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PHYSICAL AND CHEMICAL STUDIES OF THE OIL SLUDGE HYDROCARBON COMPOSITION AND THE PROSPECTS FOR THEIR USE IN THE TECHNOLOGY OF EXPANDED CLAY PRODUCTION

Abstract. The article presents the results of gas chromatographic studies of the oil sludge hydrocarbon composition, physical and chemical and heat-producing properties, which enabled to assess the potential of oil sludge as raw materials, their assortment predisposition and possible manufacturability. It has been established that the main physical and chemical characteristics of the organic part from the averaged samples of oil sludge are similar in properties to raw materials for the production of kerosene-diesel fractions. The expediency of the use of oil sludge and weakly bloating clay materials in the production technology of the popular construction material – expanded clay is substantiated. The results of experimental studies on the development of light and porous heat insulating material by granulation method are presented herein. It is shown that oil sludge from a high viscous state is transferred to a loose conglomerate with a moisture content of 12–15% by co-mixing with finely dispersed sand dune, which ensures uniform distribution when mixed with the basic mass. The peculiarities of granules burning according to a specially developed mode without preliminary drying are considered. It has been established that the addition of oil sludge increases the organic content in the mixture, thereby intensifying the process of combustion, gas generation and bloating of the ceramic body, which will positively affect the technological parameters of obtaining a product. It is found that the proposed technology allows to obtain marketable products, which can be used efficiently. At the same time, the unconditional priority is given to waste-free technologies, as the most environmentally friendly.

Key words: oil sludge, expanded clay, loess-like loam, dune sand, porous microstructure.

Introduction. In the Republic of Kazakhstan, a leading role is given to the intensive development of the oil and gas industry, since it forms the basis of the modern economy. However, the commercial development of raw hydrocarbon deposits has a technological impact on the environment objects. For example, in the process of extracting, pumping, storing oil, operating a sewage treatment plants, a significant amount of oil wastes is generated, which belong to Grades 2-3 as per toxicity level and are dangerous pollutants of surface and undergroundwaters, soil and air. At the same time, the hydrocarbon part of the oil wastes is a valuable organic raw material [1] and it can be considered as a secondary raw material resource. One type of such oil wastes is oil sludge, which is a fairly stable suspension of highly-dispersive mineral particles, organic compounds and water. This is potentially a secondary oil resource that can be brought up to the appropriate parameters and returned to the turnover.Processing of this material can ensure profitability, which will allowconducting necessary environmental protection and rehabilitation measures and preserving the financial stability of the oil production enterprise.

Solving the problem of oil sludge disposal has been the subject of many papers [2-6]. This indicates, on the one hand, the importance and relevance of this problem, and on the other hand, its complexity and the impossibility of anunambiguous solution. Therefore, it can be said that despite the diversity of existing methods, the problem of processing and using oil sludge is one of the least developedonesaccording to the technology of their disposal.

It is known that the total area of existing and promising oil and gas fields in the Republic of Kazakhstan occupies more than 60% of the country's territory, and there are more than 200 existing oil and gas fields [7-10]. On the territory of each oil-producing complex, operating for decades, there are oil sludge tanks, the number of which is growing. Their capacity at most enterprises is currently overfilled. Therefore, the disposal of newly formed and accumulated oil sludge waste should be one of the priority areas thatstipulates a very heavy demand for the creation of modern technologies and effective methods of treatment and disposal.

Based on the above, the purpose of this paper is to study the oil sludge hydrocarbon composition and its physical and chemical, heat-producing properties; to analyze the effect of the oil sludge composition on the technological parameters of its processing as a bloating agent in the production of expanded clay.

Materials and methods. Oil sludges from the collectors of Kumkol, PetroKazakhstan Kumkol Resources JSC and Aschisay, KOR JSC based on the territory of Kyzylorda Region were taken as the objects of the study.

Oil sludges are extremely diverse in composition and are complex systems consisting of oil, water and mechanical impurities, the ratio of which varies within a very wide range [7-11].

Hydrocarbon composition of oil sludge has been studied using gas chromatograph-mass spectrometer Agilent 7890A/5975C (USA).

Gaschromatographicdetermination of the total hydrocarbon content in the oil sludge when programming the temperature of the partition column makes it possible to study in detail the composition of oil hydrocarbons.

Chromatographic conditions in analyzing hydrocarbons extracted from oil sludge are given in table 1.

