RESEARCH OF USING THE ALTERNATIVE FUELS FOR IMPROVING THE INDICATORS OF THE TRACTOR DIESEL WORK

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***Topicality**: The urgency of the issue under consideration is stipulated by large-scale international research and is confirmed by the Russian Federation Government Decree No. 1-P of 08.01.2009 "Main Directions of State Policy in the Sphere of Energy Efficiency Improvement on the Basis of Using Renewable Energy Sources for the Period to 2020" and the Decree of the President of the Russian Federation from July 7, 2011 № 899 on priority directions of development of science, technology and technics in the Russian Federation.*

According to the analytical agency "AUTOSTAT", as of 2017 there are 3.7. million of trucks in the Russian Federation, of which the ecological standards "Euro-4" (and above) correspond only 14%, and annually are used more than 20 million tons for freight transport, which in the amount of processing oil to diesel gas oil is more than 70 million tons of diesel gas oil . From the above, it can be concluded that in order to solve the fuel issue and preserve the environment, it is necessary to study the performance of the diesel engine using diesel composite fuel and transfer of transport to alternative fuels.

As a raw material for the production of alternative fuels is attractive biomass, such as oilseeds and waste from processing plants.

As a result of the growing demand for ricinic oil by industry, it is necessary to study its application as a component for the production of diesel composite fuel.

However, the viscosity of ricinic oil is higher than that of diesel gas oil, so it can only be used as an additive to low-viscosity components. As a result of the addition of diesel fuel and bioethanol to ricinic oil, with preliminary preparation, decreases viscosity and are improved low-temperature properties. This mixture can be suitable for use on transport-technological machines, the point of view of qualitative spraying in areas with a moderate climate.

Based on the thermal calculation of the engine by the methods of Prokopenko R.M., Khorosh A.I., Bashirova R.M., are determined the parameters of the working cycle of the engine D-240 and are presented below the dependences on the concentrations of the components.

The article compares the obtained results with the indicators of traditional diesel gas oil.

***KEY WORDS:** DIESEL COMPOSITE FUEL (DCF), DIESEL, INTERNAL COMBUSTION ENGINE, MIXTURE, POWER, ECONOMY, ALTERNATIVE TYPE OF MOTOR FUEL, RICINIC OIL, CASTOR OIL, BIOETHANOL.*

1. INTRODUCTION.

In modern times, the development of motor – and - tractor technics is greatly influenced by:

• toughening of environmental norms on emissions of toxic substances;

• methods for increasing energy efficiency.

Today, the Russian Federation produces more than 100 million tons of motor fuel produced in the traditional way from oil (Figure No. 1) [2];

At the same time, the dynamics of reserves growth due to revaluation and geological exploration remains at the level of 2007 and 2008, which means that with an intensive increase in the number of stationary and mobile consumers of petroleum products, the demand for petroleum products may exceed the growth dynamics of reserves. As a result, there will be an intensive decrease in the world reserves of oil deposits. [2]

Therefore, one of the main ways of developing agricultural and logging production can be considered a partial transfer to alternative fuels from biomass. This will solve the problem of replacing petroleum fuel, significantly expand the resource base for fuel production, facilitate the solution of fuel supply issues for vehicles and fixed installations remote from large settlements. This can reduce the prime cost of production, subject to the independent production of components of the DCF or in cooperation with other manufacturers. [13,14]

As a raw material is attractive biomass for obtaining an alternative fuel, such as oilseeds and waste from the processing industry.

As a result of growing demand for ricinic oil, which is used in many industries, and the resumption of research in the Russian Federation aimed at selecting and processing castor oil plant, there is a need to investigate ricinic oil and bioethanol as biocomponents for the production of diesel composite fuel. [14,15]

However, the viscosity of ricinic oil is higher than that of diesel gas oil, therefore ricinic oil can only be used as an additive to low-viscosity components. As a result of the addition of diesel fuel and bioethanol to ricinic oil, with preliminary preparation, decreases viscosity and are improved low-temperature properties.

