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

№ 3 (2023)

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/YBCY7199

SRSTI 44.31.35

https://doi.org/10.48081/XOTU3472

M. G. Zhumagulov[1], A. A. Baubek[2], A. M. Gribkov[3], S. A. Glazyrin[4], M. V. Dolgov[5]

[1,2,4,5]L. N. Gumilyov Eurasian National University, Astana, Republic of Kazakhstan

[3]Kazan State Power Engineering University, Kazan, Russian Federation

e-mail: maxwellhousebest@yandex.ru

PROMISING TECHNOLOGIES FOR COMBUSTION OF USED OIL IN BURNERS

Emissions of pollutants are of great public concern due to their impact on the environment and human health. There is an acute issue of saving energy resources while reducing harmful emissions during the combustion of various types of fuel. Used oil, which consists mainly of hydrocarbons, is an excellent alternative for partial or complete replacement of typical design fuels does not contain the heavy residual fraction characteristic of heavy fuels.

This article provides an overview of alternative fuel combustion technologies. The review focuses on the principles of operation, key technologies in the field of used oil combustion. As an alternative to existing technologies on the market, an innovative design of a swirl burner for burning various types of fuel is presented in comparison with the closest analogue in terms of design and characteristics. The main advantages of using the innovative design of the burner are substantiated. The conducted literature review and analysis will be useful for further study of the efficient combustion of used oil.

Keywords: combustion, vortex burner, fuel-air mixture, vortex, alternative fuel, used oil.

Introduction

The high rate of fossil fuel depletion is the main cause of the energy crisis and pollution dilemma [1]. There is an acute issue of environmentally safe combustion of heavy hydrocarbons and substandard fuel for cheap energy production [2]. The industry is gaining attention due to worldwide concerns about greenhouse gas, carbon dioxide (CO_2), nitric oxide (NOx), sulfur oxide (SOx) and soot emissions. For example, the Intergovernmental Panel on Climate Change has provided evidence that CO_2 emissions increased by 3 % per year between 1990 and 2010 and will continue to rise [3]. Burning used oil as a heating fuel is underutilized due to the challenges of cleaning up contaminants found in the oil and overcoming its high viscosity and density to properly atomize into a fine stream and effectively mix the fuel with air [4]. In external combustion devices such as oil burners, the combustion and ejection characteristics of viscous fuels are improved by using heaters to reduce the high viscosity of the oil and swirlers to supply turbulent secondary air in a swirl form to the combustion zone in order to provide efficient atomization and mixing characteristics [5], [6]. Although the re-refining and recycling of used oil is considered more environmentally friendly, its combustion, which meets the quality requirements for heat recovery, is a fairly environmentally and economically viable option [7]. Used oil is used as an individual fuel or mixed with others for many heating systems. In ceramic kilns, used oil is used as a fuel during hardening and glazing under reducing firing conditions [8], [9]. Household heaters, foundries and, more importantly, cement kilns use used engine oil as an additional or replacement heating oil [10].

Used oil burners are justified where there are sufficient volumes of «own-made» testing – auto enterprises, service stations, car garages, heavy equipment repair enterprises. For them, it is not only waste disposal, but also cheap heat for their own needs. Greenhouses can also achieve savings when using used oil boilers. The advantage is that there is no need for gas supply lines, which leads to less risk during interruptions in gas supplies. Small enterprises, farms, livestock complexes can easily solve the issue of heating with the help of mining boilers.

Literature review

At the present stage of development of science and technology in the world, developments in the field of used oil combustion are being actively carried out. The issue is especially relevant due to the increasing price of traditional energy carriers.

Studies conducted on the incineration of used oil have reported high spray, combustion, and impressive heating values [11], [12], [13].

In the EU and the USA, systems for the disposal of used oils have long been developed. Used oil burners from the following manufacturers are popular: USA (EnergyLogic; Omni; Clean Burn), Canada (CAEQ), Germany (Kroll; Euronord EcoLogic; Giersch), Italy (Ecoflam), Finland (Danvex), South Korea (Olympia AL), China (Smart Burner; NORTEC WB), Poland (Hiton; Master MB).

