	6	7	Average value
2,5	65,0	4,48	4,74	4,75	4,86	4,71	4,84	5,05	4,77
	86,6	6,54	7,61	6,67	7,27	8,15	7,11	8,07	7,34
	108,3	7,64	8,45	7,45	8,12	8,57	7,65	8,47	8,05
	130,0	6,82	9,11	7,89	8,23	8,57	7,34	8,12	8,01
5,0	65,0	3,72	3,78	4,21	3,91	3,92	4,17	4,23	3,99
	86,6	6,69	6,53	6,64	6,65	7,08	6,21	7,23	6,71
	108,3	8,01	7,81	8,1	7,52	7,35	7,39	7,78	7,7
	130,0	7,7	7,94	7,95	7,72	7,72	7,81	7,79	7,8
10,0	65,0	3,23	3,09	3,27	3,13	3,17	3,12	3,2	3,17
	86,6	5,6	5,3	5,6	5,8	5,73	5,38	5,91	5,61
	108,3	6,32	6,49	6,17	6,22	6,19	6,24	6,51	6,3
	130,0	5,71	5,83	6,07	5,87	5,88	5,7	5,81	5,83

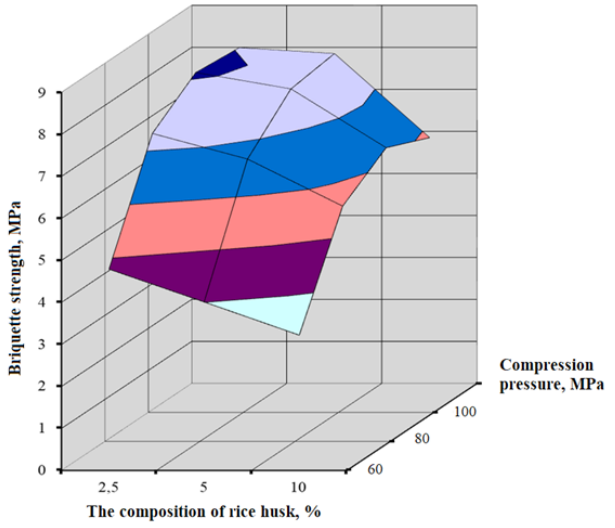

Figure 3. Dependence of the strength of briquettes on the composition and compression pressure of rice husks

Let's assume that the composition of a briquette made from oil waste consists of ARPD, coal powder and rice residue (rice husk), and use the formula given below to find the heat of combustion for this planned briquette. The heat of combustion refers to the amount of energy released during the combustion of 1 kg of solid fuel.

The lower combustion heat refers to the most important characteristic of the fuel and is determined from experience for each substance. When the elemental composition is known, the heat of combustion can be found using the formula of D.I. Mendeleev (kJ/kg or kcal/kg):

$$Q_H^P = 339C^P + 1256H^P - 109(O^P + S_L^P) - 25,14(9H^P + W^P)$$

C^P, H^P, O^P, S_L^P, W^P — impurity values (% of mass) of carbon, hydrogen, oxygen, sulfur and moisture in the fuel.

Analysis of the results

to carry out these calculations, we determine the concentrations of the additives included in the briquette, changing them in the possible range and keeping the concentration of each individually constant at a certain value. All calculations were carried out by creating a computer program, and the results obtained are shown in tables 6÷9 and figure 4 (Zhumagulov et al., 2021).

For the concentrations of all combustible impurities contained in the briquette, the values of the heat of combustion when simultaneously taking different values are given in table 6 (Tanzharykov et al., 2012).

Table 6. Heat of combustion of briquette for variable concentrations of all constituent substances

Specific heat of combustion, kcal / kg			Briquette composition, in the mass part, %			Composition compound	Heat of combustion Q, kcal
ARPD	Coal powder	Rice husk	ARPD	Coal powder	Rice husk		
10420	6560	3200	0	0,9	0,1	1	6224
10420	6560	3200	0,05	0,8	0,15	1	6249
10420	6560	3200	0,1	0,7	0,2	1	6274
10420	6560	3200	0,15	0,6	0,25	1	6299
10420	6560	3200	0,2	0,5	0,3	1	6324
10420	6560	3200	0,25	0,4	0,35	1	6349
10400	6560	3200	0,3	0,3	0,4	1	6368
10400	6560	3200	0,35	0,2	0,45	1	6392
10400	6560	3200	0,4	0,1	0,5	1	6416
10400	6560	3200	0,45	0	0,55	1	6440

The concentration of rice husk in the briquette is constant (0.10% in the mass fraction), and the concentrations of the remaining combustible impurities are simultaneously taken different values the values of the heat of combustion are given in table 7.

