STATE ENTERPRISE
“PLANT NAMED AFTER V.A. MALYSHEV”

Test for definition of the effect of the fuel catalyzer KT-14D for diesel engines on fuel efficiency and environmental performance of the two-cylinder mid-rotation diesel 7Д80А (2ЧН26/27)

2014

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PROTOCOL No. 1-14/66
of tests for definition of the effect of the fuel catalyzer KT-14D for diesel engines, given by the firm Limited Liability Company Scientific-Production Firm "Eko-Avto-Titan", on fuel efficiency and environmental performance of the two-cylinder mid-rotation diesel 7Д80А (2ЧН26/27)

of December 17-20, 2013

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Continuation on the next page

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2014

List of symbols

t_o – the ambient temperature, °C;
$P_б$ – atmospheric pressure, mc;
n – frequency of rotation of the crankshaft, rev/min;
I – current at the generator terminals, A;
U – voltage at the generator terminals, V;
$P_г$ – power on the generator terminals, kW;
$B_ч$ – hourly fuel consumption, kg/h;
g_e – specific fuel consumption, g/(kWh);
$P_s^{изб}$ – air pressure in the receiver, kgf/cm2;
$P_т^{изб}$ – pressure of exhaust gases in front of the turbine, kgf/cm2;
$P_z^{ср}$ – the maximum combustion pressure (average) for the cylinders, kgf/cm2;
t_s – the air temperature in the receiver, °C;
$t_ц^{ср}$ – exhaust gas temperature at the exit from the cylinders (average) °C;
$t_м^{вых}$ – oil temperature at the diesel outlet, °C;
$t_в^{вых}$ – water temperature at the diesel outlet, °C;
$n_{тк}$ – rotor speed of the turbocharger, rpm;
$P_м^{после\ ф.}$ – oil pressure after the coarse filter, kgf/cm2;
$P_м^{верх.кол}$ – oil pressure in the upper collector of the diesel, kgf/cm2;
$P_{топл}$ – fuel pressure in the fuel collector, kgf/cm2;
$CO_{ср}$ – concentration of carbon monoxide (average), vol.%,
$CO_{2ср}$ – concentration of carbon dioxide (average), vol.%,
$C_6H_{14ср}$ – concentration of hydrocarbon in hexane equivalent (average), vol.%,
$NO_{ср}$ – concentration of nitric oxide (average), vol.%,
$N_{ср}$ – opacity of exhaust gases (average), %.

List of annexes

Annex A	- Information about the fuel catalyzer KT-14Д for diesel engines, provided by the firm LLC “Eko-Avto-Titan” (Kiev, Ukraine).
Annex A.1	- Technical specifications ТУ У 34.3-31909330.002-2002 “Fuel catalyzers (fuel filters-catalyzers) for internal combustion engines” (Extract).
Annex A.2	- Copy of the Notice of NPFE 01:2007 about the change of technical specifications of ТУ У 34.3-31909330.002-2002 “Fuel catalyzers (fuel filters-catalyzers) for internal combustion engines” (Extract).
Annex A.3	- Description, principle of operation and competitive advantages of the fuel catalyst produced by LLC SPF “Eko-Avto-Titan” (materials are taken from the site http.//ecoat.com.ua/ of the Trade House “Eko-Avto-Titan”).
Annex Б	- “Program and methodology of stand-by tests on assessment of the effect of the fuel catalyzer KT-14Д, given by LLC “Eko-Avto-Titan”, on fuel efficiency and environmental performance of the two-cylinder mid-rotation diesel 7Д80А (2ЧН26/27)” (in Ukrainian), developed by SE “Plant named after V.A. Malyshev”.
Annex B	Materials of the commission work.
Annex B.1	- Protocol No. 1 of the meeting of the commission for testing the fuel catalyzer of fuel KT-14Д of 17.12.2013.
Annex B.2	- Protocol No. 2 of the meeting of the commission for testing the fuel catalyzer of fuel KT-14Д of 20.12.2013.
Annex Г	- Information on diesel fuel used during the tests.
Annex Г.1	- Copy of the conclusion of the chemical laboratory of SE “Plant named after V.A. Malyshev” of 23.12.2013.
Annex Г.2	- Copy of the conclusion of the chemical laboratory of SE “Plant named after V.A. Malyshev” of 25.12.2013.
Annex Д	- Information on the composition of diesel oil M14B2, used in the tests.
Annex Д.1	- Copy of the conclusion of the chemical laboratory of SE “Plant named after V.A. Malyshev” of 23.12.2013.
Annex Д.2	- Copy of the conclusion of the chemical laboratory of SE “Plant named after V.A. Malyshev” of 25.12.2013.
Annex E	- Calculation of fuel consumption during the diesel operation on the initial diesel fuel and on the fuel treated with the fuel catalyzer KT-14Д.

Continuation of the list of annexes

Annex Ж	- Results of check of operability of burners.
Annex Ж.1	- Technical act No. 3784 of 18.12.2013 of check of operability of burners of the diesel 7Д80А before tests of the fuel catalyzer КТ-14Д.
Annex Ж.2	- Technical act No. 3785 of 23.12.2013 of check of operability of burners of the diesel 7Д80А after tests of the fuel catalyzer КТ-14Д.
Annex И	- Photo tables of burner details and cylinder piston group of the first cylinder after disassembling.

Introduction

The commission formed according to the Order of the Director General (DG) of SE “Plant named after V.A. Malyshev” of 27.10.2013 No. 518 “About carrying out the tests of the fuel catalyzer on the diesel 7Д80А” carried out the stand tests of the two-cylinder mid-rotation diesel 7Д80А (2ЧН26/27) with the use of the fuel catalyzer КТ-14Д for diesel engines (hereinafter referred to as КТ-14Д) within the period from 17.12 till 20.12.2013. The tests were carried out on the testing stand No. 2 of the testing-experimental section of the diesel-assembly shop under the order of LLC “Scientific-Production Firm “Eko-Avto-Titan” (LLC SPF “Eko-Avto-Titan”) according to the contract No. 557дп of 10.12.2013 The sample of the fuel catalyzer КТ-14Д for diesel engines was given to SE “Plant named after V.A. Malyshev” by the representatives of LLC SPF “Eko-Avto-Titan” (Kiev city).

The fuel catalyzer КТ-14Д for diesel engines is a device of body construction of chamber type, in which is carried out the primary purification of fuel, activation of fuel molecules by granular catalyzers, fuel saturation at molecular level by metal salts, forming upon combustion of the mixture in the engine operational space the weeping effect. Therefore, in the consequence of fuel processing by the catalyzer КТ-14Д takes place the gradual improvement of the qualitative molecular composition of fuel and its saturation by the salts of weeping metals (see the Annex A, as well as the data given on the website of the Trade House “Eko-Avto-Titan” (http.//ecoat.com.ua/)).

The tests were carried out by the working group, created according to the Order of the DG of 27.10.2013 No. 518 in the presence of the Customer’s representatives - LLC SPF “Eko-Avto-Titan”. Facultatively in the tests took part the representatives of UkrGAGT (Kharkov city) and Azov Sea Institute of ONMA (Mariupol city) (see the Annex B).