The equipment requires regular maintenance – cleaning the combustion chamber, checking the filter and removing contaminants from it is required at least once a month. When it comes to used oil burners, the quality of American and Canadian products is unbeatable. German and Austrian modules are traditionally distinguished by high quality and reliability. Korean burners are multifunctional and more affordable. Chinese and Polish burners are produced in approximately the same quality and are a good option for heating small spaces [14].

Figure 1 shows a Kroll KG/UB burner manufactured in Germany, which is used on various equipment, including heat generators.

Figure 1 – Universal burner KROLL KG/UB 55

Figure 2 shows a vortex burner device «Burner Alternative» – 270 2-3 MW. The burner device combined (gas/liquid fuel) multicomponent, allows to burn any gaseous, liquid fuel or their mixes.

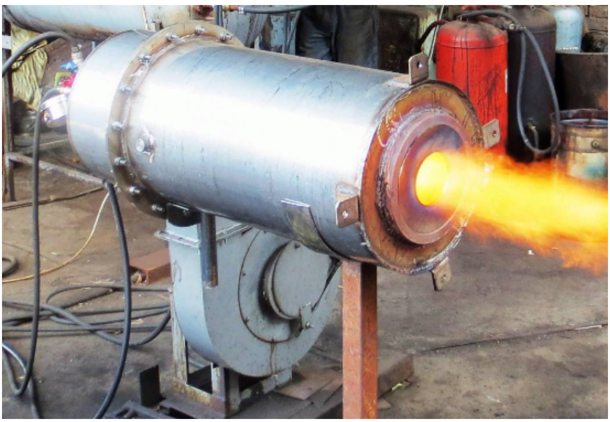


Figure 2 – Burner Alternative - 270 2-3 MW

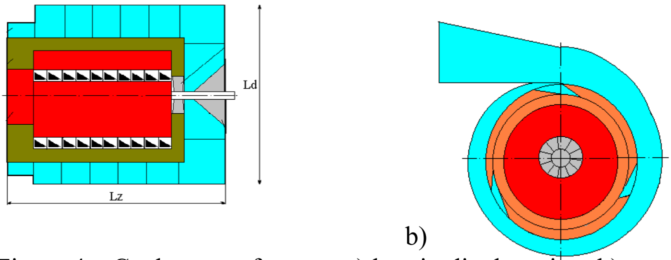
The burner can be used for burning used motor, transmission, hydraulic, turbine, transformer, vacuum oils and mixtures of these oils, diesel fuel, motor fuel, heating oil in accordance with specifications, pyrolysis fuel.

The burner operation is based on the principle of preheating and vortex mixing of fuel components (Figure 3). The primary combustion of fuel occurs in the prechamber using pneumatic nozzles and quasi-solid air vortices [15].

Figure 3 – Swirlers inside the combustion chamber

Another development of a direct-flow burner [16], [17] showed the possibility of efficient combustion of diesel fuel and used oil; when steam is supplied, due to the effect of diluting the combustible mixture and lowering the flame temperature, NOx is reduced by 30 %. Complete combustion of heavy fuels (crude oil, fuel oil, waste oil, oil production waste) in such a burner is not efficient, since it requires a longer stay of fuel droplets in the combustion chamber.

Considering Shtym`s vortex burner (Figure 4), it should be noted that the use of the cyclone-vortex method of burning liquid and gaseous fuels makes it possible to increase their heat output by 10–20 %, reduce specific fuel consumption, and bring nitrogen oxide emissions to a level not exceeding established standards in all areas, load range, reduce the cost of electricity for traction and blowing by 10–20 %. In addition, the system of automatic control of the boiler unit is greatly simplified, and the reliability of the processes of ignition, combustion and load control is increased [18].



a) b)

Figure 4 – Cyclone pre-furnace: a) longitudinal section; b) cross section

Materials and methods

The principle of operation and the design of mass-produced vortex burners using used oil are directly related to forced heating and partial evaporation of the fuel. After the fuel is supplied to the burner, it is sent to the pre-treatment chamber, heated to the required temperature and oxidized. The combustion of the air-fuel mixture takes place in a flame. The electrode, located directly in front of the nozzle, is responsible for igniting the fuel-air mixture. The turbulence of the air flow created by the fan blades is used to maintain the intensity of combustion. The principle of operation of the burner is the same as that of devices operating on diesel fuel or liquefied gas.

