Торайғыров университетінің хабаршысы
ҒЫЛЫМИ ЖУРНАЛЫ

НАУЧНЫЙ ЖУРНАЛ
Вестник Торайгыров университета

Торайғыров университетінің ХАБАРШЫСЫ

Энергетикалық сериясы
1997 жылдан бастап шығады

ВЕСТНИК Торайгыров университета

Энергетическая серия
Издается с 1997 года

ISSN 2710-3420

№ 1 (2022)

Павлодар

НАУЧНЫЙ ЖУРНАЛ
Вестник Торайгыров университета

Энергетическая серия
выходит 4 раза в год

СВИДЕТЕЛЬСТВО
о постановке на переучет периодического печатного издания,
информационного агентства и сетевого издания
№ 14310-Ж
выдано
Министерство информации и общественного развития
Республики Казахстан

Тематическая направленность
публикация материалов в области электроэнергетики,
электротехнологии, автоматизации, автоматизированных и
информационных систем, электромеханики и теплоэнергетики

Подписной индекс – 76136

https://doi.org/10.48081/WRIX7218

SRSTI 44.31.35

https://doi.org/10.48081/POCJ1209

M. V. Dolgov[1], A. A. Baubek[2], M. G. Zhumagulov[3], A. M. Gribkov[4], S. A. Glazyrin[5]
[1,2,3,5]L. N. Gumilyov Eurasian National University,
Republic of Kazakhstan, Nur-Sultan;
[4]Kazan State Power Engineering University,
Russian Federation, Kazan

POSSIBILITY OF WATER-OIL EMULSION COMBUSTION

The article describes a device developed by the authors for wave treatment of water-oil emulsion for preparation of water-oil emulsion for combustion. High efficiency of hydrocarbon fuel combustion is one of the main indicators when choosing a method of fuel mixture preparation. The scheme of an innovative vortex burner for combustion of water-oil emulsion is presented. A review of existing equipment for preparation of high quality emulsion is made. The necessity of forced oil dehydration for high quality combustion in burners is refuted. The choice of material for the dispersant body with regard to corrosion, cavitation and wear resistance requirements is presented. The analysis was carried out in order to reveal the relations of transformation of physical-chemical properties of water-oil emulsion (sedimentation and aggregative stability, structural viscosity) from temperature and from the volume of water in them. Knowledge of these physical-chemical parameters is essential to ensure the efficiency of atomization and stable combustion of the fuel under study. A methodology for determining the dynamic viscosity using a capillary viscometer with results obtained in different ranges of temperature changes of emulsified fuel preparation is presented. Data on the density of oil-water emulsion as a function of water concentration at 70 °C was obtained. The dependence of stability of emulsion based on fuel oil M-100 from settling time at 20 °C has been analysed. When using wave treatment dispersant, stable water-oil emulsions are obtained, suitable for use in power engineering as fuel.

Keywords: fuel oil, water-oil emulsion, dispersant, capillary viscometer.

Introduction

The task of clean combustion of hydrocarbon fuels has been solved for decades, resulting in a wealth of scientific and experimental experience, but research work in this direction continues unabated. An important parameter is the stoichiometric composition of the fuel mixture. As a result of swirling fuel and oxidiser flow the free pass length is increased as well as their stay in the burner channel. The paper describes the experimental results for preparation of water-oil emulsion for combustion in a vortex burner providing a stable vortex at the stage of mixing and preignition [1]. The vortex gives almost all the fuel a chance to react. Moreover, the mixing of fuel and oxidiser, given the correct stoichiometry, results in a uniform combustible mixture, which will burn better and almost completely in the burner channel. Fig. 1 illustrates the proposed burner device designed for burning water-oil emulsion (WOE) with variable moisture content up to 30 % [2].

Figure 1 – Burner device for burning WOE

Organizing the preparation of fuel for combustion in oil-fired boiler plants, ensuring the efficiency and reliability of burner devices becomes of primary importance. There is an acute problem with the preparation of the fuel mixture for combustion, caused by many factors, along with economic ones, which do not sufficiently satisfy all the necessary indicators of fuel before direct combustion [3].