The testing stand No. 2 is equipped with all necessary systems and equipments for diesel work, maintenance of its heating state and devices for measurements of all indices according to the requirements of ГОСТ 10448-80. All measurements devices have valid marks about check. The stand has the Technical passport of the stand No. 2 of the testing-experimental section of the diesel-assembly shop of SE “Plant named after V.A. Malyshev 7Д80.ПС” and the valid certificate under No. 1 of 8.112013 with the term of validity of 1 year.

The diesel loading was carried out with the help of the current generator of type КПБ, the power of which dispersed by the resistance boxes ЯС-4 in the atmosphere in the form of heat.

Results of tests

After carrying out the tests, for the consideration by the commission of SE “Plant named after V.A. Malyshev”, the following materials were presented by the working group: the stand protocol of tests installed at SE “Plant named after V.A. Malyshev” of the model, which is the property of SE “Plant named after V.A. Malyshev”, the results of measurements of concentrations of pollutants in diesel exhaust gases, the results of analyses of diesel fuel and oil, executed in the chemical laboratory of SE “Plant named after V.A. Malyshev”.

On the basis of the testing materials, the commission established the following:

1. The tests were carried out according to the “Program and methodology of stand-by tests on assessment of the effect of the fuel catalyzer КТ-14Д, given by LLC “Eko-Avto-Titan”, on fuel efficiency and environmental performance of the two-cylinder mid-rotation diesel 7Д80А (2ЧН26/27)”, approved and agreed in the established order with the interested organizations, and included the definition of the main parameters of work and verification of the environmental indices of the diesel engine in the following modes:

1) the power at the generator terminals Pr = 150 kW at the speed of the diesel crankshaft of 1000 rpm;

2) the power at the generator terminals Pr = 112 kW at the speed of the diesel crankshaft of 800 rpm;

3) the power at the generator terminals Pr = 75 kW at the speed of the diesel crankshaft of 600 rpm;

4) the power at the generator terminals Pr = 37 kW at the speed of the diesel crankshaft of 400 rpm;

5) the power at the generator terminals Pr = 0 kW at the speed of the diesel crankshaft of 300 rpm.

Additionally, after the end of the tests, the burner of the first cylinder was disassembled and its cover was removed.

2. During the tests in the diesel were applied:

- diesel fuel 3-(0,2)-(25) according to ДСТУ 3868-99 (see the Annex Г);
- lubricating oil М-14Вг under ГОСТ 12337-84 (see the Annex Д);
- cooling liquid - fresh (drinking) water from the factory main.

3. The tests were carried out in two stages:

The 1st stage - on the initial fuel 3-(0,2)-(25) according to ДСТУ 3868-99;

The 2nd stage - on the same fuel processed by the catalyzer КТ-14Д, this stage consisted of three repeated cycles.

4. During the testing period, the diesel fuel composition was monitored by sampling and their subsequent laboratory analysis in the chemical laboratory of SE “Plant named after V.A. Malyshev”.

4.1. Before the beginning of the tests, the sampling of diesel fuel was taken from the fuel tank of the stand, the analysis No. 111 (see the Annex Г.1).

4.2. Before the second stage of the tests, the fuel catalyzer КТ-14Д was installed in the fuel system of the stand. The installation of the catalyzer was carried out by the specialists of SE “Plant named after V.A. Malyshev” with the participation of the representatives of LLC SPF “Eko-Avto-Titan”. The place (нет листа 8)

However, in clause 2.2 of ТУ for catalyzer (the Annex A.1) it is stated that before the effect is manifested, the fuel catalyzer КТ-14Д after its installation on the engine should work for at least 15 hours. That is, the fuel efficiency indices for the time of testing vary according to the worked time. Therefore, the averaging of the results for three testing cycles distorts the data, since the weeping process in the catalyzer has not yet been established. In addition, we managed to track the dynamics of the effect of fuel conversion in the catalyzer on fuel efficiency during the period of its running-in. In order to assess the full effect of using the fuel catalyzer, it is necessary to compare the results obtained at the 3rd cycle of the 2nd stage with the 1st stage. In this case, the fuel economy constituted 2.67% in full power mode, 2.57% in 0.75 of full power mode, 1.24% in 0.5 of full power mode, 2.43% in 0.25 of full power mode and 1.92% at idling speed, as you can see, the difference is significant.

When processing data in order to obtain absolute values of fuel economy, it is necessary to take into account the accuracy of measurements. According to ГОСТ 10448-80 “Diesels for ships, locomotives and industrial. Acceptance rules. Tests methods.” the fuel consumption at the testing stand is determined with an accuracy of ± 1%. Taking into account the measurement inaccuracy, the fuel economy in the 3rd cycle of the 2nd stage in comparison with the 1st stage constituted 0.24% in the mode No. 3 (n = 600 rpm, Pr = 75 kW) to 1.67 % in full power mode (the testing mode No. 1, n = 1000 rpm, Pr = 150 kW). At idling speed (the testing mode No. 5, n = 300 rpm, Pr = 0 kW), taking into account the measurement inaccuracy, the fuel economy constituted 0.92%. When fuel consumption is compared at the average for three cycles, the fuel economy is within the limits of measurement accuracy or does not exceed 1%.

The methodology for calculating the fuel consumption and the fuel economy values for the operation of the diesel engine on the initial fuel and the fuel processed with the catalyzer КТ-14Д is given in the Annex E.

9. The check of ecological indices of the diesel. Before the beginning of the tests, the gas supply system from the gas sampling probe to the opacimeter and the gas analyzer was checked for leakage by creating excess pressure in the system within the range of 0.1 - 0.3 kgf/cm2. At the same time within 15 minutes, the pressure drop was not recorded.

The results of the measurement of the concentrations of pollutants (P) and the opacity of exhaust gases (EG) are given in Table 3. The Table 4 presents the average values of the concentrations of pollutants in exhaust gases, reduced to normal conditions taking into account the atmospheric pressure, temperature and humidity of the environment. The correction of the concentrations of pollutants by the oxygen content in exhaust gases was not carried out. The inaccuracy in the measurements of pollutants was determined by the accuracy of the metrologically provided means of the measurement techniques and when measuring the concentrations in exhaust gases did not exceed 5%, while measuring the opacity of exhaust gases did not exceed 1%.

The comparison of the results presented below is carried out in two versions: the average value for three cycles and only the 3rd cycle (after 15 hours of works).

9.1. The average values of the concentrations of pollutants in exhaust gases during the operation of the diesel engine on the initial fuel (the 1st stage) and on the fuel processed with the catalyzer КТ-14Д (average for three cycles of the second stage) constituted (Table 4):

in the mode with power Pr = 150 kW at 1000 rpm,
the concentration of carbon monoxide (COcp)
- on the initial fuel (the first stage) - 0.0140 vol.%;
- on the fuel processed with the catalyzer - 0.0121 vol.%;
the concentration of the sum of hydrocarbons in hexane equivalent (CHcp)
- on the initial fuel (the first stage) - 0,0010 vol.%;
- on the fuel processed with the catalyzer - 0.0016 vol.%;
the concentration of nitric oxide (NOcp)
- on the initial fuel (the first stage) - 0.0728 vol.%;
- on the fuel processed with the catalyzer - 0.0900 vol.%;

at idling speed (Pr = 0 kW at 300 rpm)
the concentration of carbon monoxide (COcp)
- on the initial fuel (average) - 0.0222 vol.%;
- on the fuel processed with the catalyzer - 0.0384 vol.%;
the concentration of the sum of hydrocarbons in hexane equivalent (CHcp)
- on the initial fuel (average) - 0.0003 vol.%;
- on the fuel processed with the catalyzer - 0.0005 vol.%;
the concentration of nitric oxide (NOcp)
- on the initial fuel (average) - 0.0401 vol.%;
- on the fuel processed with the catalyzer - 0.0364 vol.%.