Depending on the type of power control, there are certain classifications of burners. Burners are manufactured in two types:

Single stage burner - with a simple design and operating principle. Heating of the heat carrier is carried out in the maximum power mode. When the required temperature is reached, the burner turns off until the coolant cools down to the set value. After that, combustion resumes.

The principle of operation of single-stage burners is inefficient and leads to a significant waste of fuel.

Two-stage burner – a module that operates continuously without shutting down. The heating principle is as follows. The burner will work at 100 % until the coolant reaches the required temperature. Then there is a switch to 30 or 40 % reduced power. The burner does not turn off completely. A similar principle of operation has a smoothly two-stage and modulating burner units.

Although the cost of two-stage and modulating burners is much higher, the costs are fully paid off with fuel savings of up to 15–20 % compared to single-stage burners [14].

The comparative analysis of the swirl burner device with its design analogue was carried out by means of determination of aerodynamic resistance of the fuel-air mixture (head loss, Pa) in the narrowing channel (by analogy with the confuser).

Aerodynamic resistance can be determined by the universal formula for linear and local resistances of any configuration:

$$\Delta h = \lambda \cdot \left(\frac{l}{d}\right) \cdot \frac{W_r^2}{2} \cdot \rho + \xi \cdot \frac{W_r^2}{2g} \quad (1)$$

where λ – is the coefficient of friction resistance (for metal structures 0.02);

l – length of the design section, m;

d – diameter of the design section, m;

W_r^2 – radial component of velocity;

ρ – pressure, *Pa*;

ξ – local resistance coefficient. For constriction flow with constriction angle a = 20÷600, ξ is taken as 0.1.

Results and discussion

Burner manufacturers differ in how they control axial flow (swirl) through nozzle and swirler design, air pressure, and adjustment mechanisms.

One of the problems in the organization of fuel combustion in a small volume at high volumetric thermal stresses is the protection of the walls from overheating and destruction. Due to improper organization of aerodynamics and fuel spraying, the destruction of the inner surface of the pre-furnace (combustion chamber) begins almost immediately. In the case of water cooling, fistulas are formed, lining with refractory material leads to local overheating of individual zones with their subsequent melting. As a result, the symmetry of the flame is broken and coking of its individual sections occurs. Particular attention should be paid to the start-up modes and the first minutes of operation of the pre-furnace, when heating occurs and a reverse current zone stabilizing the flame (ejection zone) is formed. Some designs of pre-furnaces do not allow gradual warming up to enter a stable operating range. A common problem of many cyclone chambers is the loss of the combustion products recirculation zone and the transition to a normal once-through mode when the rated load is reached or close to it. At the same time, excess air increases sharply, the load is immediately limited by draft, and combustion stability depends entirely on the quality of atomization and air temperature. Violation of the nozzle operation leads either to the failure of the torch, or to the formation of coke deposits on the screen surfaces in the area of the fore-furnace embrasure. Also, the disadvantages of burners listed above include the problematic scaling due to difficult hydrodynamic conditions.

As a result of the review of technologies for the combustion of alternative fuels, it was concluded that the closest analogue in terms of the type of organization of the vortex in the combustion chamber is the Shtym burner shown in Figure 5.

