STUDY OF DIESEL FUEL FEED SYSTEM WITH DIVIDED PROCESSES OF FORCING AND DOSING OUT

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Abstract

A fuel delivery method that patented by authors realised by numerical and natural experiments. The traditional system is added a lock organ before an injector. The injector cavity is connected with the force main only for the time of injecting fuel. After a valve closing the injector cavity is connected with the cavity of low pressure. When cutting off at the end of the working plunger stroke the force main is discharging. In a delivery high-pressure the accumulation of energy flow takes place, it increases speed growing of pressure in the injection beginning. The valve closing is accompanied by fast pressure decrease in the end of injection process. Such feeder of fuel allows dividing forcing and dosing out processes. It improves, in comparison with traditional, both adaptive and power properties of system. Numerical experiments confirm working capacity of the modernised fuel feed system. Defined influence of its basic constructive and adjusting parameters on indicators of process of fuel delivery is presented. The offered system allows a flexible adjustment of the cycle fuel feed when changing a high speed regime as well as providing for a set speed Diesel characteristic and a versatile regulation if the cycle feed at Diesel start. The numerical experiments confirm the efficiency of the experimental system of fuel feed.

Keywords: *the system modernization, the locking device, a giving phase, pilot giving, the differential characteristic*

Building of high speed transport diesels is restricted by the absence of fuel systems providing an intensive fuel feed which means a high pressure and small duration of injection.

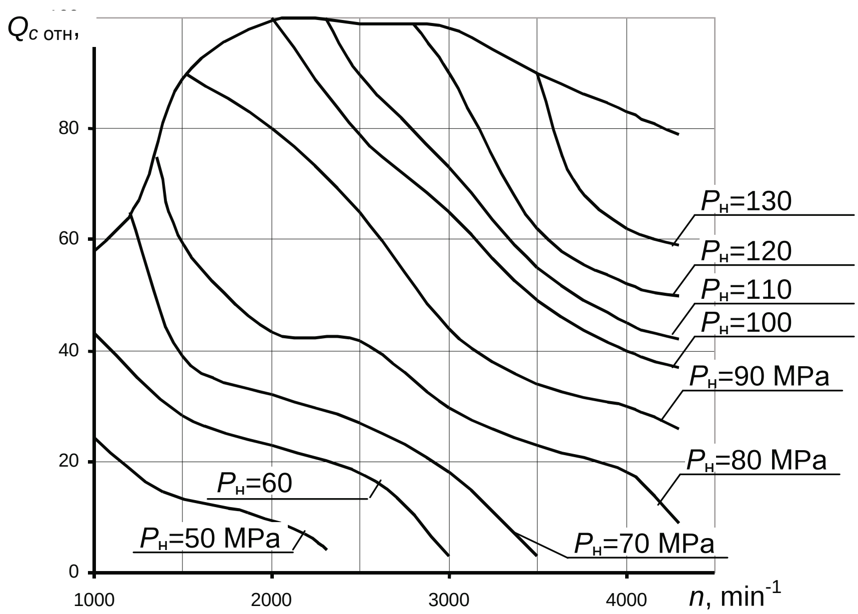

Fig. 1. The dependence of optimal pressure P_H in the accumulation system "Common Rail" on the engine shaft rotation frequency and the relative cycle feed Q concerning the Diesel Mercedes OM611 [1]

Raising the injection fuel pressure should be accompanied by a search for its pressure optimal values at different combination of high speed and loading rates of diesel work. The dependence of P_{inj} on the high speed and loading regimes is still regarded as a disadvantage of a traditional fuel feed system. However, typical for this system changing P_{inj} according to the regimes is considerably nearer to the optimal one then in the case of constant by P_{inj} [2] (Fig. 1). Under pressure in the accumulator P_H (Figure 1) it is meant the injection pressure P_{inj} in the traditional system. In any case it is important to know an optional combination P_{inj} and regime parameters of Diesel (n, Q_c). A modern level of electronic technique development permits to support an optimal value P_{inj} [2] under any combination of the high speed and loading Diesel regimes.

