CALCULATION AND RESEARCH ITINERARY FUEL CONSUMPTION OF A CAR BY ITS ACCELERATION ON THE DESIGNATED DISTANCE

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I have worked out a computing method of itinerary fuel consumption of a car by its acceleration on the designated distance.

In the process of acceleration an engine spends a considerable part of power for overcoming of inertial force and itinerary resistance. At the same time the fuel consumption increases substantially, if an engine behavior is not refined and not agreed with parameters of transmission.

The solving of this question is especially actual in connection with a leap of intensity of transport streams, like in cities and on country roads, what sets conditions for an increase number of cycles of acceleration and deceleration of a vehicle.

The suggested strategy permits to make a right choice of mechanical advantages at a designated earlier number of transmissions and appropriate to these transmissions load factor of an engine. It gives a possibility to recommend the results of analysis for design of a car transmission, in particular gearbox, like mechanical and automatic.

The use of hydromechanical gearboxes and automatic transaxle (CVT type) joint with electronic systems of their control will supply the rise of an average effective coefficient of efficiency of an engine in the process of acceleration of an engine of a car on the basis of increase of an overall performance of transmission and will result in reduction of itinerary fuel consumption.

Key words: itinerary fuel consumption of a car, acceleration, load factor of an engine

1 Purposes of the article and the formulation of research problems

The main purpose was put in the article on the basis of the technical characteristics and experimental data to carry out regular researches of influence of load factor of the engine on fuel profitability of the car at its acceleration to its admissible in the given conditions of speed of the movement (for example, 60 km/h for a settlement) and to give the recommendations, allowing to lower the fuel consumption in the case of increasein speed. For achievement of the purpose the following problems were solved.

- to accept the criterion of optimisation for acceleration process;
- to define the optimisation parametres;
- to create a mathematical model of acceleration process;
- to realise a mathematical model in the program environment for operative and evident representation of results.

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- To choose for the research the parametres of the concrete car and to receive practical recommendations about economy of fuel at its operation.

2 Statement of the basic material of the researches

As an optimisation criterion on which the comparative efficiecy of process of acceleration is defined, the weight of fuel mal, spent by the car is at passage of distance So by it. The chosen criterion of optimisation mal is valid only in case if in the decision of the task the following conditions are satisfied:

Way So is identical to all considered modes of acceleration of the car.

1. Way So should be equal or exeed the greatest way of acceleration till speed Vmax from all possible modes of dispersal of the car.
2. At each of the considered modes of acceleration the car for the way So should reach speed Vmax. Otherwise the condition 2 is not satisfied.
3. If the car has reached speed Vmax on characteristics transfer for it. Spent for the whole period of such movement the weight of fuel will correspond mal.
4. In each of the listed variants of dispersal, the gear change should occur at values of speeds of movements identical to all cases.

The fourth conditions is basic and gives a possibility to estimate fuel profitability quantity of the fuel spent not on overcome dispersal, and on a certain piece of a way on which this dispersal took place. It is obvious, that such position is more objective from the point of view of decrease in the travelling expense of fuel.

As optimisation parametre the function k_n= f(n) changes of a share of the usage of capacity of the motor from maximum. Size of expenses of fuel mal for 30 variants of dependences of loading of the engine, including linear and sedate functions have been investigted.

The technique of definition of the travelling expense of fuel with the account of intensity of dispersal on the fixed distance is based on the theory of the car and experimental data on fuel profitability of its engine (fig.1).

On 1 schedule presented on fig. on the vertical axis values of the specific expence of fuel ge, on an axis directed to the right, - frequency of rotation of the engine, mines-1, on an axis directed deep into, - a relative share of use of capacity of the engine are noted. The surface is constructed on the basis of experimental data. Represented in drawing as an example the schedule corresponds to data under the specific expense of fuel of engine ZMZ [1].

As initial data to calculation of parametre of optimisation two groups of sizes – parametres of the car and optimisation parametres act.