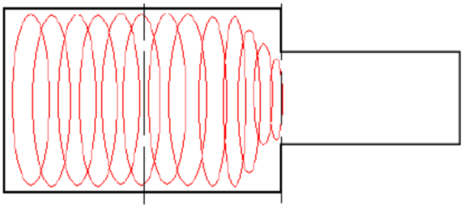


Figure 5 – Shtym`s vortex burner

Unlike the nearest innovative burner device, it has an internal pipe, due to which the overheating of the combustion chamber body is significantly reduced and, as a result, the efficiency of the device shown in Figure 6 is increased.

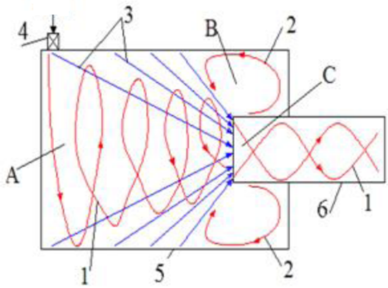


Figure 6 – Distribution of the fuel-air mixture. 1 – vortex motion of combustion products, 2 – reverse flow, 3 – flame vector in the combustion chamber; 4 – supply pipe; 5 – combustion chamber; 6 – outlet pipe. Zones A, B, C.

Fuel anρd oxidizer are fed into the combustion chamber 5 (Figure 6) tangentially through the supply pipe 4. The fuel and oxidizer enter the burner separately in the form of a swirling jet, then they are mixed in the combustion chamber 5. As they move, until they meet with the secondary air, the air mixture is preheated occurs due to mass transfer with the suction flow of hot gas and irradiation with a burning torch, which leads to oxidative reactions and ignition of fuel particles. The peak of the mixing effect falls on the inlet section of the outlet pipe 6.

Combustion initiation begins in the combustion chamber 5, accompanied by heat treatment of the fuel, the release of volatile fractions, and partial coking. The products of complete and incomplete combustion underlie the formation of a stable vortex flow (Figure 6 shows the path of gases by lines 1). Under the action of the vortex motion of gases in the axial zone A, a deep rarefaction is formed, and in zone B - reverse currents 2 of the combustion products. The reverse currents create an overpressure in zone B, as a result of which the pressure in zone B exceeds the pressure in zone C. As a result, the flame vector 3 will be directed to zone C. Thus, the vortex flow in the combustion chamber takes the form of a mini-tornado - a figured vortex with a narrowing of the vortex radius as the gas moves towards the outlet section. It should also be noted that the main vortex flow of variable cross section (mini-tornado) practically does not touch the prechamber body. Due to the part of the outlet nozzle that goes inside, friction occurs in the area of contact of the main vortex of zone A with the reverse currents of zone B, as a result of which overheating of the prechamber is almost completely eliminated, and the effect of friction of gas flows against each other has a positive effect on the temperature inside the chamber, since heat is absorbed by the threads themselves, not by the camera body.

In addition, the innovative vortex burner is easy to manufacture, highly reliable, and does not require significant capital investment for boiler upgrades [19].

To compare the proposed design of the vortex burner [20] with the closest analogue [18], the aerodynamic resistance of the outlet part of the devices was estimated. Figure 7 shows the aerodynamic drag loss curves in the presented burner device (1), and for comparison, the aerodynamic losses in the vortex pre-furnace device described in the works of Shtym (2) are calculated for similar dimensions of the device. For the structure under study, laboratory measurements of aerodynamic resistance were made according to the magnitude of the load on the blower fan electric motor. The maximum deviation in head loss was 15 %. In the proposed burner (1), the losses continuously increase due to the increase in axial speed with a reduction in the diameter of the vortex in the direction of flow along the x axis. In the first zone up to the inlet nozzle, the device (1) is inferior to the known device (2) in terms of aerodynamic resistance. However, the aerodynamic resistance increases uniformly up to the maximum value at the inlet to the outlet nozzle, which has a positive effect on the reliability of the device (1) in comparison with (2). The device (2) has in its design a sharp narrowing of the outlet channel (the entrance to the channel with straight edges of the western face with the walls), as a result of which the aerodynamic resistance increases sharply and at the stage of the exit of combustion products significantly exceeds the resistance in the device (1) by 1.34 times . Thus, the presence of an inwardly protruding part of the outlet nozzle is justified.