Figures 1 and 2 show the chromatogram of the studied oil sludge and hydrocarbon composition is given in table 2.

Table 1 - Chromatographic conditions in analyzing hydrocarbons extracted from oil sludge

Indicators	Chromatographic conditions
moving phase (carrier gas)	helium
evaporator temperature	350^{0}C
flow vent (Split)	30:1
column thermostat temperature: beginning - temperature rise - end - retention time at this temperature -	 70^{0}C 4^{0}C per minute 290^{0}C 30 min
total analysis time	85 min
ion mode of mass detector	with electron impact method
Capillary chromatographic column	HP-5MS
column length	30 m
inner diameter	0,25 mm
stationary phase	dimethylpolysiloxane (95%)

Table 2 - Group composition of hydrocarbons by results of chromatography-mass spectrometric analysis

Hydrocarbon groups contained in oil sludge	Quantitative content, wt. %	
	Oil sludge from the collectors of Kumkol, PetroKazakhstan Kumkol Resources JSC	Oil sludge from the collectors of Aschisay, KOR JSC
Paraffins	46.38	45.12
Uncondensed cycloparaffins	27.71	28.25
Condensed cycloparaffins with 2 rings	8.45	7.85
Condensed cycloparaffins with 3 rings	6.92	7.14
Benzenes	2.74	3.79
Naphthenobenzenes	0.10	0.11
Dinaphthenobenzenes	0.10	0.10
Naphthalenes	3.66	3.59
Acenaphthenes	2.96	3.21
Phenanthrenes	0.98	0.84

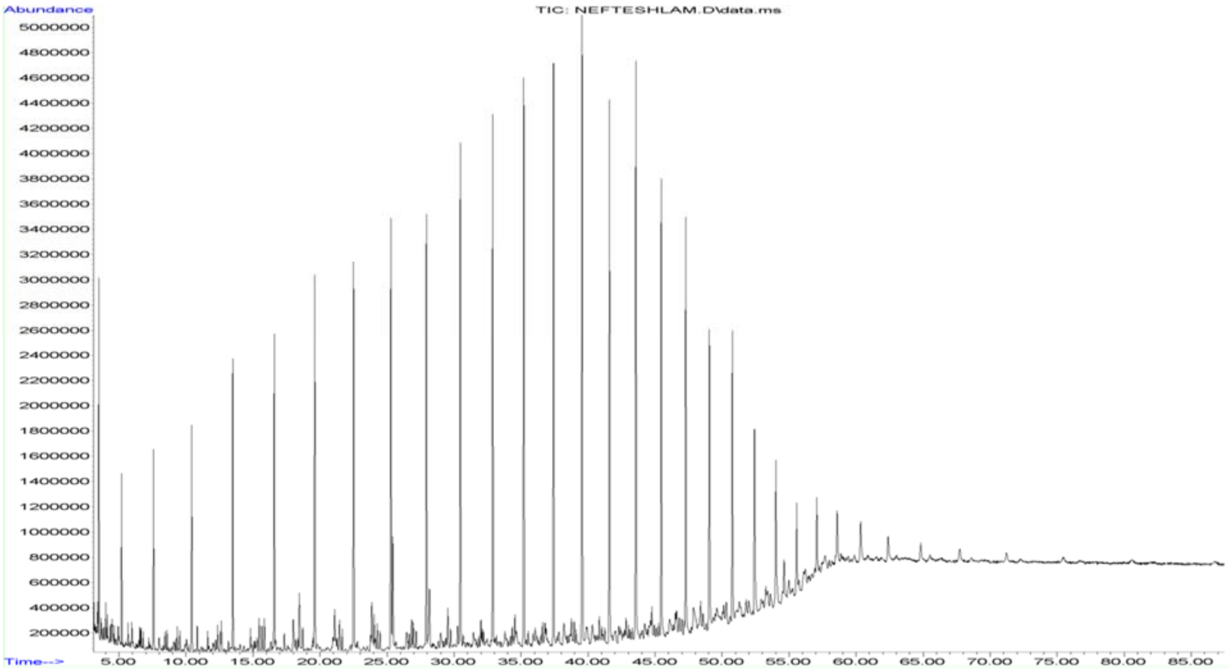

Figure 1 - Chromatogram of hydrocarbons extracted from the target oil sludge from the collectors of Kumkol, PetroKazakhstanKumkolResourcesJSC

