Increasing environmental safety, increasing service life of ice units and assembly and saving fuel consumption through application of multifunctional fuel additives

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Abstract. This article presents the results of studies on the use of multifunctional diesel fuel additives, which will reduce harmful emissions of NOx, COx, SOx into the environment by improving the operational and environmental characteristics of the original fuel and converting harmful emissions of nitrogen oxides, carbon, and sulfur into useful energy, optimize fuel consumption and increase the performance and service life of ICE units and components without changing the indicators (requirements) of State Standard for fuel, achieve diesel fuel savings of 3-5% of the total fuel consumed.

1 Introduction

One of the main mechanisms of the economy of countries is vehicles and mechanisms, which, in turn, operate solely due to the expenditure of energy resources (fuel and lubricants).

For the successful functioning of any industrial enterprise, it is extremely necessary to use fuel and energy resources efficiently and implement energy-saving measures that can significantly reduce the cost of producing commercial products.

Saving energy resources and reducing emissions of harmful gases into the environment is one of the pressing issues in the world and in our Republic. According to the law of the Republic of Uzbekistan, "On the rational use of energy," the main directions of state policy in the field of rational use of energy are:

1-creation of energy efficient and energy saving zones for the implementation of energy efficiency projects;

2-optimization of energy production and consumption modes, organization of its accounting, and following the Decree of the President of the Republic of Uzbekistan No. DP-5863, dated October 30, 2019, "On approval of the concept of environmental protection of the Republic of Uzbekistan until 2030", consistent work is being carried out in the country in the field ensuring environmental protection, rational use of natural resources, improving the sanitary and environmental situation [1-4].

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The rapidly growing global fleet of fuel-consuming technicians is a major source of air pollution and climate change.

By 2020, according to a UN study, the world's transport sector accounts for almost a quarter of global energy-related greenhouse gas emissions. In particular, vehicle emissions, the main cause of urban air pollution, are a significant source of fine particulate matter (PM2.5) and nitrogen oxides (NOx) [5-6].

To achieve energy savings and reduce the number of emissions of harmful gases into the environment, it is necessary to find innovative solutions to problems. Currently, scientists in the world have developed various multifunctional additives that are added to fuel and can significantly save fuel consumption and reduce the number of harmful emissions of NOx, COx, SOx into the environment by improving the operational and environmental characteristics of the original fuel and converting harmful emissions of nitrogen oxides, carbon and sulfur into useful energy and optimize fuel consumption and increase the performance and service life of ICE units and assemblies.

The Navoi Mining and Metallurgical Company (NMMC JSC), which is one of the ten leading world gold producing companies, is the largest mining enterprise in the Republic of Uzbekistan and has more than 3,000 units of fuel-consuming vehicles and mechanisms on its balance sheet; it was decided to conduct pilot tests of a multifunctional fuel attach LNC $MiaNO_X^R$ made in Germany [7-10].

The purpose of the test. Determination of the effectiveness of the use of the LNC $MiaNO_X^R$ additive to diesel fuel to achieve savings in diesel fuel consumption and reduce harmful environmental emissions.

Object and place of the test. Heavy-duty dump truck of Komatsu HD465-7R brand, quarry of the Central Mining Administration of "Navoi MMC" JSC.

2 Methods

A Komatsu HD465-7R heavy-duty mining dump truck with a payload capacity of 55 tons was chosen to conduct control measurements of the actual consumption of diesel fuel and verify exhaust gases. A complete diagnosis of the technical condition of the tested heavy-duty mining dump truck was carried out, during which it was determined that the selected heavy-duty mining dump truck was technically sound. A control measurement was made of the actual consumption of diesel fuel when performing a certain amount of work by filling the mining dump truck with diesel fuel before and after the work was performed. The exhaust gases of this mining truck were checked without using the LNC $MiaNO_X^R$ additive.

Further, for more than one week, a control measurement of the actual consumption of diesel fuel was carried out when performing a certain amount of work by filling the mining dump truck with diesel fuel before and after the work was completed. The exhaust gases of this mining truck were also verified with the addition of diesel fuel additives (Table 1).

Table 1.

No.	Vehicle	The date	Refueling time	Amount of filled diesel fuel (l)	Quantity of additions of additive LNC $MiaNO_X^R$ (ml)
1	HDDT with load capacity of 55 tons	20.02.2022	20:50	330.0	37.5
2	HDDT with load capacity of 55 tons	21.02.2022	10:40	270.0	13.5
3	HDDT with load capacity of 55 tons	21.02.2022	15:20	200.0	10.0
4	HDDT with load capacity of 55 tons	21.02.2022	20:40	200.0	10.0
5	HDDT with load capacity of 55 tons	22.02.2022	10:10	600.0	30.0
6	HDDT with load capacity of 55 tons	22.02.2022	20:45	450.0	22.5
7	HDDT with load capacity of 55 tons	23.02.2022	11:25	250.0	12.5
8	HDDT with load capacity of 55 tons	23.02.2022	20:30	400.0	20.0
9	HDDT with load capacity of 55 tons	24.02.2022	10:40	600.0	30
10	HDDT with load capacity of 55 tons	24.02.2022	17:00	150.0	7.5
11	HDDT with load capacity of 55 tons	24.02.2022	20:40	100.0	5.0
12	HDDT with load capacity of 55 tons	25.02.2022	11:00	500.0	25.0
13	HDDT with load capacity of 55 tons	25.02.2022	20:40	300.0	15.0
14	HDDT with load capacity of 55 tons	26.02.2022	9:25	440.0	22.0
15	HDDT with load capacity of 55 tons	26.02.2022	20:40	500.0	25.0
16	HDDT with load capacity of 55 tons	27.02.2022	8:30	500.0	25.0
17	HDDT with load capacity of 55 tons	27.02.2022	20:30	600.0	30.0

3 Results and Discussion

During the testing period on the selected heavy-duty mining dump truck, no deviations in the operating parameters of the internal combustion engine, hydraulic system, gearbox, and other components and assemblies were detected.