The main task of the work is to investigate the rheological and sedimentation properties of the water-fuel emulsion.

The combustion stage is preceded by homogenisation of the water-fuel mixture using a dispersant. Fig. 2 illustrates the experimental setup for preparation of water-oil emulsion for combustion.

Figure 2 – Dispersion system for watered fuel oil

This study aims to investigate the properties of WOE prepared through the use of a wave treatment dispersant. In the preparation of water-fuel emulsions, the quality selection of emulsion preparation devices is of paramount importance. There are several criteria for determining the quality of emulsions. One of the most important is dispersity, which has a direct impact on emulsion conductivity, viscosity and stability. Water is uniformly distributed in the fuel mass, and as the number of water droplets in the fuel increases and its size decreases, the dispersity increases, which directly affects the quality of the emulsion produced.

Based on misconceptions about the stability of emulsions, many researchers have been found to use the term ‘blending’, despite the fact that the technology they use is emulsification. While blending is convenient for fuels with relatively similar boiling points, emulsification should be used for fuel blends with different boiling points so that the benefit from micro-blending can be reflected in fuel atomisation. Secondary atomisation resulting from the micro-bursting of emulsified fuel and fuel oxygenation are responsible for improved combustion, performance and CO emissions. The latent heat of vapour formation has been found to be responsible for the reduction of NOx emissions [4].

Experimental studies of the effect of emulsion fuels on combustion, performance and emission have been carried out before. The emulsion characteristics were determined using an optical electron microscope, emulsion stability test [5].

Changes in temperature and droplet diameter over time were observed. The combustion of the emulsion droplets was divided into four stages, with the characteristics of each stage varying little depending on the water volume ratio [6].

The problems of emulsion formation in water and the stability of the emulsified oil during storage were solved using a laser diffraction particle size analyzer, image analysis and oil emulsion volume determination [7].

The research of influence of inhomogeneous system parameters on emulsification intensity at complex influence of mechanical stirring and ultrasonic oscillations was carried out. We used methods of analytical review of the results of ultrasonic emulsification of heterogeneous systems, analytical study of the propagation of ultrasonic vibrations through a layer of two-component emulsion, the experimental study of emulsification of immiscible liquids under mechanical agitation in the field of ultrasonic vibrations [8].

The principle of high quality emulsion production equipment is based on the phenomenon of cavitation. One of the possible options for the preparation of watered fuel oil with moisture content up to 20 % is the use of hydrodynamic cavitators, which have proven themselves when applied with a particle size not exceeding 10 μm in the aspect of significantly increasing the combustion rate. The cavitation treatment effect is promising in terms of micron-sized WOE. According to experimental studies, in small emulsion particles water is boiled off to form finer elements by crushing the particles. Much less intermediate products are produced during combustion. Analysis of technology reveals one of the disadvantages – energy intensity of shredding process in preparation of watered oil [9].

Fuel oil containing solid components has an increased flash point, and also has other deviations from the standards, affects the contamination of the heating surface, destabilizes the combustion process, breaks the completeness of fuel combustion, forms the flare disruption up to the emergency shutdown of equipment. Traditional methods of storage and pumping imply that the consumer receives fuel oil with excessive moisture content [10].

The issue of making equipment to prepare WOE for combustion has been addressed for decades and much experience has been accumulated in this area. Mechanical apparatuses produce homogeneous solutions. Colloidal mills and rotors based on centrifugal pumps are also used. Ultrasonic machines are used for particle size reduction by breaking the bond between the particles of molecules [11–13].

The main distinguishing feature of all of the above devices is the complexity of their design, resulting in the need for additional service and in some cases connection to a permanent power supply.

Disadvantages of above mentioned WOE dispersants are eliminated by use of the WOE wave dispersant, described in detail below. The principle of operation of the wave treatment dispersant is also based on the cavitation effect.

Materials and methods

The process of combustion of C to CO and subsequently of CO to CO_2 is characteristic of WOE due to its high water vapour content. The possibility of using oil tank effluents is due to emulsification of watered liquid hydrocarbons. Stable burning of WOE is observed at volumetric water content up to 50 % [14].