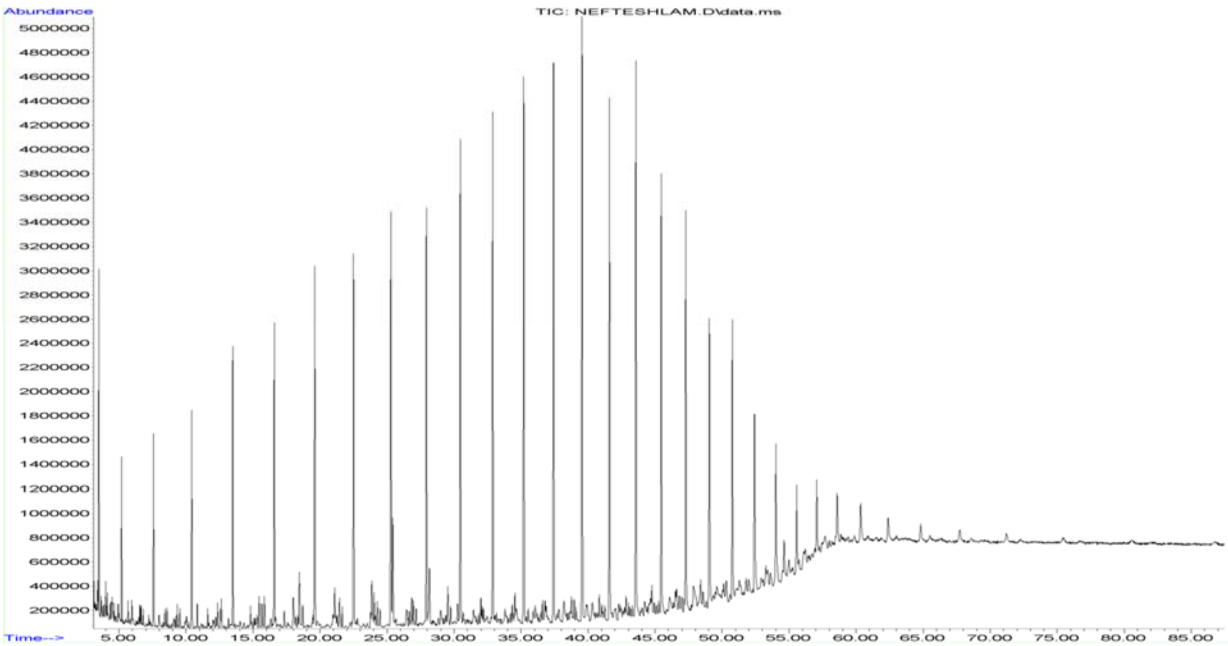

Figure 2 - Chromatogram of hydrocarbons extracted from the target oil sludge from the collector of Aschisay, KOR JSC

The physical and chemical properties, i.e. density, fractional composition, mass fraction of sulfur, combustion heat, content of mechanical impurities and chloride salts of the oil sludge under study were carried out according to known methods.

The mass fraction of sulfur in the oil sludge under studyhas been determined on the device Spectroscan-Max GF2E (Russia) by measuring the intensity of the sulfur fluorescence radiation excited under irradiation of the test sample with x-rays.

The combustion heat of the test samplehas been determined on the calorimeter S2000 of the company IKA-Werke (Germany) at the clean burning of a pre-weighed mass in the calorimetric bomb in a compressed oxygen environment andmeasurement of the amount of heat released at the combustion of auxiliary substances.

The results of the study of physical and chemical properties of oil sludge are given in table 3.

Studiesshow that the composition of oil sludge stored in sludge collectors for several years differs from the composition of fresh one. The high viscosity of oil sludge, high content of mechanical impurities and, most importantly, high aggregative stability are due mainly to the high content of asphaltenes, resins, paraffins and other high molecular components.