According to the results of analyzes of the laboratory of fuels and lubricants, after the addition of the LNC $MiaNO_X^R$ additive to K5 diesel fuel, its physical and chemical parameters did not change (Table 2).

Table 2.

Name of parameters (requirements)	Normative document for test methods (measurements)	Meaning of parameters (requirements)			
		Norms on Technical Conditions 38.301-19-155-2009	Actual values from the passport	Actual values without additive LNC $MiaNO_X^R$	Actual values with additive LNC $MiaNO_X^R$
Density at 15 ^{0}C, kg/m3	State Standard 3900	820-860	842.9	839.8	840.0
Density at 20 ^{0}C, kg/m3	State Standard 3900	-	839.4	836.2	836.4
Water content, %	State Standard 2477	no more than 0.02	not standardized	not standardized	not standardized
Kinematic viscosity at 40 ^{0}C, mm2/s	State Standard 33	2.0-4.5	3.553	3.308	3.223
Flash point, determined in a closed cup, ^{0}C	State Standard 6356	not less than 55	71	71	73
Pour point, ^{0}C	State Standard 20287	not standardized	-	-30	-30
Cloud point, ^{0}C	State Standard 5066	not standardized	-5	-5	-5
Fractional composition					
at a temperature of 250 ^{0}C it is distilled, % vol.	State Standard 2177	less than 65	22.5	24.0	24.7
at a temperature of 350 ^{0}C it is distilled, % vol.	State Standard 2177	less than 85	94.0	95.1	95.9
95% vol., distilled at ^{0}C	State Standard 2177	no higher than 360	352.0	348.8	346.7

When studying all the technical documentation, as well as analyzing the control measurements of the actual consumption of diesel fuel of heavy-duty mining dump trucks with the addition of chemicals to diesel fuel to modify it (change certain characteristics or qualities of fuel), namely LNC $MiaNO_X^R$ additives during the test period (during more than one week), diesel fuel savings of 4% were achieved (Table 3).

When checking the exhaust gases of this mining truck using the LNC MiaNOX^R additive in diesel fuel, it was found that the emission of carbon monoxide (CO) to the environment decreased by 39.4%.

Table 3.

HDDT Name	Test 1-HDDT with additive MiaNO$_X^R$	Test 2-HDDT with additive MiaNO$_X^R$	Test 2-HDDT without additive MiaNO$_X^R$
Loading horizon	347 m	347 m	347 m
Unloading horizon	370 m	370 m	370 m
Lifting height	23 m	23 m	23 m
Rock mass transported	519.8 t	526.1 t	511.85 t
Number of trips	9	9	9
Mileage with load	90 km	90 km	90 km
Distance for 1 cycle	10 km	10 km	10 km
Actual fuel consumption when running with a load	127.8 l	134.9 l	131.1 l
Specific consumption	0.246 l/t	0.256 l/t	0.256 l/t

Calculation:

I. $\text{Specific consumption}\left(\frac{\text{l}}{\text{t}}\right) = \frac{\text{Actual fuel consumption for a loaded run (l)}}{\text{Rock mass transported (t)}}$

a) $\text{Specific consumption}\ \left(\frac{\text{l}}{\text{t}}\right) = \frac{127.8\ (\text{l})}{519.8\ (\text{t})} = 0.246\frac{\text{l}}{\text{t}}$

b) $\text{Specific consumption}\ \left(\frac{\text{l}}{\text{t}}\right) = \frac{134.9\ (\text{l})}{526.1\ (\text{t})} = 0.256\frac{\text{l}}{\text{t}}$

c) $\text{Specific consumption}\ \left(\frac{\text{l}}{\text{t}}\right) = \frac{131.1\ (\text{l})}{526.1\ (\text{t})} = 0.256\frac{\text{l}}{\text{t}}$

II. Comparing specific consumption:

$$\text{Comparing specific consumption}\ (\%) = \frac{\text{a}}{\text{b}} = \frac{0.246\left(\frac{\text{l}}{\text{t}}\right)}{0.256\left(\frac{\text{l}}{\text{t}}\right)} * 100\% = 96\ \%$$

III. Saving diesel fuel when using an additive (%):

Saving diesel fuel when using an additive =100%- unit cost ratio (%).

Diesel fuel economy =100% - 96%=4%.

4 Conclusion

The results of experimental and industrial tests of diesel fuel additives had a positive effect; that is, fuel economy can be achieved by improving the environment. The mass use of multifunctional fuel additives will have an almost instantaneous environmental effect. Suppose fuel producers, before delivering their product (fuel) to the market, use multifunctional additives to fuel in a short period of time. In that case, it is possible to significantly reduce the emission of harmful gases into the environment.

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