According to the results of numerous studies, was revealed a decrease in the toxicity index of the exhaust gases of the engine, while operating with the DCF. This becomes very important at the present time.

2. RESEARCH OF WORK INDICATORS OF TRACTOR DIESEL ENGINE.

For using DCF on the basis of bioethanol and ricinic oil produced from castor oil plant, was made a study of the effect of the constituent components on the economic, power performance of the diesel engine operating cycle.

The parameters of the D-240 engine performance were studied using 7 mixtures with different component ratios: diesel gas oil (DO) + ricinic oil (RicO) + alcohol (Al), respectively (mixture 1, mixture 2, mixture 3, mixture 4, mixture 5, mixture 6, mixture 7) according to Prokopenko R. M., Horosh A.I., Bashirova R.M. [9,10,11] presented in Table 3.

For calculation, it is necessary to determine the content of the basic substances in ricinic oil according to the method of Egazaryants C.B. [12] and calculate the elementary composition of the mixture, which is determined by the content of C, H, O by the Mendeleev D.I. formula and compared with similar mixtures studied without the addition of bioethanol.

Table No. 2- Elementary composition of mixtures.

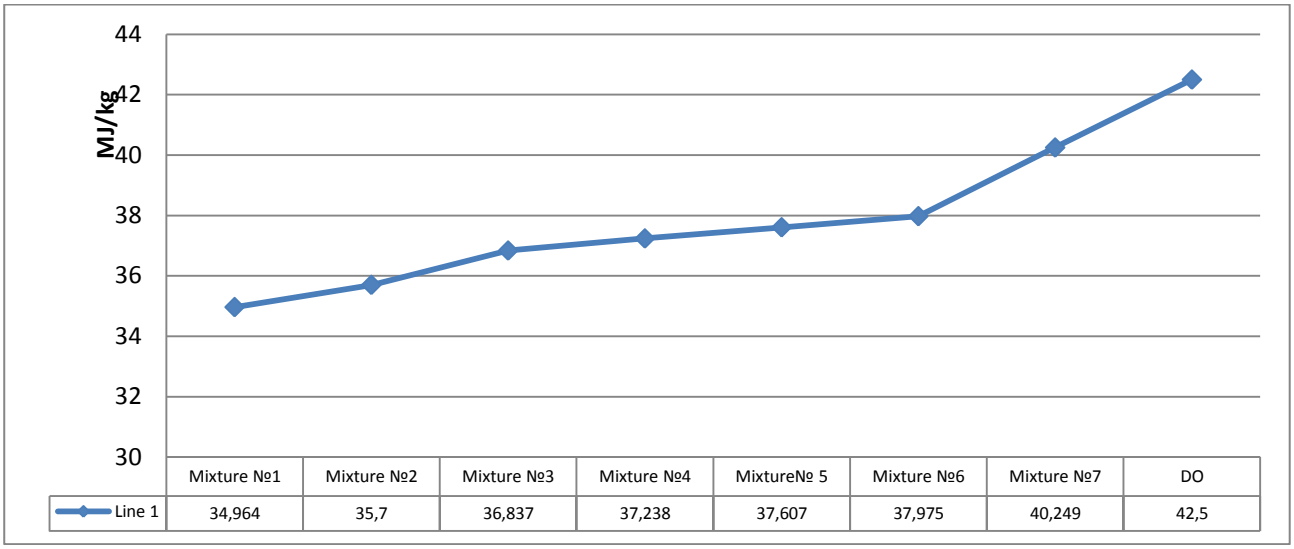
№	Indicators	Carbon C	Hydrogen H	Oxygen O
1.	DO444	0,870	0,126	0,004
2.	Mixture 1 RicO+DO	0,8495151	0,1239453	0,0265396
3.	Mixture 2 RicO+DO	0,8426868	0,1232604	0,0340528
4.	Mixture 3 RicO+DO	0,8358585	0,1225755	0,041566
5.	Mixture 1	0,7032584	0,1253704	0,1713712
6.	Mixture 2	0,7244589	0,1234731	0,152068
7.	Mixture 3	0,74871575	0,12389425	0,12739
8.	Mixture 4	0,7517721	0,1262127	0,1220152
9.	Mixture 5	0,76237235	0,12526405	0,1123636
10.	Mixture 6	0,7729726	0,1243154	0,102712
11.	Mixture 7	0,8214863	0,1251577	0,053356