All those sizes and functions which in the course of the decision of an optimising problem remain constants concern set parametres of the car. Them concern: maximum effective power engine. Nemax , nominal frequency of rotation of a cranked shaft of engine Nn, polinomial factors of function of the engine under external and partial high-speed characteristics, gear into and transmission, efficiency, driving wheel radius, weight of the car, factor of resistance of the air environment, the resulted front area of the car, factor of resistance of road at the established speed of movement, a corner of a bias of the road, the established speed of movement Vmax , speeds of movement at which there is a gear change.

The sizes which values vary in the course of optimisation for the purpose of a choice optimum concern optimisation parametres. Function concerns such parametre k_n= f(n) – relative capacity of the engine depending on frequency of rotation of a cranked shaft.

As initial data to calculation of parametre of optimisation [1] cars GAZ 3302 "Gazelle", and also the above described restrictions necessary for performance of calculation of criterion mal – SO = 866m and

Vmax = 60 km/h were applied passport [2] and experimental characteristics. Criterion calculation mal was carried out for 30 variants of optimisation, i.e. for functions k_n= f (n). These defences were subdivided into three groups – constant (k_n = const), linear and sedate functions.

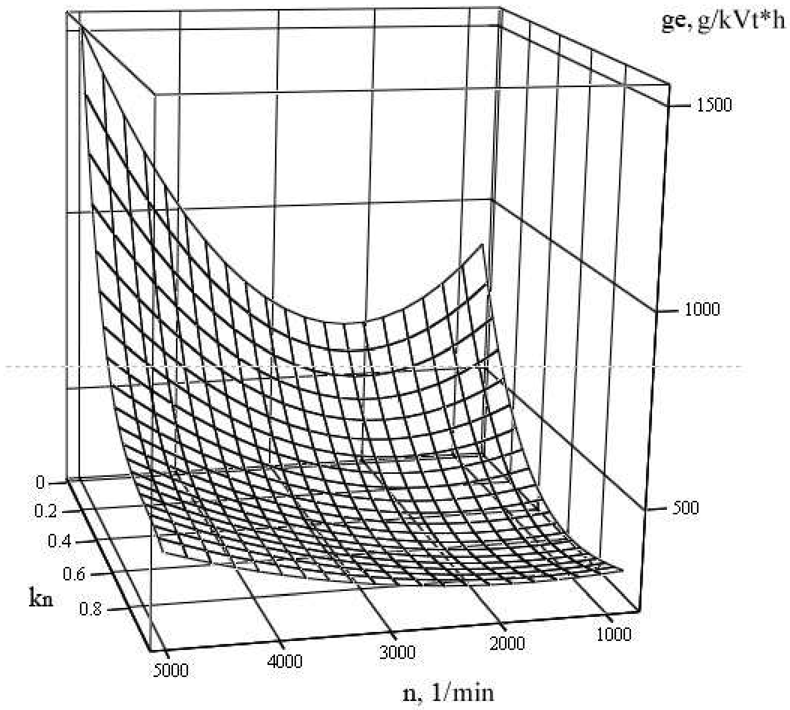

Fig.1: Function of dependence of the specific expense of fuel from frequency of rotation of cranked shaft engine and shares of use of capacity.

At constant values kn and corresponding capacity (fig.2), the criterion mal is equaled to the sizes resulted on fig.3.