The research experience showed that it is easier to achieve an optimal combination P_{inj} with the Diesel rate parameters when completing the traditional fuel system which advantageously differs the latter one from the accumulation system Common Rail.

The proposed method of fuel feed provides for the use of the traditional fuel system of a divided type. Its modernization consists in mounting a lock organ before an injector (an electromagnetic valve) at the injector cavity is connected with the force main only for the time of injecting fuel. The lock organ is arranged so in such a way that after its closure the injector cavity is connected (comes in contact) with the cavity of low pressure. The installation of an additional valve requires an increase of the working plunger stroke. When cutting off at the end of the working plunger stroke the force main is discharging [3]. The whole process of the fuel feed is divided into several phases. At first the fuel is fed to the force main of high pressure where the accumulation of energy flow takes place. This allows increasing the speed growing of pressure during the following (base) phase – the injection after closing the valve there follows a phase of rapid pressure lowering by refeeding the fuel into the low pressure main. Thus, we succeed in raising the pressure in the system when completing the process of the fuel feed and due to which the proposed system advantageously differs from the standard one.

In the modernized system the whole cycle portion of fuel is fed to the cylinder during the time the active plunger stroke. The moment of the valve opening start is defines the maximum injection pressure. An earlier opening of the valve decrease P_{inj} but a later one increases it. At each frequency of the pump shaft rotation the angle if the valve opening start corresponding to the rising limit $P_{inj\ max}$ has been defined for Q_c=71 mm^3. The moment of valve closing defines the amount quantity of the cycle fuel feed at the fixed angle of opening the valve for each frequency of n_{sh}=1000 min^{-1} one succeed in obtaining a different cycle fuel feed at the fixed maximum injection pressure P_{inj} .

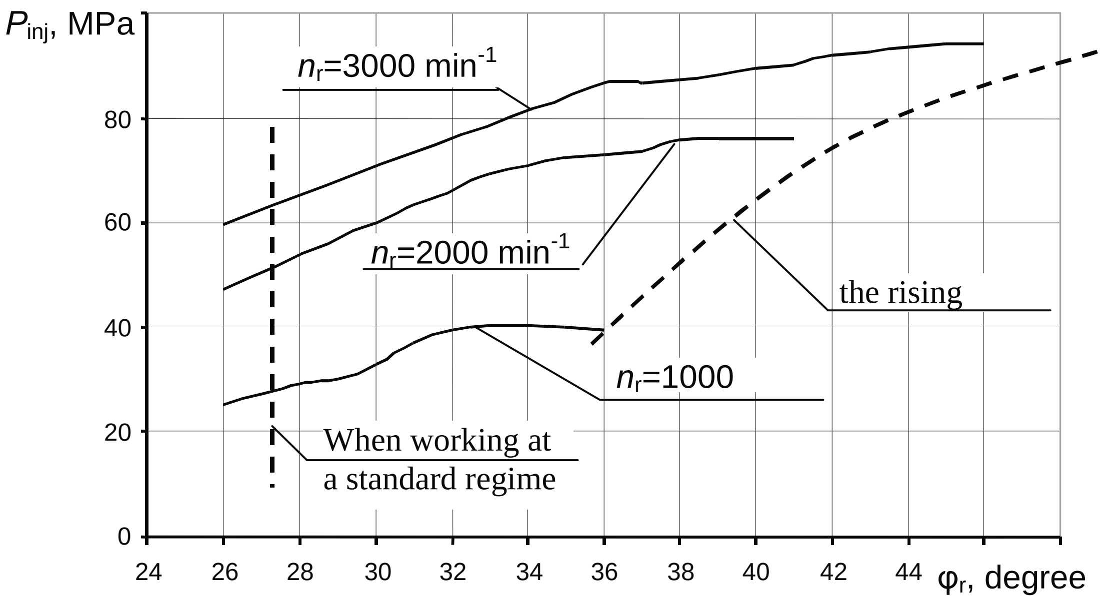

Fig. 2. The Dependence of the maximum pressure of the injection fuel P_{inj} on the angle of valve opening φ_{open}

As a result of numeral experiments it has been stated that in order to obtain a cycle fuel portion 71.5 mm^3 and the most possible injection pressure (n_{shaft}=1000 min^{-1}) an additional valve should be opened for the time corresponding to the shaft rotation of the pump by 7.3 grades (Figure 3). At n_{shaft}=2000 min^{-1} and n_{shaft}=3000 min^{-1} the additional valve should be opened for the time corresponding to the shaft rotation of the pump at 10.4^o and 13.8^o correspondingly (Figures 4, 5).

