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## TESTING OF REGENERATED SAE 15W-40 DIESEL OIL UNDER OPERATIONAL CONDITIONS

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### Abstract

This article presents information on the global consumption of mineral diesel oils and their environmental impact. Additionally, it provides the results of tests conducted on regenerated SAE 15/40 diesel oil under operational conditions. By analyzing the results, it was established that after the operation of regenerated SAE 15/40 and fresh SAE 15/40 oils in engines at a distance of 3000 km, regenerated SAE 15/40 oil was several points better than fresh SAE 15/40 oil in terms of kinematic viscosity, viscosity index, freezing point, and color index on the colorimeter, and still meets the standard requirements, and also has a useful and reliable service life. **Keywords:** *diesel oil, ecology, mineral oils, bentonite, technology, additive, oxidation, regeneration, viscosity index*

### Introduction

Currently, there are three popular methods for waste disposal. The first is the processing of waste by collecting it separately. This method is widely used in developed countries – the USA, Western Europe, Japan. Another way to dispose of waste is to burn it at waste incineration plants. This method poses a serious threat to the environment. When waste is burned this way, hazardous and toxic substances enter the environment. The equipment required to build a modern waste incineration plant with minimal environmental damage is also very expensive. Two hundred and fifty tons of high-quality lime, activated charcoal, and modifiers are used in just one month to remove toxins from

combustion products. As a result, the cost of waste disposal at such a plant also increases. For residents to be able to pay such a price for garbage collection and removal, city authorities will have to subsidize municipal services involved in garbage collection and removal. Separate recycling of waste is currently the most promising. Currently, waste utilization is carried out by burning it at waste incineration plants (Fatkullin D. D., 2019). What are used lubricants? Used lubricants are any oils obtained from petroleum or synthetic oils that have been used and contaminated with physical or chemical impurities as a result of their use. In other words, used oil is any lubricant obtained from oil or synthetic oil. During oil use, impurities such as metal

particles, sludge, water, or chemicals can eventually mix with the lubricant, rendering it unusable (Danilov A. M., 1996).

During the operation of oils in machines and technologies, oxidation products, contamination products, and other impurities accumulate in them, which sharply reduces the quality of oils. Oil containing pollutants cannot meet the requirements for them, and it is necessary to replace it with new oil early. Used oils are collected and processed to preserve valuable economically useful raw materials. During the year, about 30 million people live in the territory of the Republic of Uzbekistan. tons of used oils were collected, 6 million tons. tons, that is, 20% (Fatkul- lin D. D., 2019; Danilov A. M., 1996). The necessity of utilizing MSW (used lubricants) currently raises no doubts, as their burial and destruction (mainly by burning) create even greater environmental problems per hour than the MSW itself, and with significant costs, do not allow for the reuse of valuable secondary raw materials, which is already unprofitable from an economic point of view. At the same time, it is very important that the utilization processes themselves do not pose a significant threat to the biosphere (Fatkul- lin D. D., 2019, 2–5).

As already noted, the most rational direction in solving modern environmental problems is the practical implementation of the concept of pollution prevention, since the colossal costs of eliminating the resulting pollution and the impossibility of foreseeing and eliminating all its consequences entirely fully justify the development of new, safer technologies and the creation of fundamentally new equipment ((Fatkul- lin D. D., 2019; Potashnikov Yu.M., 2004). As in the main industries, in the field of secondary raw materials processing, more and more specialists are expressing their support for abandoning traditional methods of combating pollution by installing cleaning equipment at the end of the technological chain. The task of solving environmental problems in the production process, based on fundamentally new technological solutions, is put forward (Ye- vdokimov A.Yu., 2005). The ideal embodiment of this idea is the creation of industrial enterprises with minimal emissions. Since the occurrence of waste in industrial produc-

tion cannot be avoided, as it is impossible to avoid thermodynamically determined losses of matter and energy and completely process raw materials into desired products, the creation of enterprises of this type provides for a system of technological processes that ensure the integrated use of raw materials and energy, when the by-products and waste of one process are raw materials or reagents of another. Complex processing of raw materials includes capturing, separating, and processing all waste into finished products or relatively environmentally safe substances suitable for safe burial (Fatkul- lin D. D., 2019; Gayevik D. T., 2000).

