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Improving The Economy Of Diesel Engines With The Upgraded Sprayer Of The Injector.

Anatoly Timofeevich Lebedev[1]*, Pavel Anatolyevich Lebedev[1], Aslan Karalbievich Apazhev[2], Artur Mukhamedovich Egozhev[2], and Anzor Leonidovich Bolotokov[2].

[1]Stavropol State Agrarian University, Zootekhnicheskiy lane 12, Stavropol 355017, Russia.
[2]Kabardino-Balkarian State Agrarian University named by V.M. Kokova, Lenin Ave. 1v, Nalchik 360030, Kabardino-Balkar Republic, Russia.

ABSTRACT

Of the total number of failures of diesel engines on the power supply system, up to 40%. The obtained mathematical models show that the cyclic feeding has a significant effect on the overall fuel consumption. In turn, the cyclic fuel supply depends on the fuel properties and design-technological parameters of the injector atomizer. The injector atomizer, operating under severe conditions of high-temperature cylinder gas, is the weakest link in the fuel equipment and has a significant effect on the cyclic fuel supply. To improve efficiency, economy, and reliability, functional redundancy of the properties of the injector injector surfaces due to the modernization of the spray injector has been performed. A helical groove is provided in the guide part of the atomizer, which contributes to the asymmetric pressure of the fluid flowing from the grooves into the gap between the body and the guide part. To confirm the proposed provisions, experimental studies of cyclic feed rates, the economy of a diesel engine with serial and modernized injectors were performed. Studies of the uneven cyclic feeding show that the unevenness of feeding on unsteady operating modes of a diesel engine is 8 ... 12% and 18.5 ... 34% for a fuel pump equipped with modernized and serial injectors of injectors, respectively. The use of modernized atomizer injectors made it possible to improve the efficiency of the use of diesel engine power by increasing the power (Ne) within 8.8 ... 12.5%, reducing the specific fuel consumption by 3.3 ... 4.1%, increasing the twisting torque on the motor shaft (Me) by 5.2 ... 7.8%, and also reduce the overall fuel consumption (GT) by 2.5 ... 4.2%.

Keywords: diesel engine, injector, atomizer, efficiency, modernization.

Corresponding author

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INTRODUCTION

The production of agricultural products is currently associated with the use of a large variety of energy facilities, usually equipped with diesel engines. In the implementation of technological processes (TP), energy means, as one of the key elements of the triune system of Academician V.P. Goryachkina, is the main and main source of costs for products. The indicators for the economy of diesel engines of power equipment (DEPE) in the process of operation significantly change. The decrease in power, increase in fuel consumption, as well as increase in failures of DEPE systems, units and parts is largely determined by the operability, level of operation and reliability of fuel equipment (FE).

As practice shows and studies carried out [1], 60% of all failures are associated with the engine. Diesel engine failures associated with failure of the lubrication system are 7.6%, cooling systems - 9.3%, power systems - 39.8%, gas distribution system - 3.9%. The main part of the malfunctions and the causes that cause a decrease in the efficiency of the TP are accounted for by the injectors of fuel system injectors, the resource of which fluctuates in a wide range of 500 ... 1600 moto-hours [2].

The conditions and operating conditions of the DEPE are also of special significance. The conducted studies showed that the maximum load of the tractors' engines is accounted for the performance of such technological operations as sowing and plowing, and ranges from 75 ... 89%, with such engine load, the technician works up to 60% of the total time of its use. Currently in the village. 80.3% of the total annual volume of work is performed by universal tractors, such as transportation and inter-row processing, the working time is 50%, 47% for fodder harvesting, 45% cultivation and 47% fertilization [3]. Frequent changes in the loading of tractors not only lead to changes in the operating modes of the engine, but also to varying operating modes of the fuel pump, which provides the necessary fuel supply parameters in accordance with the loading of tractors. In this case, the indicators of the economics of DEPE will decrease significantly earlier than the specified operating time of atomizer injectors, which emphasizes the urgency of modernizing the properties of the working surfaces of parts (WSP) and maintaining optimal conditions for their operation.