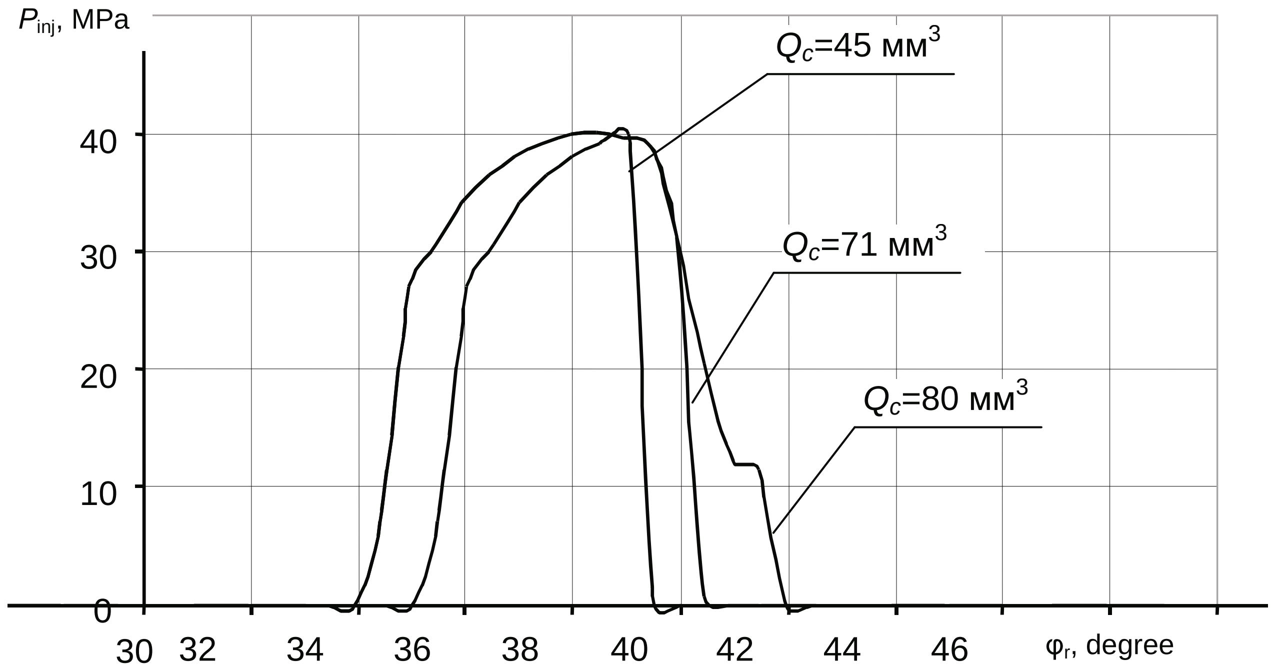

Fig. 3. The Dependence of injection pressure P_{inj} on the angle of the pump shaft rotation (n_{shaft}=1000 min^{-1} , φ_{op}=34^o)