The Table 5 compares the averaged results for the determination of pollutant emissions with the exhaust gases in the tests modes obtained with the operation of the 7Д80А diesel engine on the initial fuel (the 1st stage) and the fuel processed with the fuel catalyzer КТ-14Д (three cycles of the 2nd stage).

The relative value of the difference between the concentrations of pollutants in the exhaust gases during the operation of the 7Д80А diesel engine on the initial fuel and on the fuel processed with the fuel catalyzer КТ-14Д, taking into account the device inaccuracy, constituted:

in the mode with power Pr = 150 kW at 1000 rpm

- carbon monoxide, δ_{COcp} = 8.3%,
- hydrocarbons δ_{CHcp} = - 51.7%,
- nitric oxide δ_{NOcp} = - 18.6%;

in the mode with power Pr = 112 kW at 800 rpm

- carbon monoxide δ_{COcp} = 14.6%,
- hydrocarbons δ_{CHcp} = - 31.7%,
- nitric oxide δ_{NOcp} = - 61.4%;

in the mode with power Pr = 75 kW at 600 rpm

- carbon monoxide: the value of δ_{COcp} is within the limits of measurement accuracy,

- hydrocarbons δ_{CHcp} = - 57.8%,

- nitric oxide δ_{NOcp} = - 57.2%;

in the mode with power Pr = 37 kW at 400 rpm

- carbon monoxide: the value of δ_{COcp} is within the limits of measurement accuracy,

- hydrocarbons δ_{CHcp} = - 25.8%,

- nitric oxide δ_{NOcp} = - 56.5%;

at idling speed (Pr = 0 kW at 300 rpm)

- carbon monoxide δ_{COcp} = -51.9%,

- hydrocarbons δ_{CHcp} = - 20.0%,

- nitric oxide δ_{NOcp} = 4.1%;

where, the "-" sign means the exceed of the concentration of pollutants upon the operation of the 7Д80А diesel on the fuel processed with the fuel catalyzer КТ-14Д above the concentrations of those pollutants when the diesel engine is operating on the initial fuel.

Therefore, when the diesel engine operated on the fuel processed with the fuel catalyzer, the concentration of carbon monoxide decreased by 8.3% at full power mode, but increased at idle speed by 51.9%. The concentration of nitrogen oxide significantly increased in all testing modes (from 18.6 to 61.4%), with the exception of the idling speed, in which the use of the catalyzer reduced the concentration of nitrogen oxide by 4.1%.

The concentration of hydrocarbons in hexane equivalent (C_6H_{14cp}) in the exhaust gases at all stages of the tests, both in the operation of the diesel engine on the initial fuel and on the fuel processed with the fuel catalyzer КТ-14Д, was within the accuracy of the measurements, since 1% of the upper limit of the measuring range of the given component is 25 mln-1 or 0.0025 vol.%, while the measured values of the Ni concentrations did not exceed 0.0020%. The inaccuracy in measuring the concentration of hydrocarbons in the hexane equivalent (C_6H_{14cp}) by the 325FA02-01 gas analyzer used in other tests constitutes ± 5%.

9.2. Taking into account that as it is indicated in p. 2.2 of ТУ for the catalyzer (the Annex А.1) before the effect appearance the fuel catalyzer КТ-14Д after its installation on the engine shall work not less than 15 hours, let’s make the additional comparison of the results obtained at the first stage and at the third cycle of the second stage. In this case the average values of the concentrations of pollutants in the exhaust gases constitutes:

in the mode with power Pr = 150 kW at 1000 rpm

the concentration of carbon monoxide (CO)

- on the initial fuel - 0.0140 vol.%;
- on the fuel processed with the catalyzer - 0.0091 vol.%;

the concentration of the sum of hydrocarbons in the hexane equivalent (CH)

- on the initial fuel - 0,0010 vol.%;
- on the fuel processed with the catalyzer - 0.0018 vol.%;

the concentration of nitric oxide (NO)

- on the initial fuel - 0.0728 vol.%;

- on the fuel processed with the catalyzer - 0.0881 vol.%;

in the mode with power Pr = 112 kW at 800 rpm
the concentration of carbon monoxide (CO)
- on the initial fuel, 0.0126 vol.%;
- on the fuel processed with the catalyzer - 0.0081 vol.%;
the concentration of the sum of hydrocarbons in the hexane equivalent (CH)
- on the initial fuel - 0,0010 vol.%;
- on the fuel processed with the catalyzer - 0.0017 vol.%;
the concentration of nitric oxide (NO)
- on the initial fuel - 0.0687 vol.%;
- on fuel processed with the catalyzer – 0.1129 vol.%;

in the mode with power Pr = 75 kW at 600 rpm
the concentration of carbon monoxide (CO)
- on the initial fuel - 0,0146 vol.%;
- on the fuel processed with the catalyzer - 0.0141 vol.%;
the concentration of the sum of hydrocarbons in the hexane equivalent (CH)
- on the initial fuel, 0.0012 vol.%;
- on the fuel processed with the catalyzer - 0.0019 vol.%;
the concentration of nitric oxide (NO)
- on the initial fuel - 0.0848 vol.%;
- on the fuel processed with the catalyzer - 0.1422 vol.%;

at a power of Pr = 37 kW at 400 rpm,
the concentration of carbon monoxide (CO)
- on the initial fuel, 0.0153% vol.%;
- on the fuel processed with the catalyzer - 0.0161 vol.%;
the concentration of the sum of hydrocarbons in the hexane equivalent (CH)
- on the initial fuel, 0.0013 vol.%.;
- on the fuel processed with the catalyzer - 0.0018 vol.%;
the concentration of nitric oxide (NO)
- on the initial fuel - 0.0815 vol.%;
- on the fuel processed with the catalyzer - 0.1355 vol.%;

at idling speed (Pr = 0 kW at 300 rpm)
the concentration of carbon monoxide (CO)
- on the initial fuel - 0.0222 vol.%;
- on the fuel processed with the catalyzer - 0.0257 vol.%;
the concentration of the sum of hydrocarbons in the hexane equivalent (CH)
- on the initial fuel - 0.0004 vol.%;
- on the fuel processed with the catalyzer - 0.0002 vol.%;
the concentration of nitric oxide (NO)

- on the initial fuel - 0.0401 vol.%;
- on the fuel processed with the catalyzer - 0.0306 vol.%.

