

IMPROVEMENT OF WHEELED TRACTOR'S REGULATOR IN DIESEL ENGINE

ПОДОБРЯВАНЕ РЕГУЛИРАНЕТО ДИЗЕЛОВИЯ ДВИГАТЕЛ НА КОЛЕСЕН ТРАКТОР

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Abstract: *On wheeled tractors it is expedient to erect the universal regulators, which can be set on singlemode regulation or multimode one, on the basis of serial multimode regulator 4 UTNM the key diagram, construction and manufacture design of research sample of universal multimode – singlemode regulator were worked out.*

The work is directed at raising of fuel economy and lowering of harmful rejections of wheeled tractor when performing transport work by using universal regulator and optimal partial high-speed characteristics under one-mode regulation.

Worked out mathematical model of the system "operator-tractor train-road" for investigating of influence of character of proceeding of partial high-speed characteristics of diesel engine on expenditure of fuel and harmful rejections of wheeled tractor. Investigations, conducted on this model, showed the advantages of one-mode regulation in the cases of work of diesel engine at variable modes. Inclination of partial high-speed characteristics under one-mode regulation essentially didn't influence on economical and ecological indices of wheeled tractor. By experimental investigations is confirmed the adequacy of mathematical model and checked the efficiency of experimental universal regulator.

KEYWORDS: UNIVERSAL REGULATOR, DIESEL ENGINE, WHEELED TRACTOR, FUEL CONSUMPTION, TOXIC SUBSTANCES

INTRODUCTION

Saving of liquid fuel and protection of environment from pollution with waste gases are crucial issues nowadays. Wheeled tractors used both in the field and in transport works are the main consumers of toxic fuels and sources of harmful ejections. The engines of such tractors are usually equipped with multimode regulators, which ensure maintaining a given rotation speed of a bent shaft in the whole effective range and automatically erect fuel feeding, depending on a loading. Use of these regulators is justified in field works, where maintaining a velocity of driving of a tractor in narrow borders is required. During transport operations, most of the time the engines work on transient behaviours at partial loadings. Reference for transient behaviours are often accelerations and decelerations of a tractor. At acceleration of a diesel engine with multimode regulator, the rail of the fuel pump sharply shifts on maximum feeding of fuel, and them, in accordance with increase of a rotational speed, is erected in a particular equilibrium position, defined by a loading, which should be overcome by the tractor. That is, the passage from one partial velocity performance to another is carried out through exterior velocity performance. As a result during acceleration of a tractor, at a combustor of a diesel engine the superfluous amount of fuel acts, causing its enlarged expenditure, increase of volume of smoke and toxicity of waste gases, and also excessively dynamic loads in transmission.

To remove these negative phenomena, taking place during transport operations, singlemode regulations can be used, with the maximum frequency of a reversion (regular is restricted to work only in one mode) and the possibility for the tractor operator himself is ensured to erect fuel feeding on partial conditions, immediately operating on a rail of the fuel pump. From this appears, that on wheeled tractors it is expedient to erect the universal regulators, which can be set on singlemode regulation during transport operations and on multimode one while working in the field.

RESULTS AND DISCUSSION

With participation of the authors, on the basis of serial multimode regulator of the fuel pump 4 UTNM the key diagram, construction and manufacture design of research sample of universal multimode-singlemode regulator (1) were worked out. It has following features: ensures the possibility of multimode or singlemode regulation; the passage to singlemode regulation is carried out by the fixing of a spring of the regulator in the stretched state, owing to that the spring of the regulator becomes a rigid segment and it enables immediately to operate on a rail of the fuel pump. The slanting character of partial velocity performances on a

site from a starting of a reversion to frequency, which answers a maximum torque, is ensured with a supplementary spring of a corrector, the previous strain of which is erected by a special cam depending on a position of a regulator's control bar. It is made for deriving constant exterior velocity performance both at multimode, and at singlemode regulating.

With the purpose of a functional test of the research universal regulator and the studies of its properties experimental examinations were carried out, involving engineless examination on the fuel pump and motor examination on a diesel engine D-240. In the first one, which was carried out on the stand KI-22205 for examination of the fuel equipment, velocity performances of fuel feeding were recorded (Fig.1) of the fuel pump with the universal regulator at multimode (Fig.1a) and singlemode regulations (Fig.1b). These performances represent associations cycle fuel feeding qcyc of the fuel pump from frequency of a reversion np of the pump' shaft.