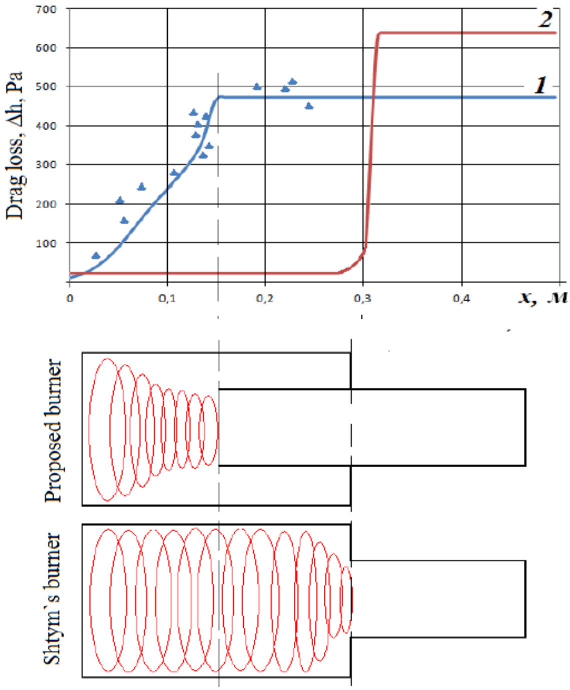


Figure 7 – Aerodynamic drag losses, Dh, Pa
1 – Proposed burner; 2 – Shtym`s burner

The philosophy behind the innovative swirl burner is to have no moving parts in the burner to ensure smooth operation without jamming and avoid repeatability issues. The advantages of the innovative burner include a relatively simple design, low energy consumption, easy adaptation to the combustion process conditions (pressure and temperature), continuous separation of particles without accumulation, performance at high concentrations of particles in the gas phase.

Conclusion

Based on the analysis of the presented materials, it can be stated that the improvement of devices for burning both low-calorie and high-calorie fuels is mainly aimed at the maximum possible increase in the efficiency of fuel combustion against the background of reducing the emission of harmful substances into the atmosphere. This is achieved through the use of a number of methods. This includes, above all, the efficient formation of the fuel-air mixture. In addition, for the efficient combustion of this mixture, it is necessary to create conditions for the recirculation of combustible substances in the furnace space itself. The proposed design of a universal burner (chamber shape) increases the residence time of the fuel in the combustion chamber and, as a result, increases the efficiency of burning various liquid hydrocarbons, including substandard ones.

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 **Huang, Y., Shen, H. Z., Chen, H., Wang, R., Zhang, Y. Y., Su, S., Chen, Y. Y., Lin, N., Zhuo, S. J., Zhong, Q. R., Wang, X. L., Liu, J. F., Li, B. G., Liu, W. X., Tao, S.** Quantification of global primary emissions of PM2.5, PM10 and TSP from combustion and industrial process sources. Environ. Science Technol. 2014; 48: P. 13834-13843.

2 **Zhao, N, et al.** Direct combustion of waste oil in domestic stove by an internal heat re-circulation atomization technology: Emission and performance analysis. Waste Management 2020; 104: P. 20–32.

3 IPCC (1999) Aviation and the Global Atmosphere [online] available from <https://www.ipcc.ch/report/aviation-and-the-global-atmosphere-2/> [13 Jun. 2019].

4 **Baukal, E. C.** The john zink hamworth combustion book : Design and operation. 2nd Edition. New York, Ohio : CRC Press, 2014.

5 **Daniel, B. J.** Waste oil burner pre-heater design. US patent no. US WO 20130206046 A1, 2012.

6 **Baukal, E. C.** Industrial combustion testing. New York, Ohio: CRC Press, Tailor and Francis Group, 2010.

7 **Tailor, E.** Turning used motor oil into heat with a used oil furnace. National rural transit assistance program. 2014.