Fig. 3 shows dispersant parts, on Fig. 4. dispersant housing and segner wheel, Fig. 5. dispersant assembled. Dispersant design is a device for wave treatment of watered fuel oil, made at the plant in Kazakhstan.

Figure 3 – Details of the dispersant

Figure 4 – Dispersant housing and segner wheel

Figure 5 – Dispersant assembly

The water-oil emulsion is homogenised by the cavitation process in the wave treatment dispersant, therefore the dispersant must be constructed according to a number of requirements:

– body and working bodies of the dispersant must be corrosion-resistant;

– cavitation resistance and wear resistance.

Stainless steels are well suited to these requirements. Table 1 shows the compositions for the dispersant body, steel grade 03X16H15M3 was selected and for the segner wheel, steel grade 12X13, whose chemical compositions are shown below.

Table 1 – Compositions of the selected steels

Steel grade	C	Si	Mn	Ni	S	P	Cr	Mo	Fe
03X16H15M3	Up to 0.03	Up to 0.6	Up to 0.8	14-16	Up to 0.015	Up to 0.02	15-17	2.5-3	~64
12X13	0.09-0.15	Up to 0.8	Up to 0.8	Up to 0.6	Up to 0.025	Up to 0.03	12-14		~84

The analysis revealed a number of changes in the dependence of physical and chemical properties of water-oil emulsion, which include aggregative and sedimentation stability, structural viscosity, and their dependence on temperature and water content. The obtained indicators are of great importance for organising efficient atomisation and stable fuel combustion, as well as for evaluating the performance of the dispersant itself.

Results and discussion

The experiment was conducted at 80 °C for M-100 fuel oil. The percentage of water content in WOE was taken in the range from 5 to 30 % (5, 10, 15, 20, 30).

WOE density. WOE is a composite mixture of two liquids of different densities, so the density is determined by the formula

$$\rho_{WOE} = \rho_O \cdot m_O + \rho_W \cdot m_W \qquad (1)$$

ρ_{WOE} – density of WOE, kg/m3;

ρ_O, ρ_W – densities of fuel oil and water respectively; kg/m3;

m_O, m_W – proportion of fuel oil and water in the water-oil emulsion.

Determined the density of M-100 fuel oil and water at 70 ^oC.

At 70 0C = 935.5 kg/m^3; = 971.6 kg/m^3.

The experiment was carried out with different concentrations of water from 5 % to 30 %. The calculation results are shown in Table 2 and the diagram according to Fig. 6.

Table 2 – Dependence of WOE density on water concentration at 70 ^oC

Water concentration, %	5 %	10 %	15 %	20 %	30 %
WOE density, kg/m^3	937,217	939,08	940,627	942,61	946,2

Fig. 6 shows that as the concentration of water in the mixture increases, the density of WOE increases. This is due to the fact that the density of water is higher than that of fuel oil.

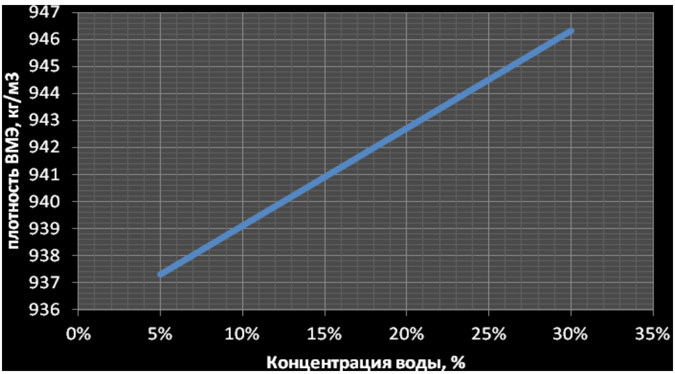

Figure 6 – Dependence of WOE density on water concentration at 70 ^oC

Hydrodynamics equation with viscosity η through the viscosimeter capillary to determine the stationary flow of a fluid (Poiseuille formula):

$$Q = \frac{\pi R^4 p}{8\eta L} \Rightarrow \eta = \frac{\pi R^4 p}{8QL} \quad (2)$$

Q – quantity of liquid flowing through the capillary viscometer per unit time, m^3/s;

R – radius of the viscometer capillary, m;

L – length of the capillary viscometer, m;

p – pressure difference at the ends of the capillary viscometer, Pa;

η – viscosity of liquid, Pa·s;

The case study justifies the use of the Poiseuille formula for laminar liquid flow when there is no slip on the viscometer capillary wall-liquid boundary. This equation is used to determine the dynamic viscosity.