The relative value of the difference between the concentrations of pollutants during the operation of the 7Д80А diesel engine at the first stage of the tests (on the initial fuel) and at the third cycle of the second stage of the tests (on the fuel processed with the fuel catalyzer КТ-14Д after 15 hours of the catalyzer work, see the Table 6), taking into account the measurement inaccuracy, constituted:

in the mode with power Pr = 150 kW at 1000 rpm

- carbon monoxide $\delta_{CO ср 3и}$ = 30.0%,
- hydrocarbons $\delta_{CH ср 3и}$ = - 65.0%,
- nitric oxide $\delta_{NO ср 3и}$ = - 16.0%;

in the mode with power Pr = 112 kW at 800 rpm

- carbon monoxide $\delta_{CO ср 3и}$ = 30.7%,
- hydrocarbons $\delta_{CH ср 3и}$ = - 65.0%,
- nitric oxide $\delta_{NO ср 3и}$ = - 59,3%;

in the mode with power Pr = 75 kW at 600 rpm

- carbon monoxide: the value of $\delta_{CO ср 3и}$ is within the limits of measurement accuracy,
- hydrocarbons $\delta_{CH ср 3и}$ = - 53.3%,
- nitric oxide $\delta_{NO ср 3и}$ = - 62.7%;

at a mode of power Pr = 37 kW at 400 rpm

- carbon monoxide: the value of $\delta_{CO ср 3и}$ is within the limits of measurement accuracy,
- hydrocarbons $\delta_{CH ср 3и}$ = - 33.5%,
- nitric oxide $\delta_{NO ср 3и}$ = - 61.3%;

at idling speed (Pr = 0 kW at 300 rpm)

- carbon monoxide $\delta_{CO ср 3и}$ = - 10.8%,
- hydrocarbons $\delta_{CH ср 3и}$ = + 45.0%,
- nitric oxide $\delta_{NO ср 3и}$ = +18,7%,

where, the "-" sign means the exceed of the concentration of pollutants upon the operation of the 7Д80А diesel on the fuel processed with the fuel catalyzer КТ-14Д above the concentrations of those pollutants when the diesel engine is operating on the initial fuel.

Therefore, when the diesel engine operated on the fuel processed with the fuel catalyzer КТ-14Д after 15 hours of work of the catalyzer, the concentration of carbon monoxide decreased by 30% at the modes No.No. 1-2 with power 150...112kW, but increased at idle speed by 10.8% (the mode No. 5 with power 0 kW at 300 rpm). With it the concentration of nitrogen oxide increased in all testing modes from 16.0 to 62.7%, with the exception of the idling speed, in which the use of the catalyzer reduced the concentration of nitrogen oxide by 18.7%.

The concentration of hydrocarbons in hexane equivalent $(C_6H_{14ср})$ in the exhaust gases at all stages of the tests, both in the operation of the diesel engine on the initial fuel and on the fuel processed with the catalyzer КТ-14Д, was within the limits of measurement accuracy.

9.3 It can be seen from the Tables 3 ... 6 that the character of the change in pollutant concentrations in different test modes is not the same, but depends on the power and frequency

rotation of the diesel engine. Therefore, it is obvious that the values of the specific emissions of pollutants depend on the type of diesel engine and the choice of its diesel locomotive characteristics. The laboratory diesel 7Д80А in the period of these tests worked in the modes of locomotive characteristics that have no analogues in operation, therefore, the obtained absolute values of the concentrations of pollutant emissions will differ from the concentrations of pollutant emissions with the exhaust gases of actually existing engines, depending on their model and power according to the locomotive characteristic. Therefore, the compliance with the standards for pollutants emissions in the exhaust gases with the use of the catalyzer КТ-14Д must be determined on each type of engine installed on a particular locomotive series.

10. opacity values of the exhaust gases during the operation of the diesel engine on the initial fuel (the 1st stage) and on the fuel processed with the catalyzer КТ-14Д (average for three cycles of the second stage) constituted (the Table 3):

in the mode with power Pr = 150 kW at 1000 rpm

opacity of exhaust gases (Ncp)

- on the initial fuel - 4%;
- on the fuel processed with the catalyzer - 8%;

at idling speed (Pr = 0 kW at 300 rpm)

opacity of exhaust gases (Ncp)

- on the initial fuel (average) -1%;
- on the fuel processed with the catalyzer (average for three cycles of the second stage) - 1%.

With a generally low enough opacity level of the exhaust gas of the 7Д80А diesel engine, the influence of the processing of the fuel by catalyzer КТ-14Д was manifested in the modes of the power of Pr=150 kW at 1000 rpm and Pr = 112 kW at 800 rpm where the absolute value of the luminous flux coefficient (the opacity of the exhaust gases) increased by 4% and 1.3% respectively when the diesel engine operated on the fuel processed with the catalyzer КТ-14Д. In the other testing modes, the difference between the opacity of the exhaust gases during the operation of the diesel engine on the initial fuel and the fuel processed with the catalyzer КТ-14Д was within the error of the opacimeter (± 1%).

Taking into account the fact that, as indicated in clause 2.2 of the Technical Specification for the catalyzer (the Annex A.1), before the effect manifestation the fuel catalyzer КТ-14Д after its installation on the engine must work for at least 15 hours, was carried out the additional comparison of the results obtained at the first stage and at the third cycle of the second stage. In this case, the values of the opacity of the exhaust gases constituted:

in the mode with power Pr = 150 kW at 1000 rpm,

the opacity of the exhaust gases $(N_{ср3ц})$

- on the initial fuel - 4%;
- on the fuel processed with the catalyzer - 8.5%;

in the mode with power Pr = 112 kW at 800 rpm,

the opacity of the exhaust gases $(N_{ср3ц})$

- on the initial fuel - 4%;

- on the fuel processed with the catalyzer - 5.5%;
in the mode with power Pr = 75 kW at 600 rpm,
the opacity of the exhaust gases $(N_{ср3ц})$
- on the initial fuel - 2%;
- on the fuel processed with the catalyzer - 2%;
in the mode with power Pr = 37 kW at 400 rpm
the opacity of the exhaust gases $(N_{ср3ц})$
- on the initial fuel - 1%;
- on the fuel processed with the catalyzer - 1%;
at idle speed (Pr = 0 kW at 300 rpm),
the opacity of the exhaust gases $(N_{ср3ц})$
- on the initial fuel -1%;
- on the fuel processed with the catalyzer (at the third cycle of the second stage) - 1%.

The absolute value of the difference between the opacity of the exhaust gases during the operation of the 7Д80А diesel engine at the first stage of the tests (on the initial fuel) and at the third cycle of the second stage of the tests (on the fuel processed with the catalyzer КТ-14Д after 15 hours of the catalyzer operation, see the Table 3) constituted:

in the mode with power Pr = 150 kW at 1000 rpm
- the opacity $\Delta N_{ср3ц}$ = - 4,5%;
in the mode with power Pr = 112 kW at 800 rpm
- the opacity $\Delta N_{ср3ц}$ = - 1,5%;
in the mode with power Pr = 75 kW at 600 rpm
- the opacity $\Delta N_{ср3ц}$ = 0%;
in the mode with power Pr = 37 kW at 400 rpm
- the opacity $\Delta N_{ср3ц}$ = o%;
at idling speed (Pr = 0 kW at 300 rpm)
- the opacity $\Delta N_{ср3ц}$ = 0%.

Therefore, the absolute values of the opacity of the exhaust gases during the operation of the 7Д80А diesel engine on the fuel processed with the catalyzer КТ-14Д after 15 hours of the catalyzer operation increased by 4.5% and 1.5% in the modes with power Pr = 150 kW at 1000 rpm and Pr - 112 kW at 800 rpm respectively. In other testing modes, the effect of the fuel processed with the catalyzer КТ-14Д on the opacity of the exhaust gases of the diesel engine was not revealed. The increased values of the opacity values obtained when working on the fuel processed with the catalyzer do not exceed the norms established by ГОСТ for this type of engine.