From the obtained data, it can be seen that the addition of bioethanol increases the amount of oxygen and hydrogen in the elemental composition of the mixture. The study of the mixture viscosity revealed that it is possible to increase the proportion of ricinic oil without adversely affecting the quality of the spray by adding bioethanol.

Table № 3 - Indicators of the working cycle of a diesel engine using mixtures of different concentrations.

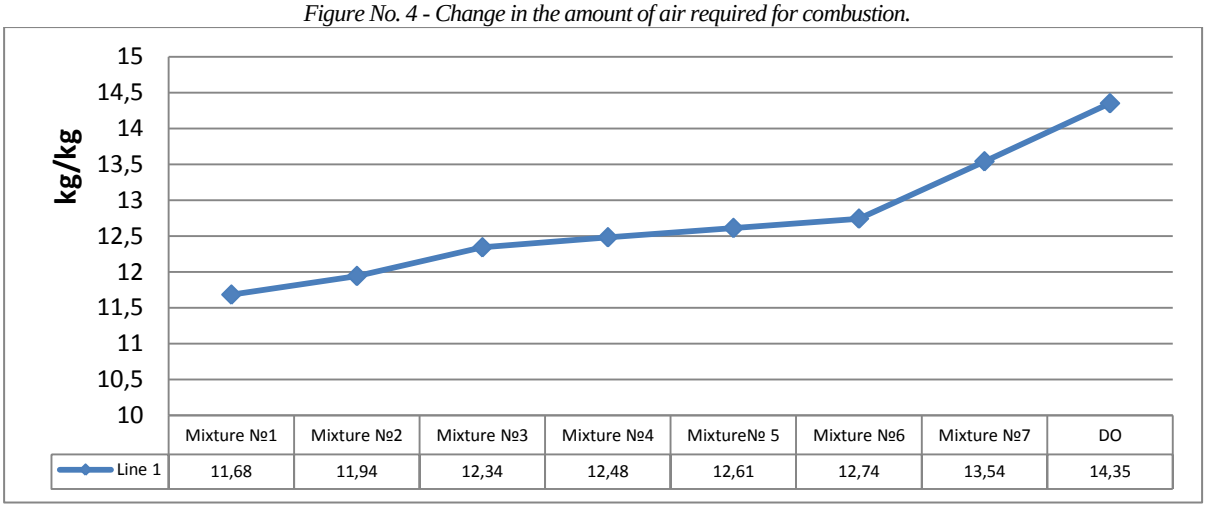
№	Indicators	DO	Mixture 1	Mixture 2	Mixture 3	Mixture 4	Mixture 5	Mixture 6	Mixture 7
	1	2	3	4	5	6	7	8	9
1.	Heat of fuel combustion , MJ / kg	42,5	34,964	35,702	36,837	37,238	37,607	37,975	40,249
2.	Amount of air, kg \ kg of fuel	14.35	11,68	11,94	12,34	12,48	12,61	12,74	13,54
3.	Index of molecular change	1,041	1,0589	1,0559	1,0531	1,0531	1,0518	1,0505	1,0456
4.	Combustion temperature, ^{0}K	2158,0	2149,53	2153,28	2157,4	2156,07	2157,77	2159,3	2165
5.	Mean effective pressure, MPa	0.7233	0,718	0,71	0,716	0,715	0,714	0,714	0,711
6.	Effective coefficient of efficiency	0.363	0,353	0,338	0,352	0,352	0,352	0,352	0,351
7.	Effective flow density	233,3	291,48	282,7	276,86	274,114	271,54	269,04	254,15
8.	Effective power, kW	63,0	62,61	62,48	62,38	62,307	62,245	62,18	61,93
9.	Change in power,%	-	- 0,62%	-0,83%	- 0,98 %	- 1,1%	-1,2%	- 1,302%	-1,7%
10.	Change in specific fuel consumption,%	-	+24,94%	+ 27,68%	+ 18,67%	+ 17,49%	+16,36%	+ 15,32%	+8,94%