Fig. 7 shows a schematic representation of a capillary viscometer for determining dynamic viscosity.

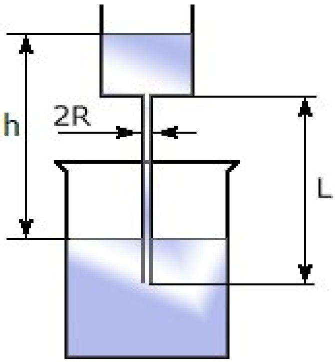

Figure 7 – Capillary viscometer

Table 3 – Viscosity of WOE in relation to water concentration at 70 °C

Концентрация воды, %	5 %	10 %	15 %	20 %	30 %
Плотность ВМЭ, кг/м^3	937,217	939,08	940,627	942,61	946,2
Расход ВМЭ, 10-6 м^3/кг	17,63	16,5	12,71	10,64	8,6
Структурная вязкость ВМЭ, Па ·с	0,182	0,191	0,253	0,304	0,368

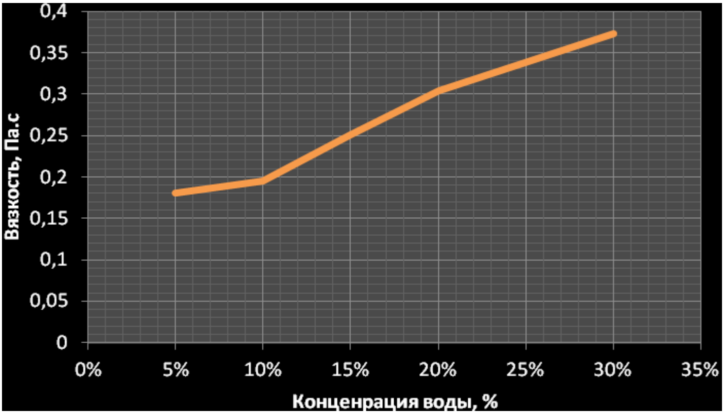

Figure 8 – Viscosities of WOE as a function of water concentration at 70 °C

The analysis of data of Fig. 8 and Table 3 shows the increase of structural viscosity of WOE with the increase of percentage of water content and shows the prevalence of viscosity of initial oil. The increase of emulsion viscosity from 0,167 Pa·s (initial oil) up to 0,373 Pa·s is observed.

The increase of percentage of water in WOE (above 30 %) causes negative consequences of combustion [15].

Calculation results using this method of determining the optimum value of transmission temperature and preparation of WOE, taking into account the percentage of water content, are shown in Table 4.

Table 4 – Temperature dependence of viscosity of M-100 fuel oil based WOE at different water contents

Emulsion	Structural viscosity, Pa·s at temperature, °C				
	20	40	50	70	80
WOE with 5 % H_2O	3,04	0,86	0,34	0,19	0,162
WOE with 10 % H_2O	12,3	1,54	0,76	0,255	0,159
WOE with 20 % H_2O	12,92	1,98	1,27	0,312	0,211
WOE with 30 % H_2O	16,74	3,73	1,91	0,377	0,278
WOE with 40 % H_2O	20,83	6,05	2,49	0,932	0,447

Analysis of the data indicates a significant decrease in viscosity of the cohesive disperse system in the temperature range from 20 to 70 °C. When water is heated in the range 70 to 80 °C the viscosity value does not decrease significantly. As an example, the viscosity of WOE with 30% water content decreases from 0.376 Pa·s (at 70 °C) to 0.276 Pa·s (at 80 °C). The necessity of further increasing the temperature of heating WOE in the range of 90–100 °C is due to the prevention of boiling of water from WOE. The preparation of WOE is conditioned by the rationing of the water content. The factor of partial loss of moisture in the plant (not in the laboratory) during emulsion preparation can be considered as a positive side effect of dewatering.