Comprehensive use of raw materials – the most complete, economically and environmentally justified use of all useful components contained in raw materials, as well as in production waste; at the same time, the maximum output of products at each stage of processing is assumed, which increases production efficiency and reduces waste generation (Fatkul- lin D. D., 2019; Khamidov B. N., Khuzhakulov A. F., Abdunazarov A. A., 2020). Based on the foregoing, the currently existing term “waste-free or environmentally harmless (pure) technology” should hardly be considered successful. Any technology is inherently and objectively opposed to the biosphere and therefore cannot but pose a threat to it (to a greater or lesser extent). The term “low-waste technology” seems most acceptable – such a method of producing products where the harmful impact on the environment does not exceed the level permitted by sanitary and hygienic standards, while for technical, economic, organizational, or other reasons, part of the raw materials and materials passes into unused waste and is sent for long-term storage or burial (Fatkul- lin D. D., 2019; Khuzhaku- lov A. F., Khamidov B. N., 2020).

### **Materials and methods**

The most important condition for organizing low-waste production is the presence of a system for neutralizing unused waste, primarily toxic waste. At the same time, the impact of waste on the environment should not exceed the maximum permissible concentrations (Fatkul- lin D. D., 2019; Khu- zhakulov A. F., Khamidov B. N., 2020).

The following ways to create low-waste technologies have been identified:

- 1) complex processing of raw materials;
- 2) development of fundamentally new processes and schemes for obtaining known types of products;
- 3) designing drainless and closed water consumption systems;
- 4) industrial waste recovery;
- 5) development and creation of territorial-industrial complexes with a closed structure of material flows of raw materials and waste.

Summarizing all this, it should be noted that mineral resource recycling, like any technogenic system, cannot be a solution to environmental problems, as it requires the expenditure of energy and substances, the production and use of which, in turn, leads to environmental pollution and degradation. The energy expended in this process cannot be reused; by disposing of some waste, we obtain others, sometimes even more dangerous ones, and create new environmental problems. The way out, we repeat, is found only in the spiritual sphere (Fatkul'in D. D., 2019, 4–12). Environmentally safe use of MSM involves their processing to obtain commodity products of various purposes (fuel, oils, plastic lubricants, preservation materials, etc.). Analysis of the current state of the issue indicates that it is practically unresolved both in theory and practice. Only some processes of processing and direction and use are exceptions. However, there is undoubtedly a trend towards low-waste utilization of MSM worldwide, driven by the increasing number of environmental problems (Fatkul'in D. D., 2019; Khuzhakulov A. F., Khamidov B. N., 2020).

In modern technical literature, when considering the issue of restoring the quality of MSW, various terms are used – purification, regeneration, secondary processing. Therefore, it is important to clearly distinguish the purpose and areas of application of these processes. By “cleaning,” we mean the continuous or periodic cleaning of the operating lubricant in the operating equipment, carried out using settling tanks, filters, centrifuges, and adsorbers. Such purification does not always lead to the production of a product corresponding in quality to the level of fresh lubricant. Often, this is not required due to operating conditions. Such

measures contribute not only to the rational disposal of MSW but also to extending the service life of lubricants. Cleaning operating oils without draining them from the equipment is only possible if there are circulating lubrication systems for a number of motor, industrial, and turbine oils and for practically all transformer oils (Fatkul'in D. D., 2019, 7–12). In the case of processing mixtures of various used petroleum oils (ONMs) collected centrally from industrial enterprises, the term “secondary processing” is used. From such raw materials, it is possible to obtain base oils of various compositions and purposes. Secondary processing is only possible at large specialized enterprises and involves the use of a complex of processes – vacuum distillation, extraction, hydrotreating, and some other physical and chemical methods (Fatkul'in D. D., 2019; Fuchs I. G., 2002). The main place in solving the problem is occupied by the ONMs. The industry of purification and regeneration of used synthetic oils also begins to develop. A significant number of experimental studies on the utilization of used plastic lubricants are known, however, their practical application is difficult due to a number of factors. The most important problem is the disposal of used environmentally safe lubricants based on synthetic oils and natural fats (Fatkul'in D. D., 2019, 6–12).