MATERIALS AND METHODS

To develop proposals for improving the ways to improve the efficiency of DEPE (using the 4K11/12.5 engine as an example), we used a promising technique to improve the efficiency of the TP [4, 5] in our studies, as well as the known dependencies for estimating the fuel efficiency of diesel engines.

Common indicators of fuel economy of diesel engines are: N_e - engine power; g_e is the specific fuel consumption; M_{kr}-torque on the motor shaft; G_T is the hourly fuel consumption.

The power of DEPE depends on the torque on the motor shaft obtained at the brake stand M_{kr} and the engine speed n:

$$N_e = 0.105 \times M_{kr} \times n, \quad (1)$$

Then, the specific fuel consumption can be determined by the formula:

$$g, \quad (2)$$

Taking into account the known values for a diesel engine of 4 × 11 / 12.5 hours, fuel consumption can be determined from the expression:

$$G_m =, \quad (3)$$

As can be seen from the presented dependencies, the cyclic fue,l supply (CFS) and the quality of its preparation for the implementation of the DEPE workflow have a significant effect. The analysis of the studies made it possible to establish the main parameters that affect the CFS in the form of a functional dependence:

$$q_c = f(P_e, t, P_v - P_{k.s.}, \tau, {}_pf_p, h, V_\delta, \rho, \quad (4)$$

P_e - effective pressure in the injector openings;
t - duration of injection;
P_v-$P_{к.s.}$ - difference in injection pressure and pressure in the combustion chamber of the engine;
τ - hydraulic density of the atomizer;
${}_pf_p$ - effective cross-section;
h - needle stroke;
V_δ - volume of fuel in the atomizer slit;
ρ - fuel density;
t - fuel temperature;
Q - coefficient of gap resistance;
C_{zag} - degree of contamination of fuel.

According to expression (4), the CFS parameters determining the quantity and quality of the fuel atomization depend mainly on the fuel properties and the design and technological parameters of the injector atomizer. The obtained theoretical dependences allow us to establish a connection between the indicators of profitability of DEPE and the parameters of the injector atomizer. In this case, according to [4, 5], the working surfaces of the injector atomizer (WSIA), being the lowest elements in the DEPE hierarchical scheme, allow controlling the reliability and efficiency of DEPE as a whole.

The injector atomizer, which is used in severe conditions of exposure to high-temperature cylinder gases, is the weakest link in the DEPE FE and has a significant impact on the CFS. Its quality depends on the quality of spraying and the accuracy of fuel dosing, and as a result, the power, efficiency, efficiency, and reliability of DEPE [3, 4].

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Using the technique [5], in order to increase the efficiency of DEPE and the efficiency of use, a functional redundancy of the properties of the WSIA was accomplished by modernizing the needle of the atomizer [6]. A helical groove is provided in the guide part of the atomizer, which contributes to the asymmetric pressure of the fluid flowing from the grooves into the gap between the body and the guide part. This modernization contributes to the uniform wear and tear of WSIA, eliminates the hanging of the needle, improves the quality of spraying fuel. To confirm the proposed provisions, experimental studies of the CFS indicators and the economics of DEPE with serial and modernized injectors were performed.

RESULTS AND DISCUSSION

Testing and adjustment of the injectors under investigation were carried out in the laboratories of KBGSA and SSAU on the instrument KI-3333 (GOCHITI) and at the test bench for injectors KI-35478.