A clarification assessment method was used to evaluate the sedimentation stability of the WOE, with an obligatory holding period in glass cylinders in a statistical condition. The results obtained are shown in Table 5.

Table 5 – Stability ratio of WOE based on M-100 fuel oil to settling time at 20 °C

Initial water content in WOE, % wt.	Concentration of water in WOE in the upper layer, % wt.				
	1 hour	2 hours	5 hours	8 hours	day
5	3,2	3,2	3,43	3,99	4,5
10	4,3	4,41	5,0	5,23	6
15	5,13	5,25	5,5	6,09	6,7
20	5,22	5,21	5,67	6,4	8
30	8,9	11	15,02	19	28,3

Conclusion

The wave dispersant experimentally demonstrates the high quality of the WOE preparation. The obtained WOE, with a water content in the range 5-30%, is stable overnight in the required temperature range. By means of dispersant of wave processing stable WOE are received, under standard conditions the prepared fuel is stored in the expense tank no more than days, therefore the WOE received by the presented technology is applicable for needs of power engineering in a wide range of application. WOE acts as a disperse system with high aggregative stability. There is a significant numerical increase in the 10 μm particle size and there is minimal conversion of the 1.25 μm dispersed phase particles towards the 2.5 μm particle size.

Information about financing

This research is funded by the Grant «The best university teacher of 2021 in the Republic of Kazakhstan» (Zhumagulov M. G.).

REFERENCES

1 **Baubek, A. A., Zhumagulov, M. G., Kartjanov, N. R. et al.** Experimental test of Water-Oil Emulsion Combustion // High Speed Turbomachines and Electrical Drives Conference 2020. E3S Web of Conferences 178. – 01012. – 2020.

2 **Baubek, A. A., Baubek, N.** Device for burning fuel European Patent no. 2864700. – 2016. [Electronic resource]. – https://data.epo.org/gpi/EP2864700B1-DEVICE-FOR-BURNING-FUEL.

3 **Баубек, А. А., Жумагулов, М. Г., Картджанов, Н. Р.** Экспериментальные исследования вредных выбросов при сжигании водо-мазутной эмульсии в инновационной вихревой горелке // IV Международная научно – практическая конференция на тему : «Актуальные проблемы транспорта и энергетики : пути их инновационного решения»; 17 марта 2016 г. – Астана, 2007. – С. 73–80.

4 **Hagos, F. Y., Ali, O. M., Mamat, R. et al.** Effect of emulsification and blending on the oxygenation and substitution of diesel fuel for compression ignition engine // Renewable and Sustainable Energy Reviews. – 2017. – 75(5). – P. 1281–1294.

5 **Tan, Y.H., Abdullah, M. O., Nolasco-Hipolito, C. et al.** Engine performance and emissions characteristics of a diesel engine fueled with diesel-biodiesel-bioethanol emulsions // Energy Conversion and Management. – 2017. – 132(2): – P. 54–64.

6 **Kim, H., Baek, S. W.** Combustion of a single emulsion fuel droplet in a rapid compression machine // Energy. – 2016. – 106(3). – P. 422–430.

7 **Laitinen, O., Ojala, J., Sirviö, J.A., et al.** Sustainable stabilization of oil in water emulsions by cellulose nanocrystals synthesized from deep eutectic solvents // Cellulose. – 2017. – 24(4). – P. 1679–1689.

8 **Afanasenko, V. G., Kulakov, P. A., Boev, E. V., et al.** Optimization of ultrasound emulsion under mechanical mixing // Bulletin of the Tomsk Polytechnic University, Geo Assets Engineering. – 2020. – 331(4). – P. 148–155.

9 **Таймаров, М. А., Ахметова, Р. В., Маргулис, С. М., Касимова, Л. И.** Влияние кавитационной обработки на выгорание частиц мазута в топках котлов. Известия высших учебных заведений. Проблемы энергетики. – 2018. – 20(9–10). – С. 52–59.