Table 3 - Properties of oil sludge

Descriptionof indexes	Indexes	
	Oil sludge from the collectors of Kumkol, PetroKazakhstan Kumkol Resources JSC	Oil sludge from the collectors of Aschisay, KOR JSC
Density, kg/m^{3}at20^{0}C	836.4	837.2
Fractional composition,% vol. 200^{0}C 300^{0}C 350^{0}C	 11 39 54	 12 38 53
Mass fraction of sulfur, %	0.024	0.016
Combustion heat, kJ/g	44.987	45.546
Content of mechanical impurities, %	0.027	0.025
Content of chloride salts, mg / dm^3	28.46	32.95

Results and discussion. It has been established that according to the physical and chemical properties, oil sludge has a dual chemical function. On the one hand, there is its affinity to light oil products such as gasoil diesel oil products, on the other hand, as per the content of metalloporphyrin complexes, carbon radicals, colloidal structureand reactive capacity, it is close to heavy oil productssuch as fuel oil.

Previouslyin the papers [12,13], the affinity of the physical and chemical properties of the hydrocarbon part of oil sludgeswith heavy oil fractions has been described, and it has been determined that they belong to the category of highly flammable and combustible materials.

It is also known from literature sources that the multicomponent composition of the oil sludge pitproducts of oil production, the presence of various chemical compounds in it create many problems during the development of processing technologies, the extraction of commercial oil from them, the removal of solid residue from oil products.

Therefore, oil sludges, which, due to their composition, are difficult to burn and do not have resource valuefrom the practical and production standpoint, are most expedient to use in the production of construction materials, namely, in the production technology of the popular construction material – expanded clay. Oil sludge will play the role of a bloating agent in the composition of expanded clay. The addition of oil sludge increases the organic content in the mixture, which intensifies the process of combustion, gas generation and bloating of the ceramic body, respectively, which will positively affect the technological parameters of obtainingaproduct.

The studies of the authors [14-18] have assessed the possibility of using local clay materials, oil-contaminated wastes for the production of expanded clay granules, methods for producing expanded clay gravel, using it as a light fillerfor various construction applications, such as thermal insulation, lightweight structural concrete, and. etc.

In this light, we have given preference in this work to the use of noncritical raw materials. When justifying the need to adjust mixtures with additives and when choosing their type, the chemical, mineralogical and granulometric compositions of the clay raw materials; availability of local resources suitable for use of materials; technical and economic effect have been taken into account. For example, as clay raw materials – weakly bloating loess-like loams, which have reserves in all regions of the Republic of Kazakhstan. The use of expensive fuel materials as a bloating and thinning agent is excluded. Instead of this, bottom oil sludge from the collectors of Aschisay, KOR JSC, based on the territory of the Kyzylorda Region is proposed.

Such methods allow obtaining marketable products, which can be usedefficiently. At the same time, the unconditional priority is given to waste-free technologies, as the most environmentally friendly.

The main properties of raw materials were studied in the papers of the authors [19,20].

Raw materials were preliminarily milled in an MShL-1P laboratory ball mill to a specific surface of 1500-2000 cm^2/g. A sample of oil sludge obtained as the result oftank cleaning, was preliminarily subjected to averaging throughmechanical mixing. It is known that the oil sludge has an increased ductility and the use in such state in the compositions is difficult. Therefore, in the first stage, the oil sludge is transferred from a high viscous state to a capillary-porouscolloidal state by co-mixing with finely dispersed sand dune. This technological operation transfers the oil sludge into a loose conglomerate with a moisture content of 12-15% and provides a convenient position for subsequent technological operations, such as proportioning and uniform distribution when mixed with the basic mass. To determine the physical and mechanical properties of the raw material and the finished product, a set of standard techniques were used according to GOST 9757-90, GOST 22263-76 and GOST 530-2007. The measurement of the thermal conductivity of the samples was carried out using an ITP-MG-4 ZOND thermal conductivity meter. The examination of the surface microstructure was carried out on a JSM – 6510 LV scanning electron microscope manufactured by JEOL.

Raw material composition was prepared from the prepared components through weighing and proportioning. Specificcompositional analysis of the object under study is represented in table 4.

Table 4 - Compositional analysis of the ceramic composition

Components, wt. %	
Loess-like loam	Conglomeratemixture “sanddune - oilsludge”
85,0	15
83,0	17
80,0	20
78,0	22
75,0	25

Ceramic body with molding water content 18-20% was prepared from the compounds under study. Then granules with fractions of 5-10, 10-20, 20-40 mm, which were subjected to heat treatment at temperatures of 200-500ºC for 0.5-1.0 hours in a ShSP-0.5-70 drying cabinet, were manufactured. Granules for bloating were burned in a rotary kiln of the RSR120/1000/13 brand according to a specially developed mode in the temperature range of 1150–1180°C. Bloated granules were tested for the definition of physical and mechanical properties.The results of experimental studies are presented in table 5.

