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RESEARCH ON POSSIBILITY OF INCREASED FUEL ECONOMY WHILE AT LIGHT LOADING OF THE DIESEL ENGINE OF WHEELED TRACTOR

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ABSTRACT

We proved by experiment the theory that in the MTZ tractor commonly used in various sectors of industry that fuel efficiency is lost at light loading. For the first time we applied the changes in design to the oblique edge of diesel engine pump element. In order to economize on fuel, we made an extra groove in the plunger which is used in the fuel system of the diesel engine of the MTZ wheeled tractor. Pump elements in which we have made design changes should be installed in 50% of the pump sections of multi-cylindered diesel engines, in every other section according to engine timing. Modified pump elements will improve fuel economy at light loading of the diesel engine as well as during the engine shut off. Up to now no design change has been made to the standard design of the UTN fuel pump element manufactured by the Nogine industry of Russia in order to increase fuel efficiency during idle and light load of the tractor engine.

KEYWORDS: Tractor, diesel engine, pump element, fuel.

INTRODUCTION

Today's standard design of a pump element dedicated to inject fuel into each cylinder of the diesel engine does not adequately reduce fuel consumption while at an idle or light loading of the tractor, but it gives a constant amount into the engine. Therefore, the main purpose is to increase fuel efficiency and enhance specific fuel consumption.

A theoretical estimation of the D-240 engine used in the MTZ-80 tractor proved that specific fuel consumption increases when revolution of the crankshaft decreases and power decreases.

The specific fuel consumption increases categorically when the RPM and power of the diesel engine decreases and the efficient use of the fuel decreases. Thus the problem of inefficient fuel consumption is the theoretical validation of the research.

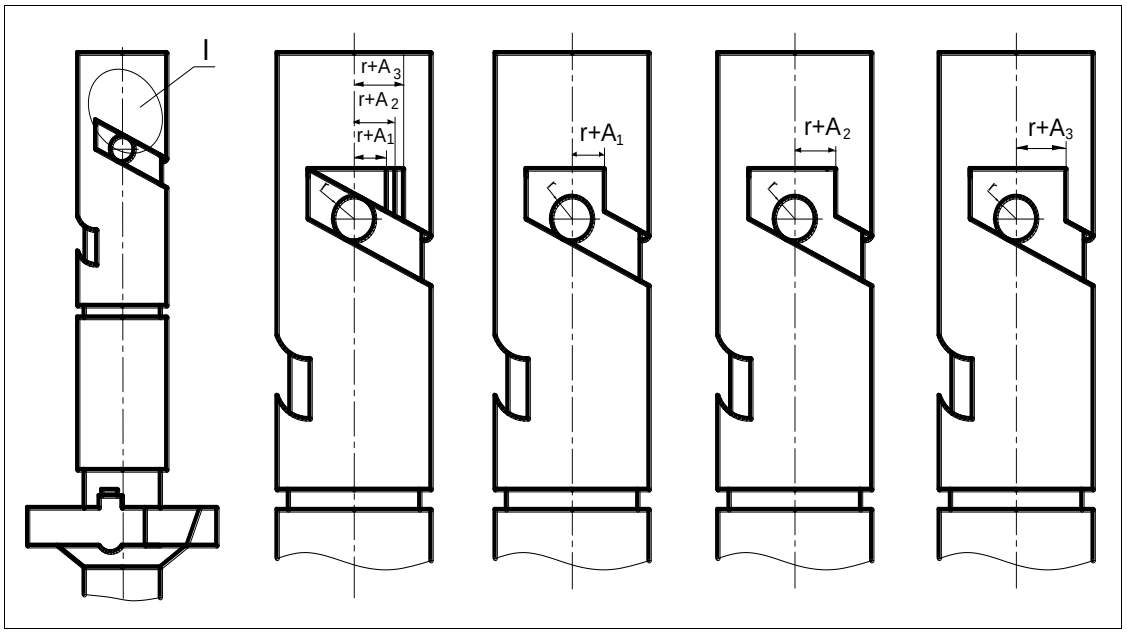
One feasible method to reduce inefficient fuel consumption while under light loading of the wheeled tractor's diesel engine is a revision to the plunger by making an extra groove in the working surface. The main goal of the extra groove is to increase the action thus reducing fuel consumption during light loading of the tractor aggregate.