10 **Кормилицын, В. И., Лысков, М. Г., Румынский, А. А.** Влияние добавки влаги в топку на интенсивность лучистого теплообмена // Теплоэнергетика. – 1992. – № 1. – С. 41–44.

11 **Корягин, В. А.** Сжигание водотопливных эмульсий и снижение вредных выбросов. – СПб. : Недра, 1995. – 367 с.

12 **Шерман, Ф.** Эмульсии. Перевод с английского под ред. А. А. Абрамзона. – Л. : Химия, 1972. – 448 с.

13 **Промтов, М. А., Червяков, В. М., Воробьев, Ю. В.** Приготовление эмульсии в роторном аппарате // Научно-технич. информ. сб. статей. – М. : ВНИИСЭНТИ, 1991. – № 3. – С. 47–50.

14 **Геллер, С. В.** Приготовление водомазутных эмульсий посредством волновой диспергации. Патент РФ №2347153. 20.02.2009. – №4. – 16.

15 **Зверева, Э. Р., Фарахов, Т. М.** Энергоресурсосберегающие технологии и аппараты ТЭС при работе на мазутах. – М. : «Теплотехник», 2012. – 181 с.

REFERENCES

1 **Baubek, A. A., Zhumagulov, M. G., Kartjanov, N. R. et al.** Experimental test of Water-Oil Emulsion Combustion // High Speed Turbomachines and Electrical Drives Conference 2020. E3S Web of Conferences 178, 01012. – 2020.

2 **Baubek, A. A., Baubek, N.** Device for burning fuel, European Patent no. 2864700. – 2016. [Electronic resource]. – https://data.epo.org/gpi/EP2864700B1-DEVICE-FOR-BURNING-FUEL.

3 **Baubek, A. A., Zhumagulov, M. G., Kartjanov, N. R.** Eksperimentalnye issledovaniya vrednyh vybrosov pri czhuganii vodo-mazutnoi emulsii v innovacionnoi vihrevoi gorelke. [Experimental studies of harmful emissions from the combustion of water-oil emulsion in an innovative vortex burner] IV Mezhdunarodnaya nauchno-prakticheskaya konferenciya na temu: «Aktualnye problem transporta I energetiki : puti ih innovacionnogo resheniya» [IV International Scientific and Practical Conference on the topic : «Current problems of transport and energy : ways of their innovative solutions»]. – 17 March, 2016. – Astana, 2007. – P. 73–80.

4 **Hagos, F. Y., Ali, O .M., Mamat, R. et al.** Effect of emulsification and blending on the oxygenation and substitution of diesel fuel for compression ignition engine // Renewable and Sustainable Energy Reviews. – 2017. – 75(5). – P. 1281–1294.

5 **Tan, Y. H., Abdullah, M. O., Nolasco-Hipolito, C. et al.** Engine performance and emissions characteristics of a diesel engine fueled with diesel-biodiesel-bioethanol emulsions // Energy Conversion and Management. – 2017. – 132(2). – P. 54–64.

6 **Kim, H., Baek, S. W.** Combustion of a single emulsion fuel droplet in a rapid compression machine // Energy. 2016. – 106(3). – P. 422–430.

7 **Laitinen, O., Ojala, J., Sirviö, J. A., et al.** Sustainable stabilization of oil in water emulsions by cellulose nanocrystals synthesized from deep eutectic solvents // Cellulose. – 2017. – 24(4). – P. 1679–1689.

8 **Afanasenko, V. G., Kulakov, P. A., Boev, E. V., et al.** Optimization of ultrasound emulsion under mechanical mixing // Bulletin of the Tomsk Polytechnic University, Geo Assets Engineering. – 2020. – 331(4). – P. 148–155.

9 **Taymarov, M. A., Akhmetova, R. V., Margulis, S. M., Kasimova, L. I.** Vliyanie kavitacionnoj obrabotki na vygoranie chastic mazuta v topkah kotlov. [The effect of cavitation treatment on the extinguishing of particles of oils in

fuel boilers] // Power engineering : research, equipment, technology. – 2018. – 20(9–10). – P. 52–59.