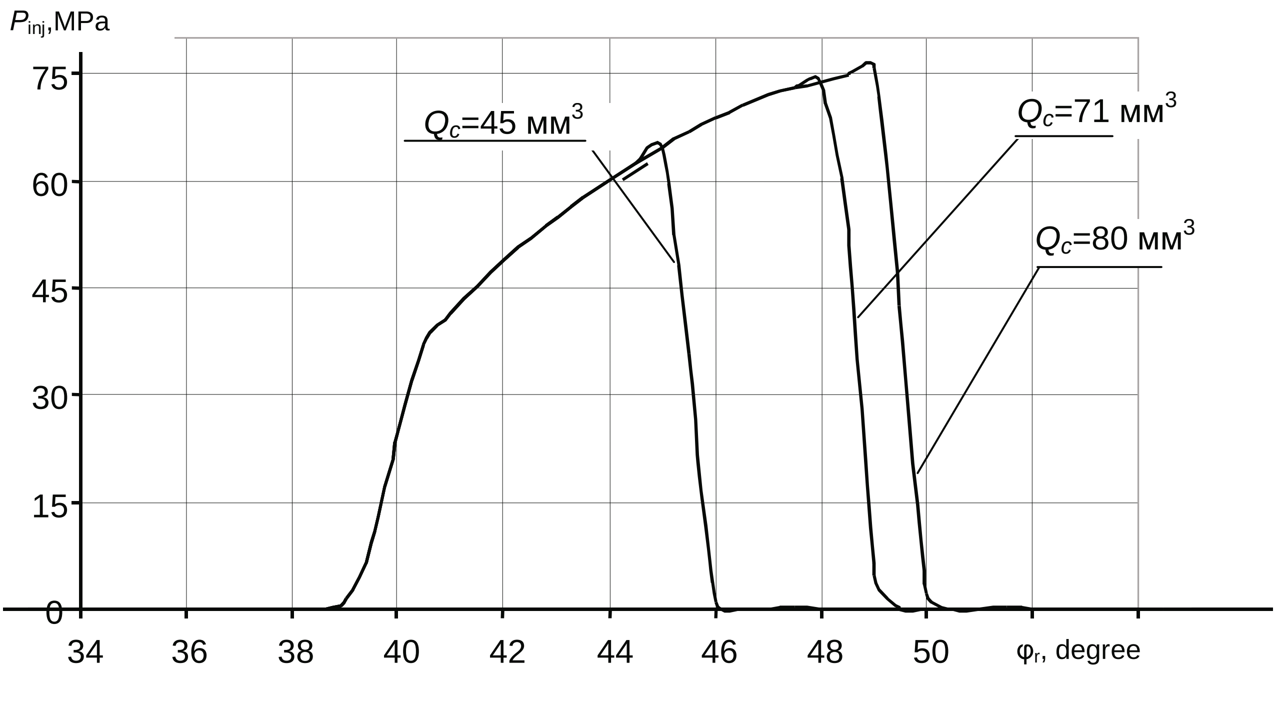

Fig. 4 . The Dependence of injection pressure P_{inj} on the angle of the pump shaft rotation (n_r=2000 min^{-1} , φ_{op}=37^o)