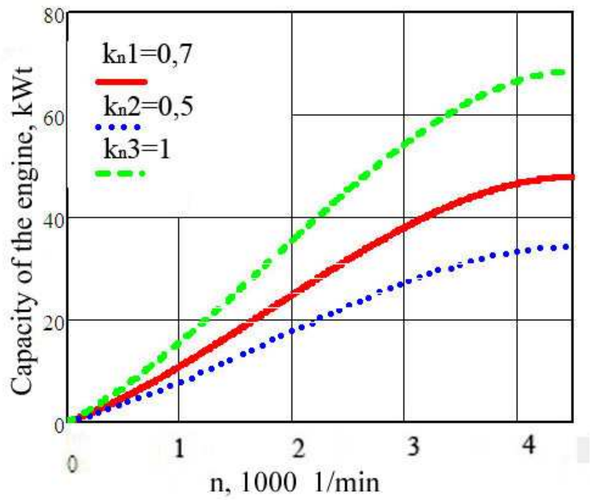

Fig. 2: Capacity functions at constant values k_n

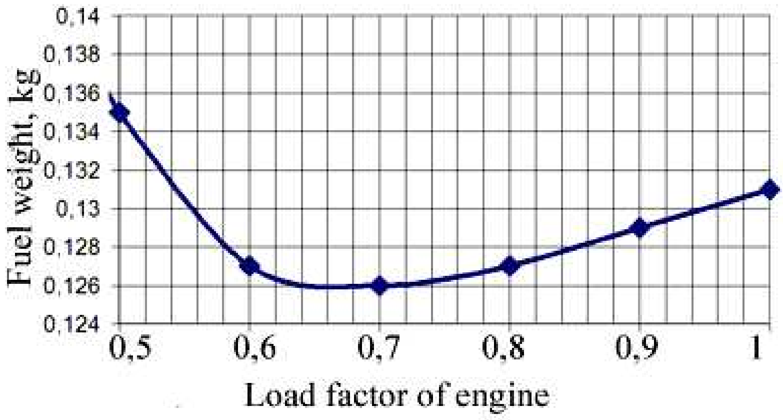

Fig. 3: Dependence of the ittinenary fuel consumption (criterion of optimisation) on degree of engine load factor (optimisation parametre) at in the course of $k_n = const$ dispersal.

Linear and sedate laws of change of parametre kn and capacity engine corresponding to them depending on frequency of rotation of a cranked shaft are presented on fig.4 and 5.

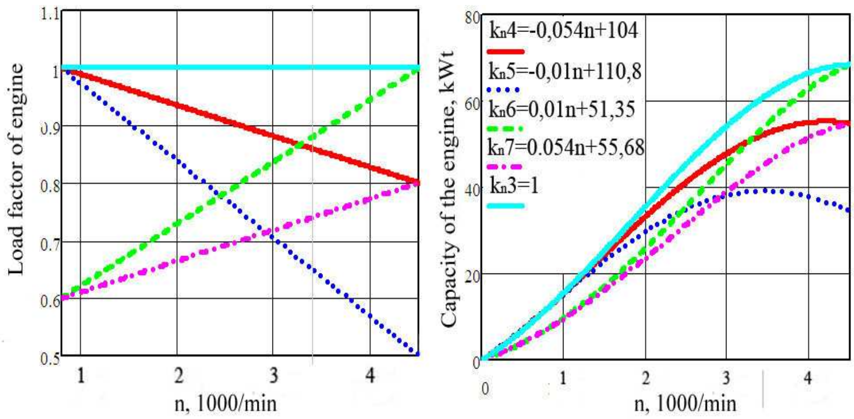

Fig. 4. The linear law of change of parametre k_n

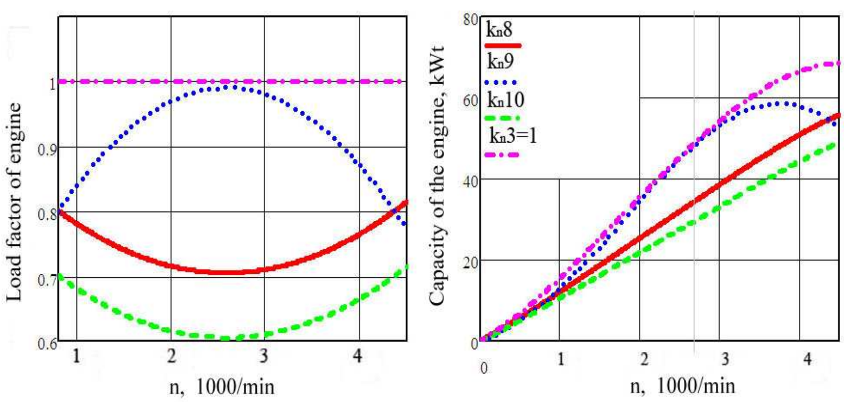

Fig. 5. Sedate the law of change of parametre k_n.

During work performance numerical values of criterion kn have been received.