11. The influences of fuel processing with the catalyzer КТ-14Д on the main parameters of the process, such as the maximum combustion pressure (average) on the cylinders $P_z^{ср}$, the temperature of the exhaust gases on the cylinders (average) $t_ц^{ср}$, the rotor speed of the turbocharger $n_{тк}$, the excess air pressure in the reservoir $P_s^{изб}$, the overpressure of the exhaust gases before the turbine $P_т^{изб}$, under the given tests it is not revealed.

12. Before the tests and after the completion of the second stage of the tests, the condition of the burners was checked (see the Annexes И.1 and И.2). The injection start pressure and the spray quality have not changed and corresponds the technical specifications. The fuel pressure drop across the fine filter has not changed. Therefore, there was no negative effect on the fuel equipment during the testing period.

13. The analyzes of diesel fuel, conducted by the chemical laboratory of SE “Plant named after V.A. Malyshev”, given in the Annex Г, show that the processing of the fuel with the fuel catalyzer КТ-14Д:

- increased the kinematic viscosity of the fuel from 3.5 (p. 3 of the Annex Г.1) to 3.69 (p. 3 of the Annex Г.2), in cCt at 20 °C;
- lowered the flash temperature from 66 °C to 64 °C;
- increased the acid number of the fuel from 0.78 .. 0.79 mg KOH to 1.07 mg KOH;
- on the fractional distillation temperature increased 50% from 248 °C to 261 °C. 96% - from 350 °C to 363 °C at the third cycle of the second stage of the tests.

14. The analyzes of the diesel oil conducted by the chemical laboratory of SE “Plant named after V.A. Malyshev” are given in the Annex Д:

before the start of the tests – the conclusion of 23.12.2013 on the analysis No. 110 (the Annex Д.1);

after the end of the third cycle of the second stage of the tests - the conclusion of 25.12.2013 on the analysis No. 117 (the Annex Д.2).

It can be seen from the presented materials that during the testing period the values of the pollution factor fluctuated somewhat, which is more likely related to the measurement inaccuracy than to the peculiarities of the diesel operation on the fuel processed with the catalyzer, since the remaining indices of the diesel oil did not change.

15. The dismantling of the diesel engine after the end of the tests is not provided by the testing program (see the Annex Б) and has the informative nature (see the Annex И). When dismantling the burner of the first cylinder, a visual inspection of the nozzle tip and nozzle needle was performed. There were no visible changes on the details considered. The risks visible on the nozzle needle (see the photo table И.1 the Annex И) are also on other needles of this type of burners and are not associated with the use of the fuel processed with the catalyzer. The carbon deposits on the tip of the nozzle tip are characteristic for the engines of the Д80 type and do not cause any complaints (see the photo table И.2 the Annex И).

The inspection of the cylinder cover did not reveal any remarks on the operation of the valve mechanism (see the photo table И.3 the Annex И). The cylinder liner has no apparent consequences of the effect of the fuel processed with the catalyzer (see the photo table И.4 the Annex И). On the head of the piston are visible whitish spots (see the photo table И.5 the Annex И). Lighter, sharp prints, diverging from the center in the amount of 8 pieces, are traces of fuel jets. When operating on the usual diesel fuel, the colour of the piston head is black with slightly discernible traces from the fuel jets.

Table 1 – The parameters of operation of the diesel engine 7Д80А on the initial fuel 3-(0,2)-(25) under ДСТУ 3868-99 (the 1st stage) and on the same fuel processed with the catalyzer КТ-14Д (the 2nd stage)

Дата	Этап	Цикл	Параметры работи дизеля 7Д80А										
			t_o,	$P_б$,	n	Pr	Вч	g_e	$P_s^{изб}$,	$P_r^{изб}$,	$P_z^{ср}$,	t_s,	$t_t^{ср}$
			°С	мм рт.ст.	об/мин	кВт	кг/ч	г/кВт. ч	кгс/см²	кгс/см²	кгс/см²	°С	°С
17.12. 2013	1	-	8	761	1000	150	44,92	299,5	0,80	0,81	98,5	51,0	500
			8	761	800	112	30,33	270,8	0,54	0,56	90,5	45,0	425
			9	761	600	75	20,01	268,0	0,28	0,30	80,5	61,0	392,5
			9	761	400	37	11,12	300,7	0,06	0,06	66,5	61,0	330
			10	761	300	0		-	0	0	43,0	28,0	115
18.12. 2013	2	1	14	754	1000	150	44,64	297,6	0,80	0,82	99,0	54,0	525
			15	754	800	112	30,05	268,3	0,52	0,56	90,0	62,0	410
			10	754	600	75	20,28	270,4	0,26	0,28	81,0	54,0	390
			9	754	400	37	11,05	298,6	0,04	0,06	67,0	50,0	315
			8	754	300	0	2,03	-	0	0	43,5	30,0	165
19.12. 2013	2	2	9	756	1000	150	43,74	291,6	0,81	0,83	99,0	51,0	502,5
			12	756	800	112	29,75	265,6	0,54	0,57	90,0	50,0	410
			12	756	600	75	20,00	267,1	0,26	0,29	79,0	53,0	390
			10	756	400	37	10,89	294,3	0,04	0,06	64,5	54,0	335
			10	756	300	0	2,06	-	0	0	43,5	40,0	140
20.12. 2013	2	3	10	756	1000	150	43,72	291,4	0,80	0,82	99,0	53,0	495
			11	756	800	112	29,55	263,9	0,52	0,57	89,0	54,0	405
			12	756	600	75	19,85	264,7	0,26	0,28	81,0	51,0	387,5
			11	756	400	37	10,85	293,2	0,04	0,06	67,0	51,0	315
			11	756	300	0	2,04	-	0	0	43,5	32,0	135
20.12. 2013	1	Повт.	11	756	300	0	2,08	-	0	0	-	-	-

Date Stage Cycle Parameters of operation of the diesel engine 7Д80А
Repeated

Table 2 – Comparison of the results of fuel economy upon the operation of the diesel engine 7Д80А on the initial fuel (the 1st stage) and on the fuel processed with the catalyzer КТ-14Д

Дата	Этап	Цикл	Показатели	Значения на режимах испытаний				
			Номер режима испытаний i	1	2	3	4	5
			n, об/мин	1000	800	600	400	300
			Pr, кВт	150	120	75	37	0
17.12.2013	1		**$Вч^{необр}$, кг/ч**	**44,92**	**30,33**	**20,10**	**11,12**	**2,08**
18.12.2013	2	1	Вч, кг/ч	44,64	30,05	20,28	11,05	2,03
19.12.2013	2	2	Вч, кг/ч	43,74	29,75	20,00	10,89	2,06
20.12.2013	2	3	Вч, кг/ч	43,72	29,55	19,85	10,85	2,04
			$Вч_{ср}^{обраб}$, кг/ч	**44,03**	**29,78**	**20,04**	**10,93**	**2,04**
$\Delta Вч = (Вч_{ср}^{исх} - Вч_{ср}^{обраб}) \cdot 100\% / Вч_{ср}^{исх}$, %				**+1,97**	**+1,80**	**+0,28**	**+1,71**	**+1,76**