First it is required to select and experiment with several variations to the area above the helical groove of the plunger. Cutting too small of an amount from the working surface decreases the chance of economizing fuel and conversely cutting too much would have the negative effect of decreased engine power and a reduction in productivity of the tractor aggregate.

MATERIALS AND METHODS

We have chosen three different dimensions that will not influence engine power but will enhance fuel economy under light load.

The design changes we have formulated for the pump element involve making an extra groove in the area above the helical groove of the plunger of the UTN-5 fuel injection pump. The three widths will be measured r+1.6, r+2.0, r+2.4 mm from the central axis of the spill passage. (Fig. 1).



(a) (b) (c) (d) (e)

Fig. 1: Versions of an extra groove in the working surface of plunger.

Here: I – amenable zone, r – radius of spill passage, A = 1.6…2.4 mm – experimental limitation of extra groove; a) unmodified plunger; b), c), d) and e) versions of the extra groove in the plunger surface.

According to the description of Fig.1, making changes on the top side of the plunger UTN-5 pump will cut fuel during the light loading of the engine. The procedure to make a triangle-shaped hollow groove is complicated and would require very meticulous machining; therefore, Russian experts have made a groove parallel to the vertical axis with the various widths specified in Fig.1, to make changes to the working surface of the plunger. (Fig.2).

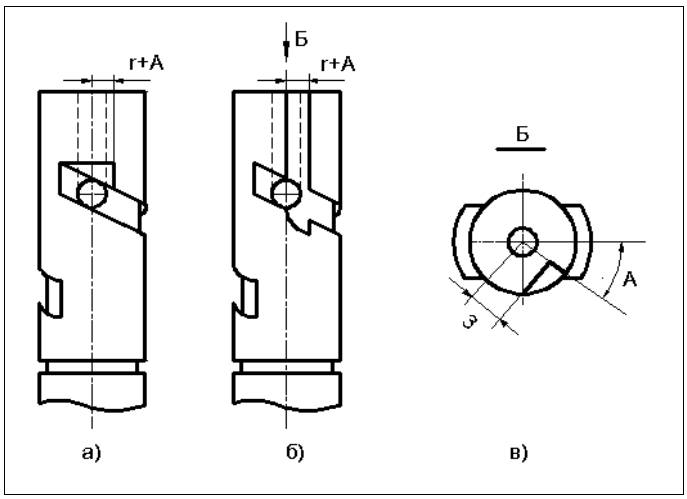


Fig. 2: Scheme of the pump element in which the design changes have been made.

Here: a) original design modification b) changes to original design c) view of the extra groove from the topside; A – size of groove in degrees, 3 – distance until central position (O_0) of the beginning of fuel off from the trace of D- flat, mm.

In principle there is no difference to the performance of the duties, whether the changes in the working surface of the plunger are triangular or a parallel groove with the vertical axis. Both eliminate fuel consumption at light loading of the engine. The main reason we chose to make the groove triangle-shaped is to maintain a closed curl in the head side of the plunger.

RESULTS AND DISCUSSION

We performed the experiment, not in the usual way which is eliminating fuel by the suitable rotation and location of the control rack, but rather installed and tested the non-standard or modified pump element and the standard pump element in alternating positions in the UTN-5 pump sections. We also changed the position of the rack by 15 mm to reduce movement (400 min^{-1}) and still maintain smooth running of the engine.

The following graph showing a speed state graphic was built by the properties of the cycle fuel. (Fig.3).

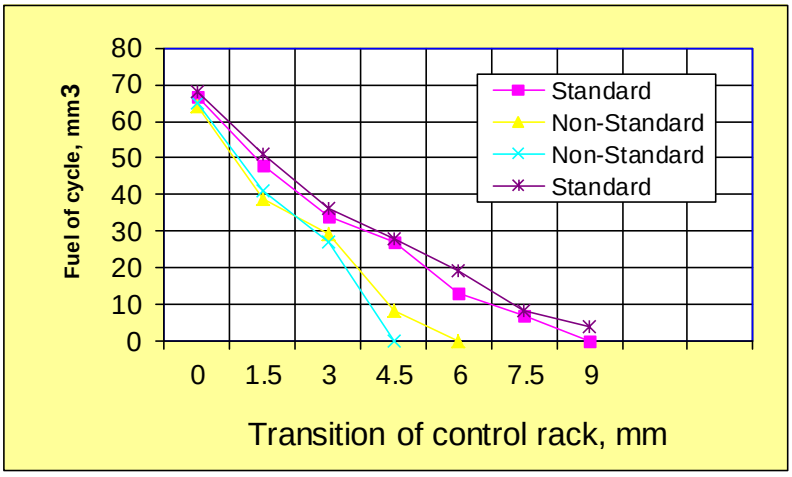


Fig. 3 Comparative speed state showing the level pump`s fuel injection.