As it is visible from these graphs, exterior velocity performances of the fuel pump with the universal regulator at multimode and singlemode regulations are identical. It is very important, as it enables the passage from one mode to another without changing the regulations of the fuel pump. The differences consist in substitution of partial performances. At singlemode regulation they transit more slantly.

For comparison of the basic indexes of a diesel engine D-240 at work with the universal regulator and different modes of regulation, the accelerations of an engine were carried out on the brake stand KI-4893. This on a fillet of the oscillography K12-22 rotational speeds of a bent shaft n , transition control bar of the regulator φ , rails of the fuel pump hp , and also acceleration time t_a of a diesel engine continuously were plotted a value of a torque M_k . The acceleration was carried out by transition control bar of the regulator from 100 up to 500 from a stationary value by its velocity in all cases of oscillographing. The outcomes of entries of the oscillograph testify, that at multimode regulation during acceleration the rail of the pump shifts to a maximum position, and is then erected precisely intermediate. That is, it come time is in a position, which answers operation on exterior velocity performance. At the expense of it the torque of a diesel engine will increase fan-in harder and the time of an exit is diminished by a terminating rotational speed on 2 sec. compared with acceleration at singlemode regulating. Eventually, relative transition of a control bar of the regulator replaces transitions of rails proportionally to transition of a bar. It enables to supervise overintensity of acceleration of a tractor in a greater measure.

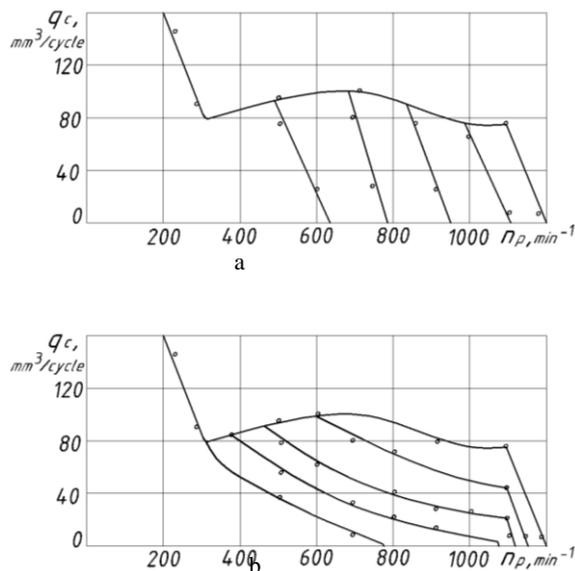


Fig. 1. Velocity characteristics of fuel feeding of the fuel pump 4 UTNM with the research universal regulator at: a) multimode regulating, b) singlemode regulating

The analysis of influence of a regulating mode on an expenditure of fuel and toxic ejections of a diesel engine at transient behaviours of operation is made on a specially designed for this purpose mathematical model, in which the basic attention is given to acceleration of a tractor with the trailer. Acceleration in the model had on three stages: acceleration of a diesel engine in a condition of no-load operation; a breakaway of a tractor train from a place with skidded ganging and acceleration with interlocked ganging.

In the mathematical model of a diesel engine, regulator of a rotational speed, main part of ganging and driving of a tractor train are described by systems of differential equations, all other composite models are described by the algebraic equations. An expenditure of fuel and air, ejections of toxic substances are described by polynomials of the second order. For a solution of systems of differential equations a Runge-Kutt-Feldberg' method was selected. The calculations were carried out on a personal computer in conditions of acceleration of a tractor train (tractor MTZ-80 with the trailer 2-PTS-855) with a rated load with a coefficient of resistance to wheels' rolling $f = 0.0126$. For comprasion of indexes of acceleration at multimode and singlemode regulation the frequency of a bent shaft' reversion at the end of acceleration on each foe both modes of regulation took root identical and equaled 1500 min^{-1} .