Date Stage Cycle Indices Values in testing modes
Number f testing mode

С учётом погрешности измерений ΔВч, %	+0,97	+0,80	0	+0,71	+0,76
Сравнение расхода обработанного топлива Вч на третьем цикле испытаний 2 этапа со значением Вч на 1 этапе испытаний (исходное топливо) на режимах испытаний №№ 1-4					
$\Delta Вч^3=(Вч_{1эт}^{исх}-Вч_{3цикл}^{обраб})\cdot 100\% / Вч_{1эт}^{исх}$	+2,67	+2,57	+1,24	+2,43	+1,92
С учётом погрешности измерений $\Delta Вч^3$, %	+1,67	+1,57	+0,24	+1,43	+0,92

Taking into account the measurement inaccuracy

Comparison of the fuel consumption $\overline{Вч}$ at the third cycle of the 2nd stage of the tests with the value of $\overline{Вч}$ at the 1st stage of the tests (the initial fuel) in the testing modes No.No. 1-4

Taking into account the measurement inaccuracy $\Delta Вч^3$, %

Note: the sign "+" means the fuel economy, the sign "-" means the increase in fuel consumption when the diesel engine is operating on the fuel processed with the catalyzer КТ-14Д.

Table 3. Pollutants emissions and the opacity of the exhaust gases during the testing of the diesel 7Д80А on the initial diesel fuel (at 1st stage) and on the same fuel processed with the fuel catalyzer КТ-14Д (the 2nd stage)

№ этапа	n	P_r	t_o	$P_б$	Средние измеренные значения			
					CO	C_6H_{14}	NO	N
	об/мин	кВт	°С	мм рт.ст.	об%	об%	об%	
1	1000	150	8	761	0.0140	0.0010	0.0977	4
	800	112	8	761	0.0127	0.0010	0.0910	4
	600	75	9	761	0.0147	0.00118	0.1098	2
	400	37	9	761	0.0153	0.0013	0.1051	1
	300	0	10	756	0,0220	0.00037	0.0497	1
2	1000	150	14	754	0.0160	0.0010	0.1175	7
	800	112	15	754	0.0167	0.0009	0.1416	4
(1 цикл)	600	75	10	754	0.0110	0.0017	0.1712	3
	400	37	9	754	0.0130	0.0016	0.1636	1
	300	0	9	754	0.0410	0.0006	0.0548	1
2	1000	150	9	756	0.0110	0.0018	0.1119	8
	800	112	12	756	0.0053	0.0015	0.1378	6
(2 цикл)	600	75	12	756	0.0167	0.0019	0.1716	2
	400	37	10	756	0.0180	0.0017	0.1713	1
	300	0	10	756	0.0370	0.0007	0.0450	0
2	1000	150	10	756	0.0090	0.0018	0.1139	8
	800	112	11	756	0.0080	0.0017	0.1428	5
(3 цикл)	600	75	12	756	0.0140	0.0019	0.1743	2
	400	37	11	756	0.0160	0.0018	0.1684	1
	300	0	11	756	0.0290	0.0006	0.0466	1

No. of stage

Average measured values

Rpm

Mm Hg

The 1st cycle

The 2nd cycle

The 3rd cycle

Table 4 - Average values of pollutants emissions and the opacity of the exhaust gases (correction for pressure and temperature for CO, CH and humidity for NO) upon the operation of the 7Д80А diesel engine on the initial diesel fuel (at the 1st stage) and on the same fuel processed with the fuel catalyzer КТ-14Д (the 2nd stage)

Дата	№ этапа	n	$P_г$	$t_о$	$P_б$	Ra	Средние приведен	
							$CO_{пр}$	$C_6H_{14пр}$

Date No. of stage Average given

Protocol of tests No. 1-14/66 Sheet 19 Sheets 24

		об/мин	кВт	°С	мм рт.ст.	%	об%	об%
17.12.2013	1	1000	150	8	761	97	0.0140	0.0010
		800	112	8	761	97	0.0126	0.0010
		600	75	9	761	97	0.0146	0.0012
		400	37	9	761	97	0.0153	0.0013
20.12.2013		300	0	10	756	97	0.0222	0.0004
18.12.2013	2	1000	150	14	754	92	0.0162	0.0010
		800	112	15	754	92	0.0169	0.0009
	(1 цикл)	600	75	10	754	92	0.0111	0.0017
		400	37	9	754	92	0.0132	0.0016
		300	0	9	754	92	0.0415	0.0006
19.12.2013	2	1000	150	9	756	84	0.0111	0.0019
		800	112	12	756	84	0.0054	0.0015
	(2 цикл)	600	75	12	756	84	0.0168	0.0019
		400	37	10	756	84	0.0181	0.0017
		300	0	10	756	84	0.0373	0.0007
20.12.2013	2	1000	150	10	756	97	0.0091	0.0018
		800	112	11	756	97	0.0081	0.0017
	(3 цикл)	600	75	12	756	97	0.0141	0.0019
		400	37	11	756	97	0.0161	0.0018
		300	0	11	756	97	0.0257	0.0002

Rpm
kW
mm Hg
r
(the 1st stage)
(the 2nd stage)
(the 3rd stage)

Table 5 – Comparison of the results on definition of pollutants emissions with the exhaust gases in the testing modes obtained (upon the operation of the 7Д80А diesel engine on the initial diesel fuel (at the 1st stage) and on the fuel processed with the fuel catalyzer КТ-14Д (three cycles of the 2nd stage)

Дата	Этап	Цикл	Показатели	Значения параметров на режимах испытаний				
			Номер режима испытаний	1	2	3	4	5
			n, об/мин	1000	800	600	400	300
			Pr, кВт	150	120	75	37	0
17.12.2013	1		$CO_{пр}$, об%	0.0140	0.0126	0.0146	0.0153	-
20.12.2013	-		$CO_{пр}$, об%	-	-	-	-	0.0222
		Среднее	$CO_{пр_{ср}}^{исх}$	0.0140	0.0126	0.0146	0.0153	0.0222
18.12.2013	2	1	$CO_{пр}$, об%	0.0162	0.0169	0.0111	0.0132	0.0415
19.12.2013	2	2	$CO_{пр}$, об%	0.0111	0.0054	0.0168	0.0181	0.0373
20.12.2013	2	3	$CO_{пр}$, об%	0.0091	0.0081	0.0141	0.0161	0.0257
		Среднее	$CO_{пр_{ср}}^{обраб}$, об%	0.0121	0.0101	0.0140	0.0158	0.0348
$\delta CO_{пр}=(CO_{пр_{ср}}^{исх} - CO_{пр_{ср}}^{обраб})\cdot 100\% / CO_{пр_{ср}}^{исх}$, об%				*13.33*	*19.58*	*4.11*	*-3.27*[1]	*-56.91*[1]
С учетом погрешности измерений (±5 %), $\delta CO_{пр}$, об%				*8,33*	*14,58*	*0*	*2,271*	*-51,91*[1]
17.12.2013	1		$C_6H_{14пр}$, об%	0.0010	0.0010	0.0012	0.0013	-
20.12.2013	-		$C_6H_{14пр}$, об%	-	-	-	-	0.0004
		Среднее	$C_6H_{14пр_{ср}}^{исх}$	0.0010	0.0010	0.0012	0.0013	0.0004
18.12.2013	2	1	$C_6H_{14пр}$, об%	0.0010	0.0009	0.0017	0.0016	0.0006
19.12.2013	2	2	$C_6H_{14пр}$, об%	0.0019	0.0015	0.0019	0.0017	0.0007
20.12.2013	2	3	$C_6H_{14пр}$, об%	0.0018	0.0017	0.0019	0.0018	0.0002
		Среднее	$C_6H_{14пр_{ср}}^{обр}$, об%	0.0016	0.0014	0.0018	0.0017	0.0005
$\delta C_6H_{14пр}=(C_6H_{14пр_{ср}}^{исх} - C_6H_{14пр_{ср}}^{обр})\cdot 100\%/C_6H_{14пр_{ср}}^{исх}$, об%[2]				*-56.67*[1]	*-36.67*[1]	*-52.78*[1]	*-30.77*[1]	*-25.00*[1]