8 **Hansen, T.** Reduction firing. Digital fire. [Online]. Available: [Electronic resource]: – http://digitalfire.com/4sight/glossary_reduction_firing.html

9 **Zakin, R. A.** guide to the ceramic kiln and various firing methods. ceramic arts Network Daily. [Online]. [Accessed 10.10.2018]. Available: http://ceramicartsnetwork.org/daily/clay-tool/ceramic-kiln/guide-ceramic-kiln-various-firing-methods/

10 **Speight, J. G., Exall, D. I.** Refining Used Lubricating Oils. New York, Ohio: CRS Press, 2014.

11 **Al-Omar, S. B.** Used engine lubrication oil as a renewable supplementary fuel for furnaces. Energy Conversion and Management 2008:49(12): P. 3648-3653.

[Electronic resource]: – https://doi.org/10.1016/j.enconman.2008.07.011

12 **Aji, I. S., El-Jummah, A. M., Aji, M. A., Ifeanyi, N. D.** Admixture of used engine oil blended with kerosene as a substitute for industrial fuel. Continental Journal of Engineering Sciences 2008: 3(6): P. 64–71.

13 **Madu, M. J., Aji, I. S., Martin, B.** Design, construction and testing of a burner that uses an admixture of used engine oil and kerosene for foundry application. International Journal of Innovative Research in Science and Engineering Technology 2011: 6(2). P. 23–31.

14 [Electronic resource]: – https://avtonomnoeteplo.ru/otopitelnye_kotly/327-promyshlennye-kotly-na-otrabotke.html

15 [Electronic resource]: – https://metalist-kremen.ucoz.ua/board/teplogeneratory/10

16 **Anufriev, I. S., Kopyev, E. P.** Diesel fuel combustion by spraying in a superheated steam jet. Fuel Process Technol 2019; 192: P. 154–69.

17 **Anufriev, I. S., Alekseenko, S. V., Sharypov, O. V., Kopyev, E. P.** Diesel fuel combustion in a direct-flow evaporative burner with superheated steam supply. Fuel, 2019. 254 p.

18 **Штым, А. Н., Штым, К. А., Воротников, Е. Г., Распутин О. В.** Исследование и освоение вихревой технологии сжигания топлива // Вестник Дальневосточного государственного технического университета. 2010 год. № 2 (4).

19 **Dolgov, M. V., Baubek, A. A., Zhumagulov, M. G., Gribkov, A. M., Glazyrin, S. A.** Possibility of water-oil emulsion combustion. Часть 1 // Вестник ТоУ. Энергетическая серия. – 2022. – № 1.

20 **Баубек, А. А., Жумагулов, М. Г., Долгов, М. В., Картджанов Н. Р.** Патент РК № 35578, 2020/0770.1, 07.11.2020. Устройство для сжигания углеводородного топлива.

REFERENCES

1 **Huang, Y., Shen, H. Z., Chen, H., Wang, R., Zhang, Y. Y., Su, S., Chen, Y. Y., Lin, N., Zhuo, S. J., Zhong, Q. R., Wang, X. L., Liu, J. F., Li, B. G., Liu, W. X., Tao, S.** Quantification of global primary emissions of PM2.5, PM10 and TSP from combustion and industrial process sources. Environ. Science Technol. 2014; 48: P. 13834-13843.

2 **Zhao, N,** et al. Direct combustion of waste oil in domestic stove by an internal heat re-circulation atomization technology: Emission and performance analysis. Waste Management 2020; 104: P. 20-32.

3 IPCC (1999) Aviation and the Global Atmosphere [online] available from [Electronic resource]: – <https://www.ipcc.ch/report/aviation-and-the-global-atmosphere-2/> [13 Jun. 2019].

4 **Baukal, E. C.** The john zink hamworth combustion book: Design and operation. 2nd Edition. New York, Ohio: CRC Press, 2014.

5 **Daniel, B. J.** Waste oil burner pre-heater design. US patent no. US WO 20130206046 A1, 2012.

6 **Baukal, E. C.** Industrial combustion testing. New York, Ohio: CRC Press, Tailor and Francis Group, 2010.