The experiments were carried out with triplicate repetition, the research object was the fuel system of the D-240 engine with the UTN-5 pump and the FD-22 injectors. The parameters of the injectors were determined on instruments KI-35478, KI-3333, the mobility of the sprayer's needle was controlled by the PUF-3 instrument of TsNITA, the hydraulic characteristics were determined on the KI-22201 stand with the KI-15713 toolkit for determining the effective cross-section. According to the results of spilling injectors and fuel

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lines on a control bench with a standard fuel pump with a fixed strip, according to the method of research, a set of serial injectors was selected, the throughput of which differs no more than ± 1 cm^3 per 2 plunger strokes. The second set was made up of injectors with upgraded diffusers. To investigate the fuel supply parameters, a control injection pump was assembled according to the experimental procedure - UTN-5 (diesel mode 4 × 11 / 12.5).

The identity of the fuel supply parameters was determined at the most loaded nominal mode. The given data allow tracing successively the dynamics of parameters and TSC changes during the operational tests for each atomizer separately, as well as a number of basic parameters for sets of injectors.

The experience of investigating the stability of cyclic feeds in sections of high-pressure pumps when it was equipped with modernized injectors, the method of successively changing the injectors for each section, showed that the nonidentity, in this case, does not exceed ± 3%. The installation of the injectors tested for all sections of the pump and all injectors per section gave a deviation from the set value of the TSC ± 1.5%. The results of these studies are presented in Figure 1.

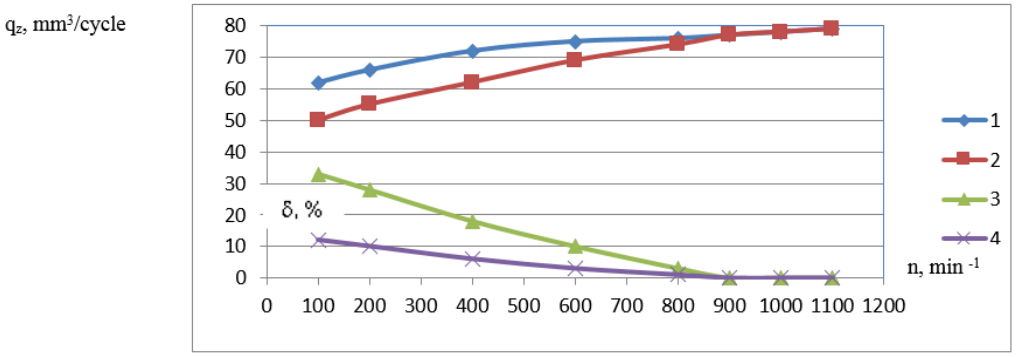

Figure 1: Velocity characteristics of the fuel pump UTN-5 engine D-240
1 and 2 - cyclic feed, respectively, with upgraded and serial injectors;
3 and 4-uneven feeding, respectively, with serial and modernized injectors

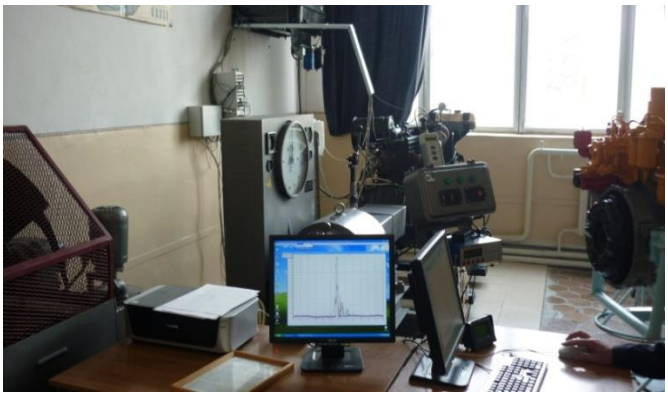

Figure 2: Brake unit KI-5543 with the control engine D-240

When analyzing the data obtained, it is evident that at high camshaft speeds corresponding to a high load of the diesel engine at nk = 850 ... 1100 min^{-1}, the unevenness of the TSC does not exceed 2%, with a decrease in the rotation speed of the camshaft to nk = 400 ... 800 min^{-1} The unevenness is 2.7 ... 16.1%.