Date Stage Cycle Indices Values of parameters in testing modes
Number of testing mode
Average
Average
Taking into account the measurement inaccuracy
Average
Average

С учетом погрешности измерений (±5 %), $\delta C_6H_{14пр}$, об%[2]				*-51,67*	*-31,67*	*-47,78*	*-25,77*	*-20,00*
17.12.2013	1		$NO_{пр}$, об%	0.0728	0.0687	0.0848	0.0815	-
20.12.2013	-		$NO_{пр}$, об%	-	-	-	-	0.0401
		Среднее	$NO_{пр_{ср}}^{исх}$ об%	0.0728	0.0687	0.0848	0.0815	0.0401
18.12.2013	2	1	$NO_{пр}$, об%	0.0978	0.1207	0.1331	0.1262	0.0431
19.12.2013	2	2	$NO_{пр}$, об%	0.0841	0.1093	0.1373	0.1332	0.0356
20.12.2013	2	3	$NO_{пр}$, об%	0.0881	0.1129	0.1422	0.1355	0.0306
		Среднее	$NO_{пр_{ср}}^{обраб}$, об%	0.0900	0.1143	0.1375	0.1316	0.0364
$\delta NO_{пр}=(NO_{пр_{ср}}^{исх} - NO_{пр_{ср}}^{обраб})\cdot 100\% / NO_{пр_{ср}}^{исх}$ об%				*-23.63*[1]	*-66.38*[1]	*-62.19*[1]	*-61.51*[1]	*9.14*
С учетом погрешности измерений (±5 %), $\delta NO_{пр}$, об%				*-18,63*[1]	*-61,38*[1]	*-57,19*[1]	*-56,51*[1]	*4,14*

Taking into account the measurement inaccuracy
Average
Average
Taking into account the measurement inaccuracy

Notes. 1. The sign "-" means the excess of the pollutant concentration when the diesel engine is operating on the fuel processed with the fuel catalyzer КТ-14Д, in relation to the corresponding concentration of the pollutant when the diesel engine is operating on the initial fuel.

2. Due to the fact that the values of hydrocarbon concentrations in the hexane equivalent ($C_6H_{14ср}$) at all stages of the tests were much less than the accuracy of measurements, the difference in this index reflects the tendency of the hydrocarbon concentration change and is given for reference only (with the measurement inaccuracy of 5% at the used gas analyzer 325ФА02-01 The 1% of the upper limit of the measuring range of this component is 25mln- or 0.0025 vol%, while the measured values of the C6H14 concentration did not exceed 0.0020%).

Table 6 – Comparison of the pollutants emissions with the exhaust gases of the 7Д80А diesel engine at the third cycle of the tests of the 2nd stage and at the 1st stage of the tests (the initial fuel) in the testing modes No.No. 105

Дата	Этап	Цикл	Показатели	Значения параметров на режимах испытаний				
			Номер режима испытаний	1	2	3	4	5
			n, об/мин	1000	800	600	400	300
			Pr, кВт	150	120	75	37	0
17.12.2013	1		$CO_{пр}$, об%	0.0140	0.0126	0.0146	0.0153	-
20.12.2013	-		$CO_{пр}$, об%	-	-	-	-	0.0222
		Среднее	$CO_{пр_{ср}^{исх}}$	0.0140	0.0126	0.0146	0.0153	0.0222
20.12.2013	2	3	$CO_{пр}$, об%	0.0091	0.0081	0.0141	0.0161	0.0257
$\delta CO_{пр}=(CO_{пр_{ср}^{исх}} - CO_{пр_{зц}^{обр}})\cdot 100\% / CO_{пр_{ср}^{исх}}$, об%				35.00	35.71	3.42	-5.23[1]	-15.77[1]
С учетом погрешности измерений (±5 %), $\delta CO_{пр}$, об%				***30,00***	***30,71***	***0***	***-0,23[1]***	***-10,77[1]***
17.12.2013	1		$C_6H_{14пр}$, об%	0.0010	0.0010	0.0012	0.0013	-
20.12.2013	-		$C_6H_{14пр}$, об%	-	-	-	-	0.0004
		Среднее	$C_6H_{14пр_{ср}^{исх}}$	0.0010	0.0010	0.0012	0.0013	0.0004
20.12.2013	2	3	$C_6H_{14пр}$, об%	0.0018	0.0017	0.0019	0.0018	0.0002
$\delta C_6H_{14пр}=(C_6H_{14пр_{ср}^{исх}} - C_6H_{14пр_{ср}^{обр}})\cdot 100\%/C_6H_{14пр_{ср}^{исх}}$, об%[2]				-70.00[1]	-70.00[1]	-58.33[1]	-38.46[1]	50.00
С учетом погрешности измерений (±5 %), $\delta C_6H_{14пр}$, об%[2]				***-65.00***	***-65.00***	***-53.33***	***-33.46***	***45.00***

Date Stage Cycle Indices Values of parameters in testing modes
Number of testing mode
Average
Taking into account the measurement inaccuracy
Average
Taking into account the measurement inaccuracy

17.12.2013	1		$NO_{пр}$, об%	0.0728	0.0687	0.0848	0.0815	-
20.12.2013	-		$NO_{пр}$, об%	-	-	-	-	0.0421
		Среднее	$NO_{пр_{ср}}^{исх}$, об%	0.0728	0.0687	0.0848	0.0815	0.0300
20.12.2013	2	3	$NO_{пр}$, об%	0.0881	0.1129	0.1422	0.1355	0.0306
$\delta NO_{пр}=(NO_{пр_{ср}}^{исх} - NO_{пр_{ср}}^{обраб})\cdot 100\% / NO_{пр_{ср}}^{исх}$ об%				-21.02[1]	-64.34[1]	-67.69[1]	-66.26[1]	23.69
С учетом погрешности измерений (±5 %), $\delta NO_{пр}$, об%				**-16,02[1]**	**-59,34[1]**	**-62,69[1]**	**-61,26[1]**	**18,69**

Taking into account the measurement inaccuracy

Notes: 1. The sign "-" means the excess of the pollutant concentration when the diesel engine is operating on the fuel processed with the catalyzer КТ-14Д in relation to the correspondent concentration of the pollutant when the diesel engine is operating on the initial fuel.