Western European countries hold a leading position in the processing of used oil, where highly developed processing industries have been established, and a number of technological processes continue to be improved. To a certain extent, the development of processing technologies is mainly aimed at neutralizing the environmentally hazardous components of used petroleum oils (Fatkul'in D. D., 2019, 2–5). Oil oils occupy a leading position in the production of lubricants. Oil oil production continues to increase, which, in turn, leads to an increase in the volume of used oils. In all industrially developed and developing countries, large-scale collection, purification, utilization, and processing of used oils are carried out, their resources account for about 50% of the consumption of new oils, and used petroleum oils account for about 30% of all petroleum waste (Danilov A. M., 1996).

**Results and discussion**

SAE 15/40 grade mineral diesel oil is used in internal combustion engines operating on diesel fuel used in production enterprises, particularly in mining and metallurgical industry enterprises producing ferrous and non-ferrous metals, and is replaced in

engines at distances of 3000 km. The results of studies to determine the physicochemical properties and composition of the spent samples of SAE 15/40 grade mineral diesel oil, treated with NaOH and regenerated with “Navbahor” bentonite, are presented in Table 1.

**Table 1.** *Physicochemical properties of the used samples of SAE 15/40 mineral diesel oil, treated with NaOH and regenerated with Navbakhor bentonite*

Name indicators	Oil SAE 15/40	Indicator value		
		Sample No. 1 used oil SAE 15W-40	Sample No. 2 oil SAE 15/40 treated with NaOH	Sample No. 3 oil SAE 15/40 regenerated with Navbakhor bentonite
1. Density 20 °C, kg/m <sup>3</sup> , GOST 3900	887	865	868	887
2. Kinematic viscosity at 100 °C, mm <sup>2</sup> /s GOST 31391	14,1	13.45	13.87	14.1
3. Viscosity index, GOST 25371	120	114	117	120
4. Water quantity, % GOST 2477	absent	0.1	0,03	absent
5. Flash point in an open crucible, °C, GOST 4333	220	212.9	206.9	221
6. Content of water-soluble acids and alkalis, GOST 6307	absent	absent	Water-soluble alkalis are present	absent
7. Mechanical impurities, % GOST 6370	absent	0.2	absent	absent
8. Freezing temperature, °C GOST 20287	-27	-18	-21	-27
9. Sulfate ash content, % GOST 1461	0.8	0.9	0.8	0.8
10. Alkaline number, mg KOH/g, not less than	6.0	6.1	6.8	6.0

The main operational properties of SAE 15/40 grade diesel oil regenerated with Navbakhor bentonite were studied under laboratory conditions at JSC “Neftgaztdiqot.” At the same time, its kinematic viscosity at 100 °C is 14.1 mm<sup>2</sup>/s, freezing point is -27 °C, alkaline number is 7.0 mg KOH/g, density at 20 °C is 887 kg/m<sup>3</sup>, viscosity index is 120, ignition temperature in an open cru-

cible is 221 °C, sulfate ash content is 0.8%, results meeting the established requirements were obtained. 20 liters of regenerated SAE 15/40 diesel oil was tested from June 25, 2025, to July 25, 2025, on trucks belonging to the “Drilling Operations Department” OJSC. MAN CLA 37.280 trucks equipped with a German 4-speed D0836 LFL13 turbocharged diesel engine, manufactured by

the Uzbek-German joint venture “JV–MAN AUTO,” were selected for testing.

The testing process was conducted under moderate difficulty conditions. The selected MAN CLA 37.280 truck engines were fueled with regenerated Navbakhor bentonite and SAE 15/40 brand fresh oil and operated un-

der the same conditions. After traveling 3000 km, samples of used motor oils were taken and their physical and chemical properties were studied in the 17<sup>th</sup> testing laboratory of the Fergana Oil Refinery. The research results are presented in Table 2.