Power and economic indicators, when studying the work of the DEPE, equipped with a power system with serial and modernized injectors, were determined by bench motor tests at the KI-5543 electric brake stand (Fig. 2).

Analysis of the obtained dependences showed that the power of DEPE equipped with experienced RFTA ranged from 18 ... 55.5 kW, and with serial RFTA 16 ... 51 kW, at the corresponding engine shaft rotation

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frequency. Specific fuel consumption of DEPE completed with experienced RFTA was 288 ... 240 g / kW, with standard equipment of -300 ... 248 g / kW. The torque on the motor shaft with the experienced RFTA was 274 ... 242 Nm, and with the serial - 254 ... 230 Nm. The total fuel consumption of DEPE equipped with experienced RFTA was 4.8 ... 12.1 kg / h, and with serial - 4.8 ... 12.4 kg / h.

When carrying out bench tests, using the example of the diesel 4h11 / 12.5, the speed characteristics of the DEPE shown in Figure 3 were obtained.

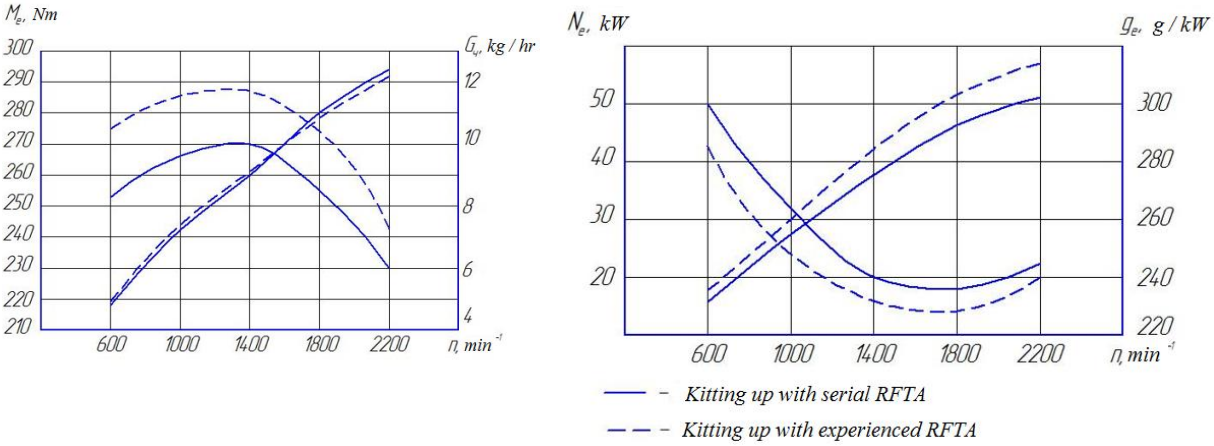

Figure 3: High-speed characteristics of the diesel 4h11 / 12,5

The use of modernized RFTA in DEPE allowed increasing the power (N_e) within the range of 8.8 ... 12.5%, reducing the specific fuel consumption (g_e) by 3.3 ... 4.1%, increasing the torque on the motor shaft (M_e) by 5 , 2 ... 7.8%, and also reduce the overall fuel consumption (G_T) by 2.5 ... 4.2%.

CONCLUSION

The use of a promising method to improve the efficiency of the TP allowed us to identify the lowest element of the system for controlling the reliability and efficiency of TP through improving the efficiency of DEPE by modernizing and generating the required properties of RFTA.

Functional redundancy of RFTA properties due to the modernization of the needle of the nebulizer improves the WSP when the high-speed characteristic of the injection pump is removed. The unevenness of supply at non-stationary operating modes of DEPE at 8 ... 12% and 18.5 ... 34% for injection pump, equipped with modernized and serial FE, respectively.

The use of modernized injectors F-22 (using the example of the diesel 4h11 / 12.5) confirm the hypothesis of increasing the efficiency of the use of energy resources by improving the efficiency of DEPE.

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