2. Due to the fact that the values of hydrocarbon concentrations in the hexane equivalent $(C_6H_{14ср})$ at all stages of the tests were much less than the accuracy of measurements, the difference in this index reflects the tendency of the hydrocarbon concentration change and is given for reference only.

Results of tests

1. The tests of the 7Д80А diesel engine upon the use of the fuel catalyzer КТ-14Д were carried out in the volume and sequence established in the Program and methods of stand tests. The tests shall be considered as completed.

2. The fuel economy of the 7Д80А diesel engine (2ЧН 26/27) when used for processing the diesel fuel with the catalyzer КТ-14Д after 15 hours of the catalyzer operation constituted 2.67% in the full power mode, 2.57% in the mode 0.75 of full power, 1.24% in the mode 0.5 of full power, 2.43% in the mode 0.25 of full power and 1.92% at idling speed.

The fuel economy of the 7Д80А diesel engine (2ЧН 26/27) (taking into account the measurement inaccuracy +-1) when used for processing the diesel fuel with the catalyzer КТ-14Д after 15 hours of the catalyzer operation constituted 1.67% in the full power mode, 1.57% in the mode 0.75 of full power, 0.24% in the mode 0.5 of full power, 1.43% in the mode 0.25 of full power and 0.92% at idling speed.

3. The concentration of the pollutants emissions in the exhaust gases of the7Д80А diesel engine (2ЧН 26/27) (adjusted on pressure and temperature for

CO, CH and humidity for NO), when applied for the processing of the diesel fuel with the catalyzer КТ-14Д (for three cycles of the second stage of the tests) constituted (in parentheses are given the data of measurements when working on the initial fuel): in the full power mode, the concentration of carbon monoxide (CO) - 0.0121 (0.0140) vol.%; the concentration of the sum of hydrocarbons (CH) in the hexane equivalent – 0.0016 (0.0010) vol.%; the concentration of nitric oxide (NO) - 0.0900 (0.0728) vol.%; in the mode of 0.75 of full power, the concentration of carbon monoxide (CO) is 0.0101 (0.0126) vol.%; the concentration of the sum of hydrocarbons (CH) - 0,0014 (0,0010) vol.%; the concentration of nitrogen oxide (NO) - 0.1143 (0.0687) vol.%; in the mode of 0.50 of full power, the concentration of carbon monoxide (CO) is 0.0140 (0.0146) vol.%; the concentration of the sum of hydrocarbons (CH) – 0.0018 (0.0012) vol.%; the concentration of nitric oxide (NO) - 0.1375 (0.0848) vol.%; in the mode of 0.25 of full power, the concentration of carbon monoxide (CO) is 0.0158 (0.0153) vol.%; the concentration of the sum of hydrocarbons (CH) – 0.0017 (0.0013) vol.%; the concentration of nitrogen oxide (NO) - 0.1316 (0.0815) vol.%; at idling speed, the concentration of carbon monoxide (CO) is 0.0348 (0.0222) vol.%; the concentration of the sum of hydrocarbons (CH) - 0.0005 (0.0004) vol.%; the concentration of nitric oxide (NO) is 0.0364 (0.0401).

The concentration of the pollutants emissions in the exhaust gases of the 7Д80А diesel engine (2ЧН 26/27) (adjusted on pressure and temperature for CO, CH and humidity for NO), when applied for the processing of the diesel fuel with the catalyzer КТ-14Д after 15 hours of the catalyzer operation constituted (in parentheses are given the data of measurements when working on the initial fuel): in the full power mode the concentration of carbon monoxide (CO) is 0.0091 (0.0140) vol.%; the concentration of the sum of hydrocarbons (CH) in the hexane equivalent – 0.0018 (0.0010) vol.%; the concentration of nitric oxide (NO) – 0.0881 (0.0728) vol.%; in the mode of 0.75 of full power the concentration of carbon monoxide (CO) - 0.0081 (0.0126) vol.%; the concentration of the sum of hydrocarbons (CH) – 0.0017 (0.0010) vol.%; the concentration of nitric oxide (NO) - 0.1129 (0.0687) vol.%; in the mode of 0.50 of full power, the concentration of carbon monoxide (CO) is 0.0141 (0.0146) vol.%; the concentration of the sum of hydrocarbons (CH) – 0.0019 (0.0012) vol.%; the concentration of nitrogen oxide (NO) - 0.1422 (0.0848) vol.%; in the mode of 0.25 of full power, the concentration of carbon monoxide (CO) is 0.0161 (0.0153) vol.%; the concentration of the sum of hydrocarbons (CH) – 0.0018 (0.0013) vol.%; the concentration of nitric oxide (NO) - 0.1355 (0.0815) vol.%; at idling speed, the concentration of carbon monoxide (CO) is 0.0257 (0.0222) vol.%; the concentration of hydrocarbons (CH) - 0.0002 (0.0004) vol.%; the concentration of nitric oxide (NO) is 0.0306 (0.0401) vol.%.

4. The opacity of the exhaust gases (the absolute value) in the modes of full power and 0.75 of full power when the diesel engine is operating on the fuel processed with the catalyzer КТ-14Д, increased by 4% and 1.3%

accordingly. In the other test modes, the difference between the opacity of the exhaust gases during the operation of the diesel engine on the initial fuel and the fuel processed with the catalyzer КТ-14Д was within the measurement inaccuracy of the opacimeter (± 1%). The measured values of the opacity are within the limits established by ГОСТ for diesel engines of this class (no more than 14%).

Since the laboratory diesel 7Д80А in the period of these tests worked in the modes of diesel locomotive characteristics, which have no analogs in operation, therefore the obtained absolute value of the concentration of pollutants will differ from the concentrations of pollutants emissions with the exhaust gases of actually existing engines depending on their model and power according to the locomotive characteristic. Therefore, the compliance with the standards for pollutants emissions in the exhaust gases using the catalyzer КТ-14Д must be determined on each type of engine installed on a specific series of locomotives.

5. The main parameters of the operating process, such as the maximum combustion pressure (average) for the $P_z^{ср}$, cylinders, the exhaust gas temperature in the cylinders (average) $t_ц^{ср}$, the rotor speed of the turbocharger $n_{тк}$, the excess air pressure in the $P_s^{изб}$, receiver, the excess pressure of the exhaust gases in front of the turbine $P_т^{изб}$, not changed.

6. The effects of the fuel catalyzer КТ-14Д on the performance of fuel equipment and fuel filters for these tests were not revealed.

7. In the diesel fuel processed with the catalyzer КТ-14Д, the flash point changed from 66 to 64 °С, the acid number increased from 0.79 to 1.07, the fuel distillation temperature increased by fractional composition at 50% from 248 to 261 °С, at 96% from 350 to 363 °С.

8. No significant changes were observed in the lubricating oil after the tests.

Conclusion

On the basis of the aforesaid the commission notes:

1. The catalyzer КТ-14Д when installed on a diesel engine has no negative effect on the fuel system and conrod-piston group of the engine.

2. When the diesel fuel passes through КТ-14Д and after its interaction with catalytic elements, the chemical composition of the fuel does not change.

3. At each stage of the tests, there is a steady trend in fuel economy.

4. The environmental indicators of emissions of harmful substances, taking into account the ideal parameters of stand

the engine remained practically unchanged within the inaccuracy limits.
5. The use of КТ-14Д is recommended on the used engines.