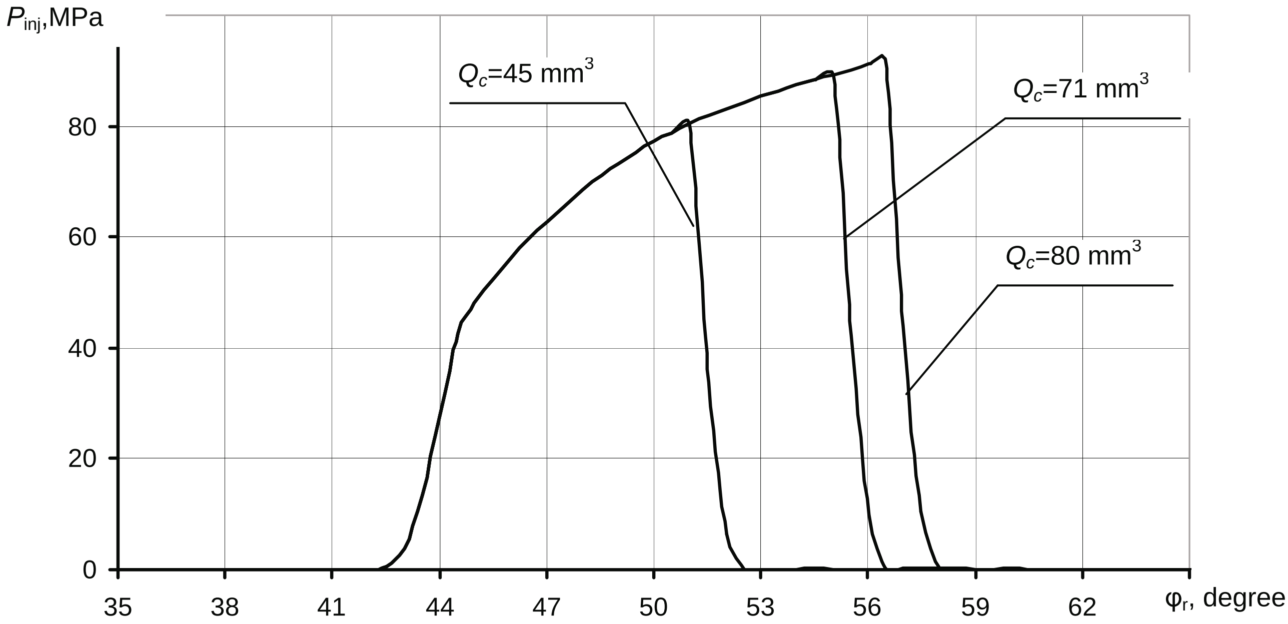

Fig. 5. The Dependence of injection pressure P_{inj} on the angle of the pump shaft rotation (n_r=3000 min^{-1} , φ_{op}=40^o)

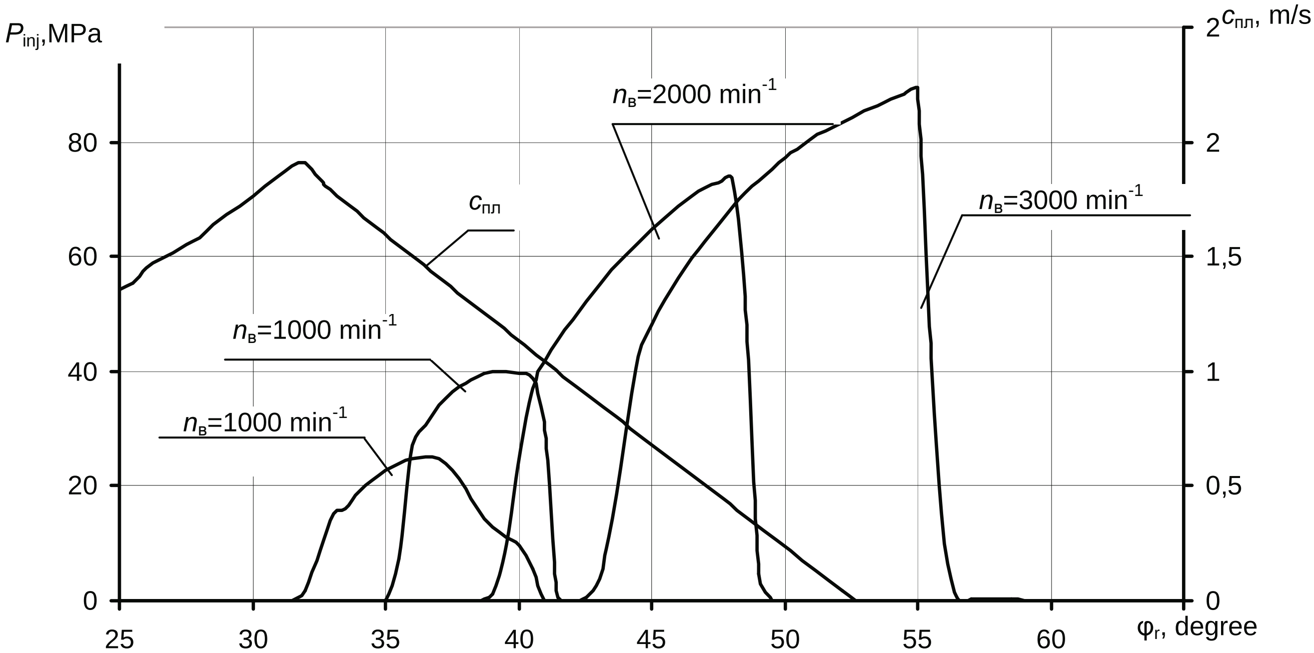

Fig. 6. The Dependence of injection pressure P_{inj} and the plunger speed on the angle of the pump shaft rotation φ_{shaft} at Q_c=71 mm^3