Table 5 - Physical and mechanical properties of the samples under study

Composition No.	Sensitivity coefficient to drying asper the Chizhsky rapid method, sec.	Burning temperature, ^0C	Bulk density kg/m³	Cylindercrushing strength, MPa	Thermal conductivity W/mK
1	130	1170 ± 15	520	4.5	0.12
2	145		510	4.3	
3	166		480	3.9	0.08
4	180		475	3.7	
5	195		450	3.5	

According to the results of experimental studies, with an increase in the content of conglomerate mixture “sanddune - oilsludge” through a reduction of loam content, a decrease in the bulk density of the material from 520 to 450 kg/m^3 is observed. Low indicators of bulk density are seen in compositions No. 4 and No. 5 and they are in the range of 450-475 kg/m^3. Similar changes occur in respect of thermal conductivity and cylindercrushing strength. The minimum values of strength and thermal conductivity are also seenin compositions No. 4 and No. 5, while the cylindercrushing strength of these compositions is in the range of 3.5–3.7 MPa, and the thermal conductivity equals to 0.08 W/mK.

According to the qualification of heat insulating materials, samples of compositions No. 4 and No. 5 belong to class B (0.06–0.115 W/mK), and compositions No. 1, No. 2 and No. 3 belong to class C (0.1–0.175 W/mK). According to GOST 9757-90, samples of compositions No. 4 and No.5 belong to P200as per strengthgrade, and samples of compositions No. 1, No. 2 and No. 3 belong to P150. Analysis of the research results shows that the granular heat insulating material obtained has the best thermal-insulating and physical and mechanical properties as compared to the properties of typicalmontmorillonite-type expanded clay.

The most important value of chemical and mineralogical content of the raw material composition in the system “loess-like loam – oil sludge – sand dune”lies in the fact that it predetermines the complex physico-chemical processof structure formationof the finished product, including phase transformations at the main stages of thermal treatment.

Figure 3 shows the research results of the surface morphology, quantitative energy-dispersive microanalysis on the elemental constituentsof the sample of composition “loess-like loam 80% - conglomerate (sand dune-oil sludge) 20%” using a scanning electron microscope.

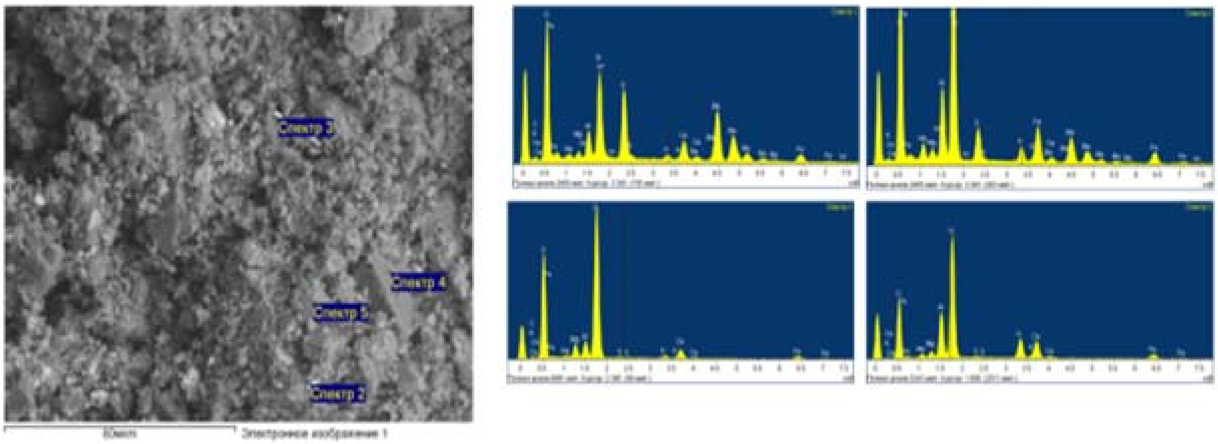

Figure 3 - Surface morphology, quantitative energy-dispersive microanalysis on the elemental constituentsof the sample of composition “loess-like loam 80% - conglomerate (sand dune-oil sludge) 20%”

The components of the system under consideration (clay minerals, oil sludge-basedorgano-mineral part) are directly involved and interact with each other in the formation of a porous structure with the release of a gaseous phasedue to combustion of oil sludge burning, without which pore formation and bloating are impossible.