7 **Tailor, E.** Turning used motor oil into heat with a used oil furnace. National rural transit assistance program. 2014.

8 **Hansen, T.** Reduction firing. Digital fire. [Online]. Available: [Electronic resource]: – http://digitalfire.com/4sight/glossary_reduction_firing.html

9 **Zakin, R. A.** guide to the ceramic kiln and various firing methods. ceramic arts Network Daily. [Online]. [Accessed 10.10.2018]. Available: http://ceramicartsnetwork.org/daily/clay-tool/ceramic-kiln/guide-ceramic-kiln-various-firing-methods/

10 **Speight, J. G., Exall, D. I.** Refining Used Lubricating Oils. New York, Ohio: CRS Press, 2014.

11 **Al-Omar, S. B.** Used engine lubrication oil as a renewable supplementary fuel for furnaces. Energy Conversion and Management 2008:49(12): P. 3648-3653.

[Electronic resource]: – https://doi.org/10.1016/j.enconman.2008.07.011

12 **Aji, I. S., El-Jummah, A. M., Aji, M. A., Ifeanyi, N. D.** Admixture of used engine oil blended with kerosene as a substitute for industrial fuel. Continental Journal of Engineering Sciences 2008: 3(6): P. 64–71.

13 **Madu, M. J., Aji, I. S., Martin, B.** Design, construction and testing of a burner that uses an admixture of used engine oil and kerosene for foundry application. International Journal of Innovative Research in Science and Engineering Technology 2011: 6(2). P. 23–31.

14 [Electronic resource]: – https://avtonomnoeteplo.ru/otopitelnye_kotly/327-promyshlennye-kotly-na-otrabotke.html

15 [Electronic resource]: – https://metalist-kremen.ucoz.ua/board/teplogeneratory/10

16 **Anufriev, I. S., Kopyev, E. P.** Diesel fuel combustion by spraying in a superheated steam jet. Fuel Process Technol 2019; 192: P. 154–69.

17 **Anufriev, I. S., Alekseenko, S. V., Sharypov, O. V., Kopyev, E. P.** Diesel fuel combustion in a direct-flow evaporative burner with superheated steam supply. Fuel, 2019. 254 p.

18 **Shtym, A. N., Shtym, K. A., Vorotnikov, E. G., Rasputin, O. V.** Issledovanie I osvoenie vihrevoi tehnologii szhiganiya topliva [Research and development of vortex combustion technology] // Vestnik Dalnevostochnogo gosudarstvennogo tehnicheskogo universiteta. 2010 god. № 2 (4).

19 **Dolgov, M. V., Baubek, A. A., Zhumagulov, M. G., Gribkov, A. M., Glazyrin, S. A.** Possibility of water-oil emulsion combustion. Chast 1 // Vestnik ToU. Energeticheskaya seriya. – 2022. – № 1.

20 **Baubek, A. A., Zhumagulov, M. G., Dolgov, M. V., Kartdzhanov, N. R.** Patent RK № 35578, 2020/0770.1, 07.11.2020. Ustroistvo dlya szhiganiya uglevodorodnogo topliva [Hydrocarbon fuel combustion appliance].

Accepted for publication on 18.09.23

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

[1,2,4,5]Евразийский национальный университет имени Л. Н. Гумилёва, Республика Казахстан, г. Астана

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

Принято к изданию 18.09.23.

КРАТКИЙ ОБЗОР СЖИГАНИЯ ОТРАБОТАННОГО МАСЛА В ГОРЕЛОЧНЫХ УСТРОЙСТВАХ

Выбросы загрязняющих веществ вызывают большую озабоченность у общественности в связи с тем, что они воздействуют на окружающую среду и здоровье человека. Остро стоит вопрос об экономии энергоресурсов с одновременным снижением вредных выбросов в ходе сжигания различных видов топлива. Отработанное моторное масло, состоящее в основном из углеводородов, является отличной альтернативой для частичного или полного замещения типовых проектных видов топлива, не содержит тяжелой остаточной фракции, характерной для тяжелых топлив.