Figure No. 3 - Change in the heat of fuel combustion.



It can be seen that the high content of alcohol significantly influences the reduction of the heat of the fuel combustion, for example, a mixture of 80% DO and 20% RicO has a combustion heat of 40.986 MJ / kg, and a similar mixture with an alcohol of 80x10x10 already has 40.24 MJ / kg. Due to the addition of bioethanol, the viscosity of the mixture and the low-temperature properties are significantly reduced: the turbidity and crystallization temperature decreases and makes it suitable for use in standard diesel power systems, in terms of quality spraying. [5,8]

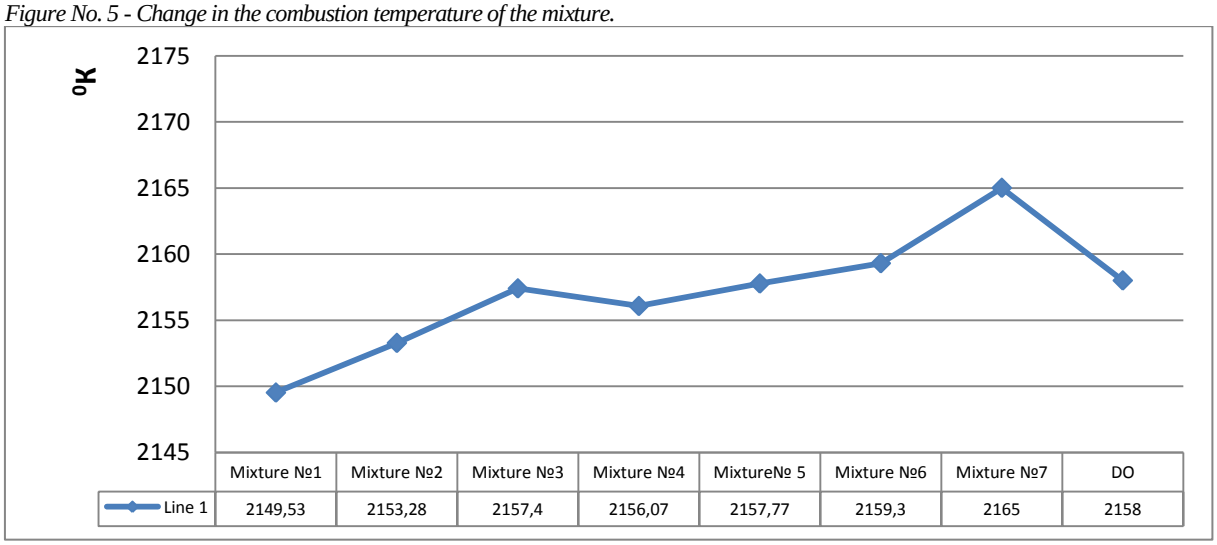
Figure No. 4 - Change in the amount of air required for combustion.



An important feature of the addition of bioethanol in diesel composite fuel mix is the reduction in the required amount of air for firing 1 kg of fuel. From this it can be concluded that for the transfer of the diesel internal combustion engine (ICE) with the system without adjusting the amount of air supplied, it is necessary to modernize the air supply system of the internal - combustion engine.