3 Conclusions and prospects of the further researches in the given direction

Results show in the evident image of the ittinenary fuel consumption 1 on a load factor of engine in the course of car dispersal. One of ways of improvement of fuel profitability should consider the control and management of dynamics of its dispersal.

The offered mathematical model gives the chance to investigate fuel profitability at several ways of dispersal. Proceeding from the received data for the considered car a number of values of the expense of fuel is received. Thus it is accepted, that in all cases of automatic telephone exchange thre passes the same way (866 m) and is dispersed till the same speed 60 km/h.

It is established, that the ittinerary fuel consumption has the least value equal of 0,1250 kg/866 m, corresponding to linear function kn7 (fig.4), i.e. the most economic in the course of research from all accepted variants has appeared a dispersal mode at which function kn with growth of turns of a cranked shaft increases the value as the crow flies, passing through schedule points (fig. 4) 60% at 800 1/minutes and 80% at 4500 1/minutes the Worst has appeared a dispersal mode kn10 (fig.5) at which function kn changed under the sedate law, and the ittinerary fuel consumption has made 0,1411 kg on 866 m. The difference with a mode kn7 (fig.4) makes about 10%.

Comparing a curve kn7 with the diagramme of the specific expense of fuel (fig.1) in co-ordinates kn, n, we come to conclusion, that the minimum expense of fuel at automatic telephone exchange dispersal is accompanied by such function kn (OPT) =f(n) at which to each value n in a working range of turns there corresponds such value kn at which the specific expense of fuel of the engine is minimum. On fig. 6 the curve kn7 and function kn (OPT) =f(n) is resulted.

Starting with fig. 6 function kn (OPT) =f(n) almost coincides with function kn7. If to execute algorithm of calculation of criterion of optimisation for function kn (OPT) =f(n) the received value will make 0,1248 kg/866 m – result surpasses function kn7.

Thus, the most economic for dispersal is such dependence kn =f(n) at which frequency of rotation of the engine n during each moment of time is accompanied by such share of lpading k, at which efficiency of engine for frequency n is maximum. To define such function probably by differential summaration of function of the specific expense of fuel on a variable k for each value n with the account of the chosen step. Hence, the most economic is the mode of dispersal of the automatic telephone exchange, corresponding to the maximum average efficiency of engine, etc. car systems.

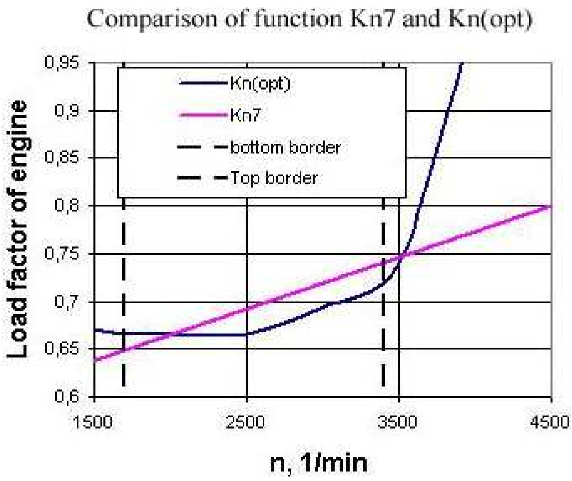

Fig. 6: Comparison $k_{n\ (OPT)}$ =f (n) and k_n7

The most economic modes of dispersal of the car with the step gearbox which does not allow to receive in each point of a range of capacity of automatic telephone exchange an optimum combination of sizes k and n which causes the maximum efficiency at demanded capacity are considered and defined.

The increase in density of some transfer numbers (by application of multystage transmissions) allows to raise average efficiency of the engine in the course of dispersal. Still more effect can be reached at installation of variators that provides the greatest possible efficiency of the engine on all range of demanded capacity. The further direction of researches is creation of algorithms of definition of an optimum operating mode of a variator on the basis of optimum function of degree of use of capacity of the engine in the course of dispersal kn =f(n) according to engine characteristics.

The method of definition of fuel profitability of the car considered and offered for calculations at its dispersal is offered for researches of modes of dispersal of other vehicles with the account of their dynamic properties.

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