It has been established that the addition of oil sludge increases the organic content in the mixture, which intensifies the process of combustion and gas generation, increases its capability to bloat, reduces the average density of the material; at the stage of drying, it acts as a thinning agent.

Organic impurities and iron oxides, increasing the intensity of oxidation-reduction processes, increase gas generation, reducing simultaneouslythe melting point and melt viscosity. The oxides of aluminium and silicon increase the viscosity, the burning temperature and as a result the strength of expanded clay. It is established that the combustion process of oil sludge in the composition of the conglomerate mixture allows raising the temperature inside the keln and speeding up the bloatingprocess of the ceramic body, and helps to reduce energy costs for the manufacture of products by 25-30%.

Bloating and formation of the structure in the composition under study is due to the optimum combination of components determining the rheological parameters of the pyroplastic body. This is due to the special nature of the structure and composition of the crystal lattices of the minerals of the constituent components included in the group of quartz, kaolinite, hydromica, and others. Lightweight heat insulating material such as “expanded clay” and its porous microstructure is shown in figure 4.

Figure 4 - Expanded clay and its porous microstructure

Conclusions. As can be seen from the above, the studies undertaken suggest that the use of oil sludge as abloating agenthas a positive impact on the technological parameters of the ceramic bodyprocessing, makes it possible to obtain granular material – expanded clay based on weakly bloating loess-like loams. It also solves the issues of rational use of natural resources, provides the construction industry with a competitive construction material.

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МҰНАЙ ШЛАМДАРЫНЫҢ КӨМІРСУТЕК ҚҰРАМЫН ФИЗИКА-ХИМИЯЛЫҚ ЗЕРТТЕУ ЖӘНЕ ОЛАРДЫ КЕРАМЗИТ ӨНДІРІСІ ТЕХНОЛОГИЯСЫНДА ПАЙДАЛАНУ ПЕРСПЕКТИВАЛАРЫ

Аннотация. Мақалада мұнай шламының шикізат ретіндегі ықтимал әлеуетін, ассортименттік бейімділігі мен өндірілу қабілетін бағалауға мүмкіндік тудырған мұнай шламының көмірсутек құрамын, физика-химиялық және калориялық қасиеттерін газды хроматографиялық зерттеу нәтижелері келтірілген. Мұнай шламының көмірсутек құрамын зерттеу Agilent 7890A / 5975C газды хромато-масс-спектрометр арқылы зерттелетін мұнай шламындағы күкірттің массалық бөлігі – Spectroscan-Max GF2E қондырғысы, ал калориялық мәні – IKA-Werke C2000 калориметрі арқылы жүргізілді. Араластырылып алынған сынамалардың органикалық бөлігінің негізгі физика-химиялық сипаттамалары қасиеттері бойынша керосинді-дизельдік фракцияларды өндіру үшін қолданылатын шикізатқа жақын екендігі анықталды. Мұнай шламын және Қазақстан Республикасының барлық өңірінде кездесетін нашар ісінетін сазды топырақты белгілі құрылыс материалы – керамзитті өндіру технологиясында пайдаланудың мақсаттылығы негізделген. Эксперименттік зерттеулер арқылы жеңіл және кеуекті жылу оқшаулағыш материалды түйіршіктеу әдісімен дайындау технологиясының нәтижелері анықталған. Мұнай шламын жоғары тұтқырлықтағы күйден негізгі қоспаға қосуға ыңғайлы 12-15% ылғалдықтағы конгломератты күйге барханды құммен араластыру арқылы қол жеткізуге болатындығы көрсетілген.