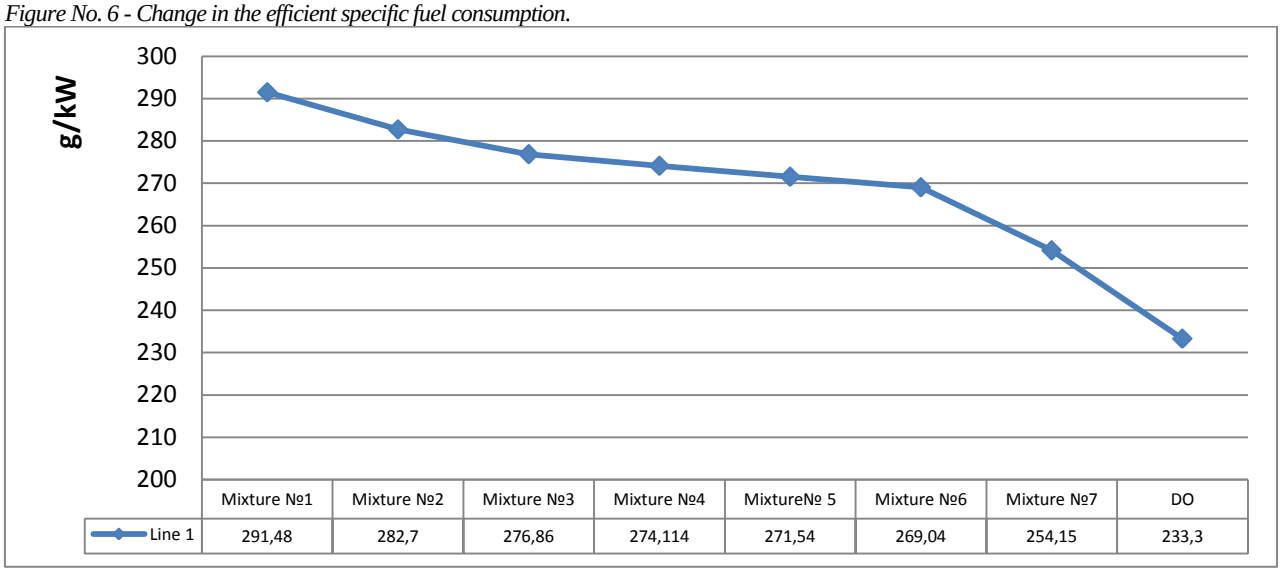
Thus, it is possible to operate the ICE on a depleted fuel-air mixture without modernization, which affects negatively the response of the piston diesel ICE. It is necessary to change the amount of supplied air depending on the added components concentrations.

Figure No. 5 - Change in the combustion temperature of the mixture.



Increasing the proportion of bioethanol also affects the combustion temperature. According to calculations, it was revealed: the lower the amount of diesel fuel is and the higher the amount of alcohol is, the lower the combustion temperature of the mixture is. But with the addition of not more than 25% of the biocomponents, the combustion temperature rises according to the made calculations.