Table 7. The concentration of rice husk is constant, the heat of combustion of the briquette for variable concentrations of the remaining constituent substances

Specific heat of combustion, kcal / kg			Briquette composition, in the mass part, %			Composition compound Rice husk	Heat of combustion Q, kcal
ARPD	Coal powder	Rice husk	ARPD	ARPD	Coal powder		
10420	6560	3200	0	0,9	0,1	1	6224
10420	6560	3200	0,05	0,85	0,1	1	6417
10420	6560	3200	0,1	0,8	0,1	1	6610
10420	6560	3200	0,15	0,75	0,1	1	6803
10420	6560	3200	0,2	0,7	0,1	1	6996

10420	6560	3200	0,25	0,65	0,1	1	7189
10400	6560	3200	0,3	0,6	0,1	1	7376
10400	6560	3200	0,35	0,55	0,1	1	7568
10400	6560	3200	0,4	0,5	0,1	1	7760
10400	6560	3200	0,45	0,45	0,1	1	7952

Assuming that the concentration of coal powder in the briquette is constant (0,40% in the mass fraction), the concentrations of the remaining combustible impurities are simultaneously different values, the values of the combustion heat are given in table 8. The lines of change in the heat of combustion made from the obtained values in these tables are shown in figure 4.

Table 8. The concentration of coal powder is constant, the heat of combustion of the briquette for variable concentrations of the remaining constituent substances

Specific heat of combustion, kcal / kg			Briquette composition, in the mass part, %			Composition compound Rice husk Rice husk	Heat of combustion Q, kcal ARPD
ARPD	Coal powder	Rice husk	ARPD	ARPD	Coal powder		
10420	6560	3200	0	0,4	0,6	1	4544
10420	6560	3200	0,05	0,4	0,55	1	4905
10420	6560	3200	0,1	0,4	0,5	1	5266
10420	6560	3200	0,15	0,4	0,45	1	5627
10420	6560	3200	0,2	0,4	0,4	1	5988
10420	6560	3200	0,25	0,4	0,35	1	6349
10400	6560	3200	0,3	0,4	0,3	1	6704
10400	6560	3200	0,35	0,4	0,25	1	7064
10400	6560	3200	0,4	0,4	0,2	1	7424
10400	6560	3200	0,45	0,4	0,15	1	7784

The average value of the values of the heat of combustion obtained by varying the concentrations of combustible impurities in the briquette is given in table 9.

Table 9. Average combustion heat of briquette

Specific heat of combustion, kcal / kg			Heat of combustion of briquette composition Q, kcal			Average burning heat Q, kcal
ARPD	Coal powder	Rice husk	Everything is changing	Rice husk stable (in 10% mass portion)	Coal powder stable (40% in mass fraction)	
10420	6560	3200	6224	6224	4544	5664
10420	6560	3200	6249	6417	4905	5857
10420	6560	3200	6274	6610	5266	6050

10420	6560	3200	6299	6803	5627	6243
10420	6560	3200	6324	6996	5988	6436
10420	6560	3200	6349	7189	6349	6629
10400	6560	3200	6368	7376	6704	6816
10400	6560	3200	6392	7568	7064	7008
10400	6560	3200	6416	7760	7424	7200
10400	6560	3200	6440	7952	7784	7392