В данной статье представлен обзор технологий сжигания альтернативного вида топлива. Основное внимание в обзоре уделяется принципам работы, ключевым технологиям в области сжигания отработанного масла. В качестве альтернативы существующим на рынке технологиям, представлена инновационная конструкция вихревого горелочного устройства для сжигания различных видов топлива в сравнении с ближайшим аналогом по конструкции и характеристикам. Обоснованы основные преимущества использования инновационной конструкции горелочного устройства. Проведённый литературный обзор и анализ будет полезен для дальнейшего изучения эффективного сжигания отработанного масла.

Ключевые слова: сжигание, вихревое горелочное устройство, топливно-воздушная смесь, вихрь, альтернативное топливо, отработанное масло.

**М. Г. Жумагулов[1], А. А. Баубек[2], А. М. Грибков[3], С. А. Глазырин[4] , М. В. Долгов[5]*
[1,2,4,5] Л. Н. Гумилёв атындағы Еуразиялық ұлттық университеті, Қазақстан Республикасы, Астана қ;
[3]Казань ұлттық энергетикалық университеті, Ресей Федерациясы, Казань қ.
Басып шығаруға 18.09.23 қабылданды.

ПАЙДАЛАНҒАН МАЙ ОТТЫҚТАРЫН ЖАНУҒА ШОЛУ

Ластаушы заттардың шығарындылары қоршаған ортаға және адам денсаулығына әсеріне байланысты қоғамды алаңдатады. Әртүрлі отын түрлерін жағу кезінде зиянды шығарындыларды азайту кезінде энергия ресурстарын үнемдеу мәселесі өткір тұр. Негізінен көмірсутектерден тұратын пайдаланылған мотор майы типтік конструкциялық отынды жартылай немесе толық ауыстыруға тамаша балама болып табылады, ауыр отынға тән ауыр қалдық фракцияны қамтымайды.

Бұл мақалада балама отын жағу технологияларына шолу жасалады. Шолу жұмыс істеу принциптеріне, мұнай қалдықтарын жағу саласындағы негізгі технологияларға назар аударады. Нарықтағы қолданыстағы технологияларға балама ретінде әр түрлі отын түрлерін жағуға арналған бұрандалы қыздырғыштың инновациялық дизайны дизайны мен сипаттамалары бойынша ең жақын аналогпен салыстырғанда ұсынылған. Оттықтың инновациялық дизайнын пайдаланудың негізгі артықшылықтары негізделген. Өткізілген әдебиеттерді шолу және талдау мұнай қалдықтарының тиімді жануын одан әрі зерттеу үшін пайдалы болады.

Кілтті сөздер: жану, құйынды оттық, отын-ауа қоспасы, құйынды, балама отын, пайдаланылған мұнай.

Теруге 18.09.2023 ж. жіберілді. Басуға 29.09.2023 ж. қол қойылды.
Электронды баспа
29.9 Mb RAM
Шартты баспа табағы 22,2. Таралымы 300 дана. Бағасы келісім бойынша.
Компьютерде беттеген: А. К. Мыржикова
Корректор: А. Р. Омарова, Д. А.Кожас
Тапсырыс №4140

Сдано в набор 18.09.2023 г. Подписано в печать 29.09.2023 г.
Электронное издание
29.9 Mb RAM
Усл. печ. л. 22,2. Тираж 300 экз. Цена договорная.
Компьютерная верстка: А. К. Мыржикова
Корректор: А. Р. Омарова, Д. А. Кожас
Заказ № 4140

«Toraighyrov University» баспасынан басылып шығарылған
Торайғыров университеті
140008, Павлодар қ., Ломов к., 64, 137 каб.

«Toraighyrov University» баспасы
Торайғыров университеті
140008, Павлодар қ., Ломов к., 64, 137 каб.
67-36-69
E-mail: kereku@tou.edu.kz
www.vestnik-energy.tou.edu.kz