A traditional fuel system is remarkable for its sufficiently long pipeline of high pressure. As a result a direct wave of pressure reaches the injector cavity after the plungers achieving the maximum speed (Figure 6) This brings to great flow energy losses which is also worsened more by the factor that some fuel part is fed at the open cut off cavity. An experimental system divides the processes of feeding and forcing. This improves the injection process indices.

The latter convinces in the necessity of using a cam with a part of the constant speed. At that as the calculation results have shown the experimental system allows realizing a definite cycle fuel feed for a less time in comparison with the traditional system. (Figure 7) These results in increasing the pressure speed growing and the maximum cycle pressure due to a great lot of fuel accumulated in the ignition chamber during the offered system permits the possibility o the pilot fuel feed by advanced opening of the lock organ before the base phase is feeding.

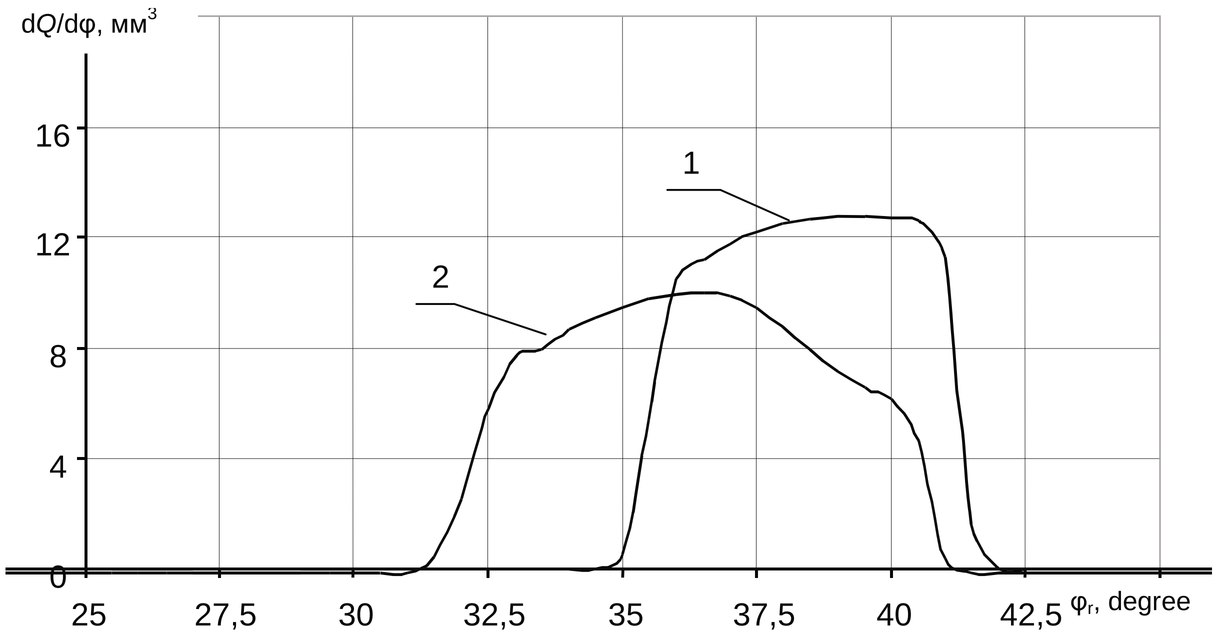

Fig. 7. Differential characteristics of fuel feed n_r=1000 min^{-1}: 1 – the experimental system, 2 – the standard system