Зерттелетін құрам негізіндегі қалыпты ылғалдылығы 18-20% болатын керамикалық қоспа дайындалды. Осы қоспадан фракциялары 5-10, 10-20, 20-40 мм түйіршіктелген материал дайындап, арықарай 200-500ºС, 0,5-1,0 сағат көлемінде ШСП-0,5-70 шкафында кептірілді. Сонан соң түйіршіктелген материал RSR120/1000/13 маркалы айналмалы пешінде дайындалған режимге сәйкес 1150-1180ºС температура аралығында ісіру үшін күйдірілді. Ісінген түйіршікті материалдың физика-механикалық қасиеттері МЕМС 9757-90, 22263-76, 530-2007 кешенді стандартты әдістемелерді пайдалану арқылы жүргізілді. Үлгілердің жылу өткізгіш қасиеті ИТП-МГ-4 «ЗОНД» қондырғысы арқылы анықталды, беткі қабатының микроқұрылымы «JEOL» фирмасының JSM – 6510 LV растрлы электронды микроскопта жүргізілді. Яғни, ұсынылған технологияның тағы бір ерекшелігі керамикалық қоспадан дайындалған түйіршіктердің, алдын ала кептірілмей-ақ, арнайы жасалған режим бойынша айналмалы пеште күйдірілу мүмкіндігі қарастырылған. Мұнай шламын қосу шихтада органикалық зат құрамын жоғарылатады және осы арқылы керамикалық массаның жану, газ бөлу, ісіну үдерістерін белсендіре отырып, материал дайындаудың технологиялық параметрлеріне қолайлы әсер ететіндігі анықталған.

Жылусақтағыш материалдардың квалификациялық талабына сәйкес керамзиттің ұтымды құрамы Б (0,06–0,115Вт/мК) класына жататындығы және МЕМС 9757-90 сәйкес мықтылығы бойынша П200 маркасына сәйкестігі анықталды. Ұсынылған технология тиімді пайдалануға болатын тауарлы өнім өндіруге мүмкіндік береді. Жұмыста басымдық экологиялық тұрғыдан тиімді қалдықсыз технологияларлар дайындауға бағытталған.

Қарастырылған құрылымдағы компоненттер, яғни, сазды минералдар, мұнай шламының органоминералды бөлігі, бір-бірімен әрекеттесе отырып, мұнай шламының жану барысында бөлінген газды фаза әсерінен қуысты құрылымды түзуге қатысады. Бұл үдеріссіз қуыс түзбейді және ісінбейді.

Органикалық қоспалар және темір оксиді тотығу-тотықсыздану үдерістерінің қарқындылығын арттыра отырып, газ түзілісін жоғарылатады және балқу температурасы мен балқыма тұтқырлығын төмендетеді. Алюминиий оксиді мен кремний тұтқырлығын және күйдіру температурасын жоғарылатады, нәтижесінде керамзитті беріктендіруге үлес қосады. Сонымен қатар, конгломерат құрамында мұнай шламының жану үдерісі пеш ішіндегі температураны жоғарылатуға және керамикалық қоспаның ісіну жағдайын жылдамдатуға ықпал етеді. Нәтижесінде өндіру үдерісіне жұмсалатын энергияны 25-30 % үнемдеу мүмкіндігі туындайды.

Зерттелетін композициядағы ісіну және құрылым түзу үдерістері компоненттер құрамының ұтымдылығымен тікелей байланысты және пиропластикалық қоспаның реологиялық параметрлеріне де әсер етеді. Бұл кварц, каолинита, гидрослюда және т.б. тобына кіретін құрам компонент минералдары құрылымының және кристалл торының ерекшеліктері арқылы негізделеді.

Жүргізілген зерттеулер мұнай шламын ісіндіру компоненті ретінде пайдалану керамикалық қоспаны өңдеудің технологиялық параметрлеріне оңтайлы әсер ететіндігін, осы арқылы нашар ісінетін сары топырақты саздақтан түйіршектелген материал-керамзит алуға болатындығын дәлелдеді. Сонымен қатар, табиғи ресурстарды ұтымды пайдалануға болатындығын, құрылыс индустриясын бәсекеге қабілетті құрылыс материалымен қамтамасыз етуге болатындығын айқындады.

Түйін сөздер: мұнай шламы, керамзит, сары топырақты саздақ, барханды құм, кеуекті микроқұрылым.

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ФИЗИКО-ХИМИЧЕСКИЕ ИССЛЕДОВАНИЯ УГЛЕВОДОРОДНОГО СОСТАВА НЕФТЯНЫХ ШЛАМОВ И ПЕРСПЕКТИВЫ ИСПОЛЬЗОВАНИЯ ИХ В ТЕХНОЛОГИИ ПРОИЗВОДСТВА КЕРАМЗИТА

Аннотация. В статье приведены результаты газохроматографического исследования углеводородного состава нефтешламов, физико-химических и теплотворных свойств, которые позволили оценить возможный потенциал нефтяного шлама как сырья, их ассортиментную предрасположенность, возможную технологичность. Изучение углеводородного состава нефтешлама проводили с помощью газового хромато-масс спектрометра Agilent 7890A/5975C, массовую долю серы в исследуемом нефтешламе – на приборе Спектроскан-Макс GF2E, теплоту сгорания – на калориметре С2000 фирмы IKA-Werke.