10 **Kormilicyn, V. I, Lyskov, M. G, Rumynskiy, A. A.** Vliyanie dobavki vlagi v topku na intensivnost luchistogo teploobmena. Teploenergetika [The effect of the addition of moisture to the furnace on the intensity of radiant heat exchange // Thermal power engineering]. – 1992. – (1). – P. 41–44.

11 **Koryagin, V. A.** Szhiganie vodotoplivnyh emulsii I snizhenie vrednyh vybrosov. [Burning of water-fuel emulsions and reduction of harmful emissions] Saint Petersburg : Nedra, 1995. – 367 p.

12 **Sherman, F.** Emul'sii. Perevod s angliyskogo god red. A.A. Abramzona [Emulsions. Translated from English under the editorship of A. A. Abramzon]. – L. : Chemistry. – 448 p.

13 **Promtov, M. A., Chervyakov, V. M., Vorobyev, V. M.** Prigotovlenie emulsii v rotornom apparate. Nauchno-tehnicheskii informacionnyi sbornik statei [Preparation of an emulsion in a rotary apparatus // Scientific and technical. inform. collection of articles]. – Moscow : VNIISENTI, 1991. – (3). – P. 47–50.

14 **Geller, S. V.** Prigotovlenie vodomazutnyh emulsii posredstvom volnovoi dispergacii. Patent RUS №2347153. 20.02.2009. – № 4. 16. [Preparation of water-oil emulsions by wave dispersion. Patent of the Russian Federation №2347153. 20.02.2009. – №4. 16.]

15 **Zvereva, E. R., Farahov, T. M.** Energoresursosberegayushie tehnologii i apparaty TES pri rabote na mazutah [Energy-saving technologies and thermal power plants when working on fuel oil]. – Moscow : «Teplotehnik», 2012. – 181 p.

Material received on 28.02.22.

**М. В. Долгов*[1]*, А. А. Баубек*[2]*, М. Г. Жумагулов*[3]*, А. М. Грибков*[4]*, С. А. Глазырин*[5]

[1,2,3,5]Гумилёв атындағы Еуразиялық ұлттық университеті,
Қазақстан Республикасы, Нур-Султан қ.;
[4]Казань ұлттық энергетикалық университеті,
Ресей Федерациясы, Қазан қ.
Материал 28.02.22 баспаға түсті.

СУ-МАЗУТТЫ ЭМУЛЬСИЯНЫ ЖАҒУ МҮМКІНДІГІ МӘСЕЛЕСІНЕ

Мақалада авторлар әзірлеген су-мазут эмульсиясын жағуға дайындау үшін суланған мазутты толқындық өңдеуге арналған құрылғы сипатталған. Көмірсутекті отынды жағудың жоғары *тиімділігі жанғыш қоспаны дайындау әдісін таңдаудағы негізгі көрсеткіштердің бірі болып табылады. Су-мұнай эмульсиясын жағуға арналған инновациялық құйынды қыздырғыш құрылғының схемасы ұсынылған. Жоғары сапалы эмульсияны дайындауға арналған қолданыстағы жабдыққа шолу жасалды. Жанарғы құрылғыларында сапалы жағу үшін мазутты мәжбүрлі дегидратациялау қажеттілігі жоққа шығарылды. Коррозияға төзімділікке, сондай-ақ кавитация мен тозуға төзімділікке қойылатын талаптарды ескере отырып, диспергатор корпусын жасау үшін материалды таңдау туралы мәліметтер ұсынылған. Су-мазут эмульсиясының физика-химиялық қасиеттерін (тұндыру және агрегаттық тұрақтылық, құрылымдық тұтқырлық) температурадан және олардағы су көлемінен түрлендірудің арақатынасын анықтау мақсатында талдау жүргізілді. Осы физика-химиялық параметрлерді білу зерттелетін отынның жануы мен тұрақты жануының нәтижелілігін қамтамасыз ету үшін айтарлықтай. Эмульсияланған отынды дайындау температурасының өзгеруінің әртүрлі диапазондарында алынған нәтижелері бар капиллярлық вискозиметрді қолдана отырып, динамикалық тұтқырлықты анықтау әдістемесі келтірілген. 70 °С температурада судың концентрациясына байланысты су-мазут эмульсиясының тығыздығы бойынша деректер алынды, 20 °С кезінде тұндыру уақытына М-100 мазут негізіндегі эмульсия тұрақтылығының тәуелділігіне талдау жасалды.*