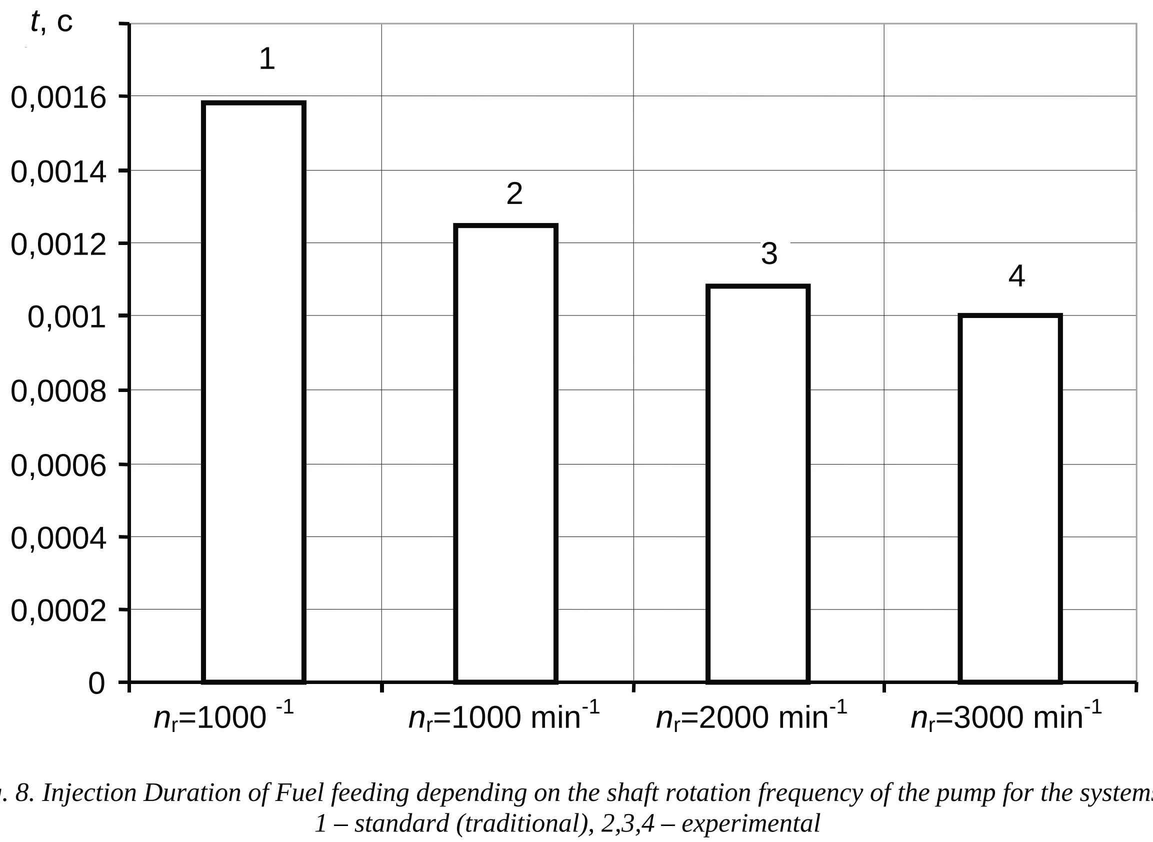

Fig. 8. Injection Duration of Fuel feeding depending on the shaft rotation frequency of the pump for the systems: 1 – standard (traditional), 2,3,4 – experimental

In the experimental system, where the proposed method of fuel feed is realized, the duration of fuel injection lowers at an average by 16 % for all regiments (Figure 8) the maximum injection pressure increases by 37% (Figure 2), and the average by 34% at the considered range of high speed regiments of the fuel pump. The offered system allows a flexible adjustment of the cycle fuel feed when changing a high speed regime as well as providing for a set speed Diesel characteristic and a versatile regulation if the cycle feed at Diesel start. The numerical experiments confirm the efficiency of the experimental system of fuel feed. The influence on its base (main) designing and adjusting parameters on the indices of the fuel feed process have been determined.

References

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