In Fig.2 the outcomes of the theoretical rating examinations on mathematical model, namely influence of control bar's position of the regulator during acceleration on ejections of toxic substances and fuel of a tractor MTZ-80 are shown at different modes of regulation. Continuous lines show the relation of time t_a , route s_a to ejections of toxic substances: oxides of nitrogen and carbon, hydrocarbons and soot (g_{NOx} , g_{CO} , g_{CH} , g_C) and expenditure of a fuel g_f at acceleration up to a velocity 6,5 m/sec for the position of regular control bar at singlemode regulation. Dotted lines show the same indexes at multimode regulation. As can be seen from relations, even for accepted limitations on frequency of a reversion at the moment of switching gears during acceleration, the application of singlemode regulation considerably widens the possibilities of a tractor operator to supervise overintensity of acceleration of a tractor train with the purpose of saving fuel and reduce pollution of environment. For the phase of acceleration by partial transition of a regulator' bar, the singlemode regulation enables, increasing the acceleration time by 24.4%, to lower ejections of toxic substances with exhaust gases: for CO up to 49.7%, for CH up to 44.4%, for NO_x up to 16.5%, for soot up to

54.6% and to reduce an expenditure of fuel by 23.3%. At sharp complete transition of a bar economics, dynamic indexes and toxic ejections at regulation are identical.

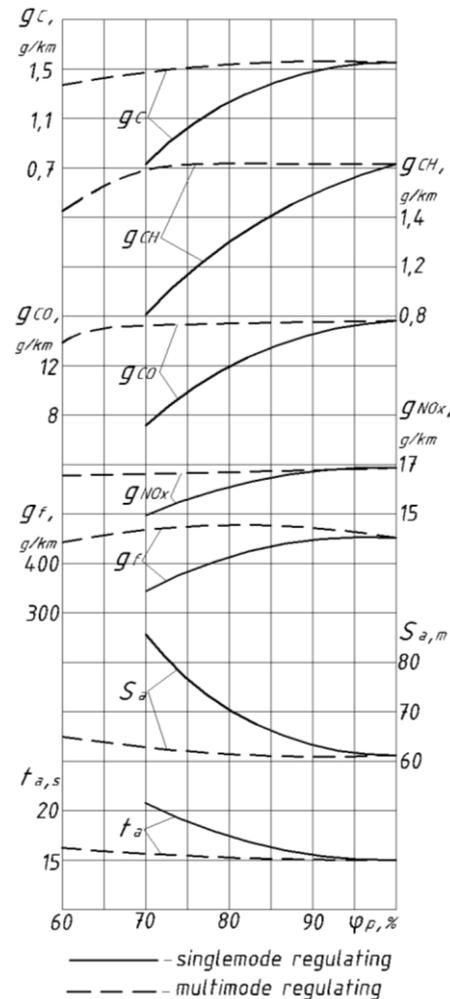


Fig. 2. Influence of control bar's position on ejections of harmful substances, expenditure of fuel, route and acceleration time of tractor MTZ-80 with the trainer at different modes of regulating

Nowadays the reduction of toxic ejections by wheel tractors is essential in the countryside, where they usually are exploited, as the rise of atmospheric pollution as well as ground and pools poisoning is increasingly observed there. It is proved, that the rate of such toxic substances as oxides of nitrogen, carbon, hydrocarbons, soot in the atmosphere at work sites and in cabins of tractors can at times exceed standard norms. And it badly affects a worker's health. It must also be mentioned, that engineering works are often conducted near human habitats, and wheel tractors work frequently also in enclosed locations, serving cattle-breeding farms, hothouses, storehouses etc.

The adequacy of the mathematical model during acceleration of a tractor train was tested comparison of calculated indexes, which characterize mode of operations of a diesel engine (position of a bar of the regulator and rails of the fuel pump) and dynamic indexes of a tractor train (velocity of a tractor and acceleration time) with the experimentally obtained ones.

The experimental glow irises were obtained by a continuous entry of the designated indexes on a fillet of the magnetolectric oscillograph K 12-22, using thus the block of scale amplifiers and transmitters – rheostatic for fixing transition of a bar and rails of the fuel pump, and tachogenerator for definition of a rotation speed of a driving wheel, which was then enumerated in a velocity of a tractor.

The engine steadily worked in all conditions both at multimode and singlemode regulations, and the switching from one mode to another was carried out from the tractor's cabin.

On the whole, the results of the carried out examinations prove the expediency and possibility of the application of universal multimode-singlemode regulators on diesel engines of wheeled agricultural tractors.

CONCLUSIONS

On wheeled tractors it is expedient to erect the universal regulators, which can be set on singlemode regulation or multimode one, on the basis of serial multimode regulator 4 UTNM the key diagram, construction and manufacture design of research sample of universal multimode – singlemode regulator were worked out.

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