Установлено, что основные физико-химические характеристики органической части из усредненных проб нефтешламов по свойствам близки к сырью для производства керосино-дизельных фракции.

Обоснована целесообразность использования нефтяного шлама и слабовспучивающихся глинистых материалов, запасы которых имеются во всех регионах Республики Казахстан, в технологии производства популярного строительного материала – керамзит. Приведены результаты экспериментальных исследований по разработке технологии легкого и пористого теплоизоляционного материала методом гранулирования. Показано,что нефтешлам из высоковязкого состояния переводится в сыпучий конгломерат с влажностью 12–15% путем совместного перемешивания с тонкодисперсным барханным песком, что обеспечивает равномерность распределения при перемешивании с основной массой. Из исследуемых составов приготовлены керамическая масса с формовочной влажностью 18-20 %. Затем изготовлены гранулы с фракциями 5-10, 10-20, 20-40 мм, которые подвергались термообработке при температурах 200–500ºС в течении 0,5-1,0 часа в сушильном шкафу ШСП-0,5-70. Гранулы для вспучивания обжигались во вращающейся печи марки RSR120/1000/13 по специально разработанному режиму в интервале температур 1150-1180ºС. Вспученные гранулы подвергались испытанию по определению физико-механических свойств с использованием комплекса стандартных методик согласно ГОСТ 9757-90, ГОСТ 22263-76, ГОСТ 530-2007. Измерение теплопроводности образцов осуществили с помощью измерителя теплопроводности ИТП-МГ-4 «ЗОНД», изучение микроструктуры поверхности проведена на растровом электронном микроскопе JSM – 6510 LV фирмы «JEOL».

Таким образом, по предлагаемой технологии рассматриваются особенности обжига гранул по специально разработанному режиму без предварительной сушки. Установлено, что добавление нефтяного шлама повышает содержание органики в шихте, тем самым интенсифицирует процесс горения, газообразования и вспучивания керамической массы, что благоприятно повлияет на технологические параметры получения материала. Согласно квалификации теплоизоляционных материалов, оптимальные

составы керамзита относятся классу Б (0,06 - 0,115 Вт/мК) и согласно ГОСТу 9757-90 относятся к марке по прочности П200.

Установлено, что предлагаемая технология позволяет получать товарную продукцию, находящую квалифицированное применение и при этом безусловный приоритет принадлежит безотходным технологиям как наиболее экологичным.

Компоненты рассматриваемой системы (глинистые минералы, органо – минеральная часть на основе нефтешлама) взаимодействуют с друг другом и участвуют непосредственно в образовании пористой структуры с выделением газообразной фазы за счет горения нефтешлама, без которой невозможно порообразование и вспучивание.

Органические примеси и оксиды железа, повышая интенсивность окислительно-восстановительных процессов, увеличивают газообразования, снижая одновременно температуру плавления и вязкость расплава. Оксиды алюминия и кремния повышают вязкость, температуру обжига и в конечном итоге – прочность керамзита. Установлено, что процесс горения нефтешлама в составе конгломератной смеси позволяет повысить температуру внутри печи и ускорить процесс вспучивания керамической массы. А также способствует снижению энергозатрат на производство изделий на 25-30 %.

Вспучиваемость и образование структуры в исследуемой композиции обусловлено оптимальным сочетанием компонентов, определяющим реологические параметры пиропластической массы. Это обуславливается особым характером строения и состава кристаллических решеток минералов, составляющих компонентов, входящих в группу кварца, каолинита, гидрослюды и других.

Проведенные исследования позволяют утверждать, что использование нефтяных шламов в качестве вспучивающей добавки благоприятно влияет на технологические параметры переработки керамической массы, дает возможность получить гранулированный материал – керамзит на основе слабовспучивающихся лессовидных суглинков. А также решает вопросы рационального использования природных ресурсов, обеспечивает строительную индустрию конкурентоспособным строительным материалом.

Ключевые слова: нефтешлам, керамзит, лессовидный суглинок, барханный песок, пористая микроструктура.

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