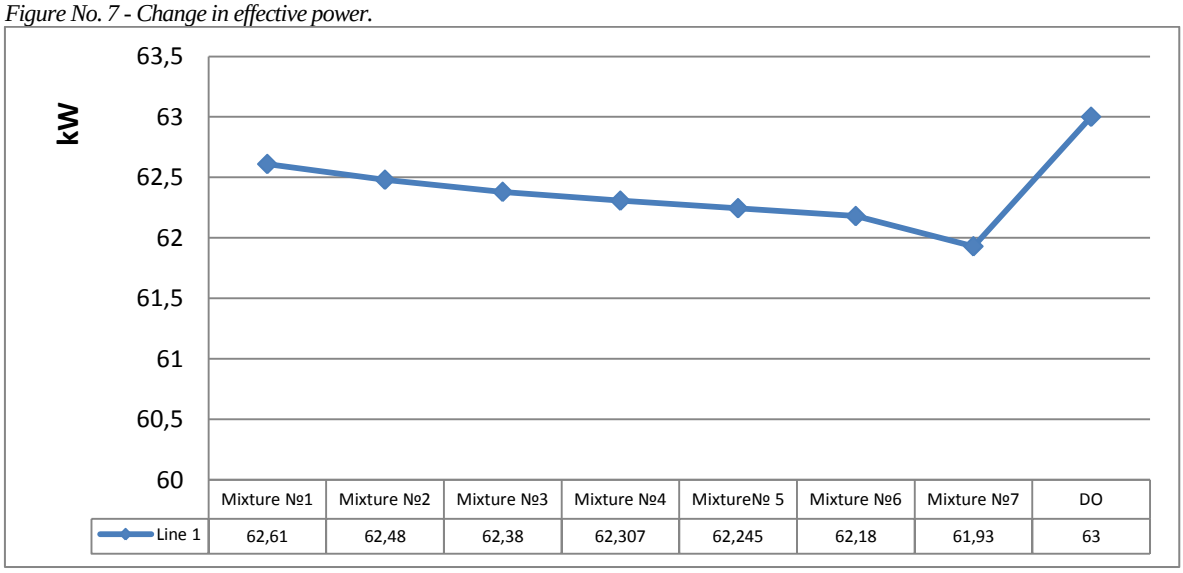
Figure No. 6 - Change in the efficient specific fuel consumption.



According to the schedule, a significant increase in the specific fuel consumption is affected by an increase amount of bioethanol.

If we compare the mixture with the 60% content of DO, it can be seen that the specific consumption increases on average by 2.5 g / kW with a change in the alcohol content for every 5%.

Figure No. 7 - Change in effective power.



But the presence of alcohol favorably influences the performance of ICE, so based on the obtained data on the example of mixtures with a 60% content of DO, it is evident that when the alcohol content is changed by 5%, the effective power increases on the 62-70 W.

3. CONCLUSIONS

1. As a result of reducing the required amount of air for combustion of mixture, occurs a significant change in the α coefficient - a coefficient of air excess;

2. The addition of bioethanol makes it possible to increase the proportion of ricinic oil in the mixture without adversely affecting the quality of the spray;

3. The increased share of biocomponents allows increasing the autonomy of the enterprise and reducing the cost of products;

4. The specific consumption increases by an average on 2.5 g / kW with a change in alcohol increase by every 5%;

5. With an increase in the content of alcohol for every 5%, the effective power increases by an average on 62-70 W, compared to similar proportions of RicO and DO without the addition of alcohol.

6. It was found that the lower the amount of diesel gas oil is and the higher the amount of alcohol is, the lower the combustion temperature of the mixture is. But with the addition of not more than 25% of the biocomponents, the combustion temperature rises according to the performed calculations.

4. CONSEQUENCE.

A multicomponent diesel composite fuel made from castor oil plant and traditional petroleum feedstocks can be used to solve the problems of oil fuel substitution. It is more advantageous to use it at enterprises situated far from large settlements, in connection with which it is possible to achieve a reduction in the cost of production, provided that the components are produced independently or in cooperation with other producers.

5. CONFLICT OF INTEREST

The authors confirm that the presented data do not contain a conflict of interest.

6. GRATITUDES

The work was prepared with the support of the Ural State Agrarian University in Ekaterinburg.