**Table 2.** Results of tests of used and fresh SAE 15/40 diesel oils under operating conditions

No.	Name of indicators	Norm according to Ts 05767930–240:2014	Re-generated SAE 15/40, 0 km	Regenerated SAE 15/40, 3000 km	Fresh SAE 15/40, 0 km	Fresh SAE 15/40, 3000 km	Fresh SAE 15/40, 4000 km	Fresh SAE 15/40, 4500 km
1.	Kinematic viscosity, at temperature, 100 °C, mm <sup>2</sup> /s	13.5–14.5	13.9	14.5	14	15.2	14.9	15.5
2.	Viscosity index	no more than 85	126	121	92	82	117	104
3.	Flash point in an open crucible, °C	no more than 220	220	221	227	231	227	22
4.	Alkaline number, mg KOH/g	no more than 6.0	6.8	6.5	7.15	6.8	6.2	5.8
5.	Freezing temperature, °C	no more than –15	–21	–19	–19	–15	–17	–14
6.	Color on the colorimeter, with dilution of 15:85, units. CNT	no more than 4,0	1.0	2	3	4.5	2	3
7.	Density, at 20 °C, kg/m <sup>3</sup>	no more than 910	883	889	888	893	893	897
8.	Sulfate ash content, %	no more than 1.15	0.8	1.05	0.9	1.2	1.1	1.4

### Conclusion

Analyzing the results of this table, it was established that after the operation of regenerated SAE 15/40 and fresh SAE 15/40 oils in engines at a distance of 3000 km, regenerated SAE 15/40 oil was several points better than fresh SAE 15/40 oil in terms of kinematic viscosity, viscosity index, freez-

ing point, and color index on the colorimeter, and still meets the standard requirements, and also has a useful and reliable operating life. It has been proven that the operational quality indicators of the obtained oil sample meet the requirements for modern diesel oils and meet operational requirements.

### References

Fatkullin D. D. Technology of Processing Used Mineral Oil / D. D. Fatkullin. – Text: immediate // Young Scientist. 2019. – No. 9 (247). – P. 106–108. – URL: <https://moluch.ru/archive/247/56903>

- Danilov A. M. Additives and Supplements. Improving the Environmental Characteristics of Petroleum Fuels, – M.: Chemistry, 1996. – 231 p.
- Potashnikov Yu. M. Utilization of Production and Consumption Waste Study Guide. – Tver.: TDTU Publishing House, 2004. – 107 p.
- Yevdokimov A. Yu. Lubricants 2005.
- Weisberg L. A. et al. New technologies for processing household and industrial waste, “Secondary Resources”. – No. 5–6. 2001. – P. 45–51.
- Murray Robin. Zero Waste (“Zero Waste”). Ecology and Life, – No. 6 (44) 2004.
- Shkolnikova V. M. Fuel, lubricants and technological fluids. – Moscow, “Higher School”. 1998.
- Fuchs I. G. Plastic Lubricants. – Moscow, “Higher School”. 2002.
- Gayevik D. T. Lubrication of Equipment at Metallurgical Enterprises. – Moscow, 2000.  
URL: <https://ecoportal.su/public/waste/view/1560.html>
- Khamidov B. N., Khuzhakulov A. F., Abdunazarov A. A., (2020). “Methods for cleaning spent Tp-22s turbine oil from undesirable components,” Scientific and Technical Journal of Namangan Institute of Engineering and Technology: – Vol. 2. – Issue. 10. – Article 12.  
URL: <https://namdu.researchcommons.org/journal/vol2/iss10/12>.
- Khuzhakulov A. F., Khamidov B. N., Methods for cleaning turbine oil from unwanted components of the TP-30 turbine// “XVI–International Scientific and Practical Conference “Spitzenforschung – 2020”. Warsaw May, 7. 2020. – 122 p.

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