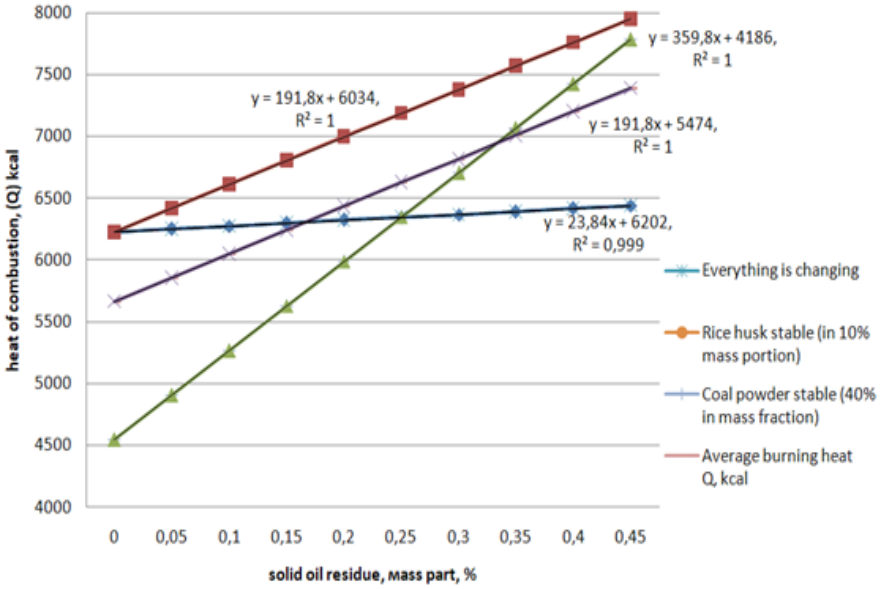

Figure 4. Obtained and average values of the combustion heat depending on the concentration changes in the briquette composition

As can be seen in figure 4, the average values found for all considered cases of combustion heat vary between 5664 kcal and 7392 kcal. Therefore, the exact value of the heat of combustion directly depends on the conditions for their gluing and technological production of briquette fuel, the mutual identification of these compounds. So, from the considered calculations, it was found that for a fuel briquette made from oil waste, the minimum value of the heat of combustion will be Q_{min} = 4544 kcal, and the largest possible value will be Q_{max} = 7952 kcal.

In the course of the study on the extraction of briquettes from coal of the Kiyakty deposit, the possibility of using ARPD waste as a binder was considered. Waste is a semi-solid viscous mass that maintains its state of aggregation at a temperature of 25÷30^{0}C, therefore, when using them as a binder with a charge of a homogeneous composition, it will be necessary to heat them to a melting point of 120÷130^{0}C.

The resulting briquette pattern was placed in a mold. Experimental work showed that the burned samples did not break, but took the shape of a plate (table 10).

Table 10. Results of briquette tests

t, min	0	5	10	15	20	25	30	35	40
T, ^{0}C	0	147	256	487	612	790	563	462	402

Figure 5. The process of combustion of a briquette made of Coal of the Kiyakty deposit with a ARPD binder

Conclusion

Based on the data obtained, a methodology for selecting the charge composition was developed, an analysis of the binding components was carried out. Laboratory studies on the conditioning of lignite were carried out and the physico-mechanical properties of the resulting briquettes were determined.

As a result of mathematical processing, the relationship between the physico-chemical properties of coal and the technological parameters of briquetting was revealed. 6 charge options have been developed and technological briquetting parameters have been established that meet the requirements for briquette fuel.

To confirm the results of laboratory tests, tests were carried out on the developed conditions for briquetting non-conditioning coal. Tests of the developed options for briquetting lignite of Class 0÷5 mm with a humidity of 10÷17 % confirmed the results of laboratory tests. The results of the tests clearly showed the possibility of briquetting non-conditioned brown coal of the Kiyakty field using connecting components at a pressing pressure of 100÷130 MPa. The strength of briquettes from charge of optimal composition is 7,7÷10,4 MPa.

The technological scheme of coal briquetting was developed, the equipment was selected and the scheme of the apparatus circuit was proposed. Basically, the assessment of the quality of briquette fuel is characterized by its strength properties. In this regard, to obtain briquetted fuel based on ARPN, it is necessary to take the amount of ARPN in the mixture in the range of 22÷26 %, coal 60÷70 %, rice husk 5÷10 %. According to the analysis, obtaining the amount of ARPN in briquetted fuel as 22÷26 % meets all the requirements in terms of quality compared to high-quality hard coal briquettes. The heat dissipation property is high, and the water absorption

is 2 % higher than the recommended value. The high ash content depends on the amount of coal ash used and the amount of rice husk.

The presence of sulfur in the briquette affects its quality and leads to the release of sulfur oxide into the air during the combustion process. ARPD from the Kumkol field contains a very small amount of sulfur, about 0,1÷0,3 %.

At the same time, one of the other important indicators of briquettes is its heat dissipation property during combustion. For this purpose, work was carried out on burning the briquette model in boiler furnaces. As a result, it turned out that the briquette fuel burns well, and the burner flame takes up the volume of fuel and burns for 35÷40 minutes. During combustion, the briquette fuel softens, but retains its shape well.

In this regard, as a result of the work carried out, it was shown that ARPD will be in high demand as a result of its use in the composition of briquetted fuel. The use of briquetted fuel of the proposed composition will expand the possibility of using accumulated ARPD waste from local oil fields and contribute to solving problematic issues related to the protection of the natural environment from harmful waste.

Author's Certificate No.70189 and innovative patent for "composition of briquette fuel based on asphalt-resin-paraffin deposits" were obtained (Tanzharykov, 2011).

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