7. REFERENCES

1. Markov Vladimir Anatolievich, Devyanin Sergey Nikolaevich, Kaskov Sergey Iosifovich Optimization of the composition of mixtures of petroleum diesel fuel with vegetable oils // Izvestiya Vuzov. Mechanical engineering. 2016. № 7 (676). URL: https://cyberleninka.ru/article/n/optimizatsiya-sostava-smesey-neftyanogo-dizelnogo-topliva-s-rastitelnymi-maslami (дата обращения: 05.03.2018).
2. 2. State report On the state and use of the Mineral Resources of the Russian Federation in 2015 / A.V. Akimova, N.A. Vasilkova, L.A. Dorozhkina D.R. // Compilation - FGBU "VIMS" Moscow 2016 p. 339
3. Ukhanov A.P., Ukhanov D.A., Adgamov I.F. Investigation of the properties of biological components of diesel mixed fuel // Niva of the Volga Region. 2014. № 1 (30).URL: https://cyberleninka.ru/article/n/issledovanie-svoystv-biologicheskih-komponentov-dizelnogo-smesevogo-topliva (дата обращения: 05.03.2018).
4. Pankov Yu.V., Novopashin L.A., Denezhko L.V., Sadov A.A. Quantitative relationships and properties of mixed hydrocarbon composition systems for a diesel engine // Agrarian Bulletin of the Urals. 2016. No. 12 (154). P. 72-76.
5. Ukhanov DA, Adgamov IF Results of motor studies of diesel d-243-648 when working on safflower-mineral fuel // In the collection: EDUCATION, SCIENCE, PRACTICE: INNOVATIVE ASPECT Collected materials of the International Scientific and Practical Conference dedicated to the Day of Russian Science. The Penza State Agricultural Academy. 2015. P. 76-80.
6. Denezhko L.V., Novopashin L.A., Asanbekov K.A. Investigation of rapeseed mixtures of various compositions in a tractor diesel // Agrarian Herald of the Urals. 2015. No. 1 (131). Pp. 53-54.
7. Prokopenko, N.I. Experimental studies of internal combustion engines [Electronic resource]: Proc. allowance / N.I. Prokopenko. - Electron. Dan. - St. Petersburg: Lan, 2010. - 592 p. - Access mode: https://e.lanbook.com/book/611. - Ver. from the screen.
8. Bashirov R.M. Autotractor engines: design, theory and calculation basics [Electronic resource]: Proc. - Electron. Dan. - St. Petersburg: Lan, 2017. - 336 p. - Access mode: https://e.lanbook.com/book/96242. - Ver. from the screen.
9. Khorosh A.I. Diesel engines of transport and technological machines [Electronic resource]: Proc. allowance / A.И. Good, I.A. Good. - Electron. Dan. - St. Petersburg: Lan, 2012. - 704 p. - Access mode: https://e.lanbook.com/book/4231. - Ver. from the screen.
10. 10. Egazaryants C.B. Separation and. analysis of diesel oil fuels on cationized silica gel by high-performance liquid chromatography. / / Petrochemistry. 2009. - T. 49. - № 2. - P. 172.
11. V. Popa, I. Volf Biomass as Renewable Raw Material to Obtain Bioproducts of High-Tech Value 1st Edition Elsevier Radarweg 29, Box 211, 1000 AE Amsterdam, Netherlands The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom 50 Hampshire street, 5th Floor, Cambridge, MA 02139, United States Copyright 2018 Page Count: 492 URL: https://www.elsevier.com/books/biomass-as-renewable-raw-material-to-obtain-bioproducts-of-high-tech-value/popa/978-0-444-63774-1 (дата обращения: 02.03.2018).
12. T. McKeon, D. Hayes Industrial Oil Crops 1st Edition Academic Press and AOCS Press 2016 Page Count: 474 URL: https://www.elsevier.com/books/industrial-oil-crops/mckeon/978-1-893997-98-1 (дата обращения: 03.03.2018).
13. S. Stout Z. Wang Standard Handbook Oil Spill Environmental Forensics 2nd Edition Imprint: Academic Press 2016 Page Count: 1142 URL: https://www.elsevier.com/books/standard-handbook-oil-spill-environmental-forensics/stout/978-0-12-803832-1 (дата обращения: 07.03.2018).
14. P. Poltronieri O. D'Urso Waste and By-Products 1st Edition Imprint: Elsevier, 2016 Page Count: 398 URL: https://www.elsevier.com/books/biotransformation-of-agricultural-waste-and-by-products/poltronieri/978-0-12-803622-8 (date: 06.03.2018).