As seen from the above Fig. 3, the pump element to which we have made the design changes is better at reducing fuel than the standard pump element when the rack position is 4.5 mm and 6 mm.

To establish the control, we installed the standard pump element into all sections of the UTN-5 fuel injection pump, made an adjustment on the test bench according to the methodology

and operated the MTZ-80 tractor in 7th gear. We towed a tractor with its transmission at first in neutral and then changed the load from light to heavy by starting in 9th gear and moving through the gears to 6th gear. We executed the field experiment on 100 km of road.

Following this, the standard pump element was installed into 2 sections of the engine and the modified pump element into the other 2 sections. We put the UTN-5 fuel injection pump in which the calibration was made identical to that in the control experiment on the engine of the previously used MTZ-80 tractor. In order to compare the fuel consumption, we executed the experiment with the same 5 gearing conditions as in the control.

The more the engine load of MTZ-80 tractor increases, the more the fuel consumption increases. The graph shows that fuel consumption during the operation of the standard and modified pump elements is dependant on load. (Fig. 4).

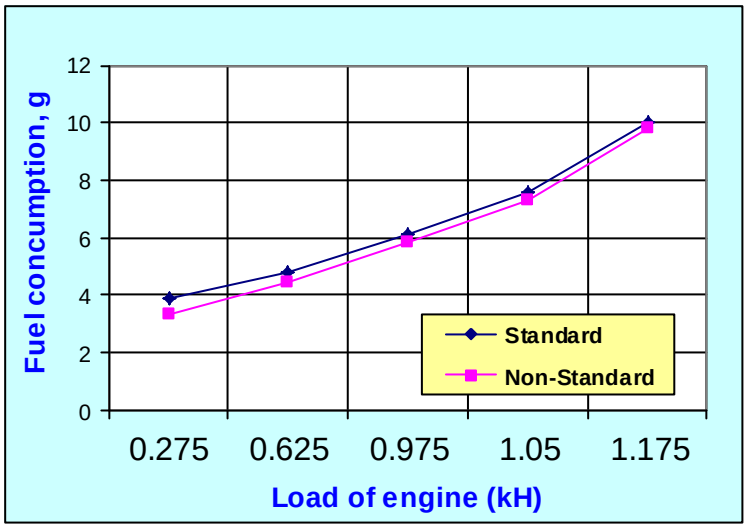


Fig. 4: Dependence of fuel consumption of the MTZ-80 tractor at varying engine loads.

CONCLUSIONS

1. The result of the experiment was increased fuel economy of 13 % during operation of the modified pump element in the MTZ-80 tractor engine when under light load and 1.7 % under heavy load.
2. We experimented with the tractor on a 100 km stretch of road with various loads (between 10% and 80%) and compared the fuel usage of both the standard and modified element to determine the fuel reduction achieved.
3. We operated the T-25A tractor with the UTN pump on the road 15 times for a duration of 35 minutes each. Fuel economy with one of the two cylinders employing the modified

pump element was 7% greater that of two cylinders employing the standard pump element.

4. As seen from the graph (Fig. 4) which shows fuel consumption in relation to load, there is a notable difference between fuel usage of the standard element and the modified element during light load but the difference has been reduced during heavy load. This proves that the modified element works the same as the standard element during heavy load when more power is required.
5. The modified pump element economized fuel better than the standard pump element whether in regular or high RPM of the MTZ-80 tractor's engine, reducing the fuel usage accordingly.
6. There was a dissimilarity in the fuel consumption during the operation of the modified pump element installed in the T-25A tractor and operation of the standard pump element. This proves in practise our hypothesis that the design changes will decrease fuel consumption during light loading of the wheeled tractor dedicated to agriculture.

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