

**METHODOLOGY FOR COMPARATIVE ASSESSMENT OF PASSENGER CARS
IN URBAN CONDITIONS USING INFORMATION TECHNOLOGY**

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Abstract

There are many methods in the world to reduce the fuel consumption of passenger cars, in most cases aimed at increasing the structural efficiency of the equipment. In real-life operating conditions, traditional methods for assessing modern passenger car designs need to be improved. One of the ways to solve the problem is to use mathematical models of the relevant processes using information technology. This article provides software for modeling the fuel efficiency of passenger cars during the driving cycle.

Keywords. Passenger car, fuel efficiency, petroleum product.

Introduction

Currently, the number of models and modifications of passenger cars in the world exceeds 3000. Their production volume is more than 75% of the 89.7 million total production volume, including trucks and buses [4]. In terms of the volume of petroleum products used by motor vehicles, passenger cars account for 67% [5]. The majority of passenger cars are operated in urban environments.

Ensuring the fuel efficiency of cars is an urgent task of our time and depends on many factors, in particular on operating conditions. The fuel efficiency of vehicles operated in various conditions is usually determined using international driving cycles [2, p. 93]. The standard driving cycle expresses the sequence of modes (stopping, accelerating, braking and moving at a constant speed) according to the degree of traffic congestion during the operation of the vehicle over time (Fig. 1). For the purpose of comparatively assessing the fuel efficiency of vehicles, this method relatively covers large-scale and varied operating conditions. Skills have been developed to assess the level of perfection of cars using fuel efficiency indicators based on general driving cycles [2, p. 12].

The increase in the number of cars in cities, traffic intensity and traffic density, and the difference in average speeds [4] determine the need to continue research in the direction of increasing fuel efficiency. Therefore, the development of a standard driving cycle that expresses the characteristics of specific urban conditions and determining fuel consumption using the developed driving cycle is relevant.

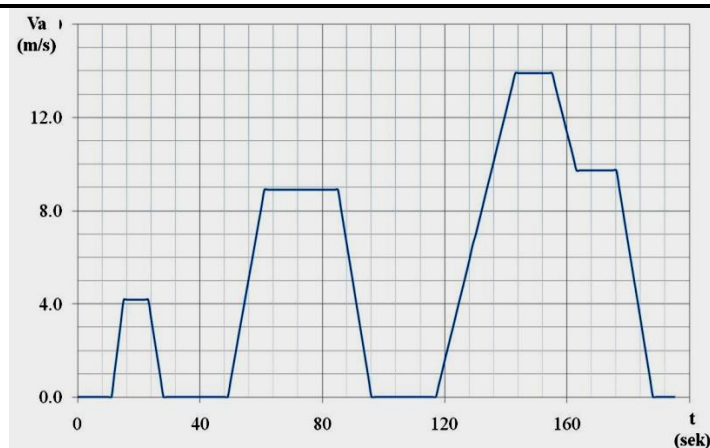


Fig 1. Standardized European urban driving cycle

It is known that the fuel efficiency indicators of passenger cars are different under the same driving conditions, and also each car is differently adapted to driving conditions in terms of fuel consumption.

Choosing an economical car for specific driving conditions and justifying its parameters requires complex, long-term experimental studies and processing of voluminous statistical data of the research results. Solving the problem is possible using modern information technologies and mathematical modeling methods with the development of their software.

For these purposes, we have developed software using the “Microsoft Visual” studio application. The developed software is designed to select an efficient passenger car for specific driving conditions, as well as to select effective driving conditions for specific vehicles. In addition, it is possible to assess the complexity of the traffic conditions.

Below is the main software window for selecting the appropriate performance evaluation mode (Fig. 2):

- Mode 1. Selecting an efficient vehicle for specific traffic conditions;
- Mode 2. Selecting an efficient traffic condition for a specific vehicle;
- Mode 3. Assessing the degree of difficulty of the traffic condition.