Кілтті сөздер: мазут, су-мазут эмульсиясы, диспергатор, капиллярлық вискозиметр.

**М. В. Долгов[1], А. А. Баубек[2], М. Г. Жумагулов[3], А. М. Грибков[4], С. А. Глазырин[5]*

[1,2,3,5]Евразийский национальный университет имени Л. Н. Гумилёва, Республика Казахстан, г. Нур-Султан;

[4]Казанский государственный энергетический университет, Российская Федерация, г. Казань.

Материал поступил в редакцию 28.02.22.

К ВОПРОСУ ВОЗМОЖНОСТИ СЖИГАНИЯ ВОДО-МАЗУТНОЙ ЭМУЛЬСИИ

В статье описан разработанный авторами аппарат для волновой обработки обводненного мазута для подготовки водо-мазутной эмульсии к сжиганию. Высокая эффективность сжигания *углеводородного топлива является одним из основных показателей при выборе способа подготовки горючей смеси. Представлена схема инновационного вихревого горелочного устройства для сжигания водо-мазутной эмульсии. Произведён обзор существующего оборудования для подготовки эмульсии высокого качества. Опровергнута необходимость в принудительной дегидратации мазута для качественного сжигания в горелочных устройствах. Представлены данные по выбору материала для изготовления корпуса диспергатора с учётом требований к коррозионностойкости, а также устойчивости к кавитации и износостойкости. Проведён анализ с целью выявления соотношений преобразования физико-химических свойств водо-мазутной эмульсии (седиментационная и агрегативная устойчивость, структурная вязкость) от температуры и от объёма в них воды. Знание данных физико-химических параметров значительно для обеспечения результативности распыла и стабильного горения исследуемого топлива. Приведена методология для определения динамической вязкости с использованием капиллярного вискозиметра с полученными результатами в разных диапазонах изменения температуры подготовки эмульгированного топлива. Получены данные по плотности водо-мазутной эмульсии в зависимости от концентрации воды при температуре 70 ^{o}C. Выполнен анализ зависимости стабильности эмульсии на основе мазута М-100 от времени отстоя при 20 °C. При использовании диспергатора волновой обработки получаются стабильные водо-мазутные эмульсии, пригодные для применения их в энергетике в качестве топлива.*

Ключевые слова: мазут, водо-мазутная эмульсия, диспергатор, капиллярный вискозиметр.

Теруге 28.02.2022 ж. жіберілді. Басуға 18.03.2022 ж. қол қойылды.
Электрондық баспа
3,77 Mb RAM
Шартты баспа табағы 13,12. Таралымы 300 дана. Бағасы келісім бойынша.
Компьютерде беттеген: З. С. Искакова
Корректор: А. Р. Омарова
Тапсырыс № 3883

Сдано в набор 28.02.2022 г. Подписано в печать 18.03.2022 г.
Электронное издание
3,77 Mb RAM
Усл. печ. л. 13,12. Тираж 300 экз. Цена договорная.
Компьютерная верстка: З. С. Искакова
Корректор: А. Р. Омарова
Заказ № 3883

«Toraighyrov University» баспасынан басылып шығарылған
«Торайғыров университет»
коммерциялық емес акционерлік қоғамы
140008, Павлодар қ., Ломов к., 64, 137 каб.

«Toraighyrov University» баспасы
«Торайғыров университет»
коммерциялық емес акционерлік қоғамы
140008, Павлодар қ., Ломов к., 64, 137 каб.
8 (7182) 67-36-69
E-mail: kereku@tou.edu.kz
www.vestnik-energy.tou.edu.kz