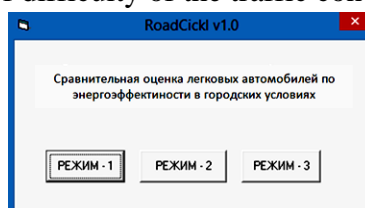


Fig. 2. View of the main software window

Mode 1. To determine an effective car in specific driving conditions, it is necessary to select a driving cycle (Fig. 3), which simulates the driving conditions of cars, as well as two different brands of cars. Currently, there are more than 55 standard driving cycles and many car models in the world, the parameters of which are entered into the software database. Initial vehicle data includes the following technical parameters: N_e - maximum engine power, [кВт]; M_e - Maximum engine torque, [Нм]; w_N - maximum angular velocity of the crankshaft, [c^{-1}]; m_a - Gross vehicle weight [кг]; B- car width, [m]; H- car height, [m]; U_o - final drive ratio; $U_{кп}$ - gear ratio of the gearbox;

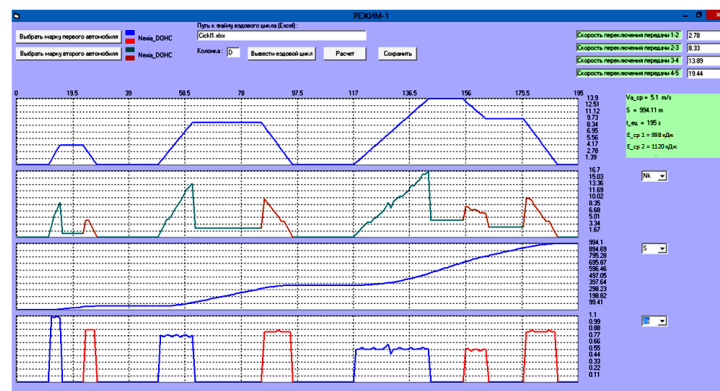


Fig 3. General view of the first calculation mode window

Therefore, when you click the ‘calculate’ button, the program calculates the required values in the following order:

a. Determination of crankshaft angular velocity ω_e

$$\omega_e = \omega_a \cdot U_{mp} = \frac{V_a}{r_k} \cdot U_{kn} \cdot U_0; [c^{-1}]$$

Here: V_a - vehicle speed (the angular velocity of the crankshaft is determined for each vehicle speed given in the driving cycle every second);

U_0 - final drive ratio;

U_{kn} - gear ratio of the gearbox (in the driving cycle, the gear shift time is standardized according to the vehicle speed. Therefore, on the first mode window there is an item for entering the vehicle speed in m/s, at which the gearbox operating mode changes);

r_k - wheel rolling radius.

$$r_k = 0,5 \cdot d + \Delta \cdot B \cdot \lambda; [M]$$

Here: d – rim diameter; B – tire section width; λ – tire profile radial deformation coefficient;

$\Delta = \frac{H}{B}$ – profile height to width ratio; λ_{cm} – coefficient of vertical deformation of a tire (for passenger cars $\lambda_{cm} = 0,85 \dots 0,9$).

b. Determination of fuel consumption. The vehicle's fuel consumption varies depending on the driving mode (idling, accelerating, decelerating, driving at a constant speed). Therefore, it is necessary to determine the vehicle's driving modes during the driving cycle as follows:

- engine idle condition $V_n = V_{n+1} = 0$;
- condition of the vehicle acceleration mode $V_n < V_{n+1}$;
- condition of the vehicle deceleration mode $V_n > V_{n+1}$;
- condition of the vehicle moving at a constant speed $V_n = V_{n+1} \neq 0$.

Fuel consumption in idling mode per second is determined by the formula obtained by approximating experimental data:

$$G_{\text{rx}} = \left(162.84 \cdot 10^{-9} \cdot \left(\frac{\omega_{\text{xx}} \cdot 30}{\pi} \right)^2 - 119.61 \cdot 10^{-6} \cdot \left(\frac{\omega_{\text{xx}} \cdot 30}{\pi} \right) + 0.42936 \right) \cdot 0.217; [z p / c]$$

here: ω_{xx} - angular velocity of the crankshaft in idle mode.

In deceleration mode, the engine is disconnected from the transmission and goes into idle mode. Therefore, the condition for determining fuel consumption for the deceleration mode is determined similarly to the idle mode. In addition, modern power systems for injection engines have a forced idle mode, in which the fuel supply is turned off up to a certain angular speed of the crankshaft, which will also be taken into account in future program updates.

According to the expression, minimizing the degree of complexity of the driving cycle in specific urban conditions is achieved by improving the organization of traffic and the transport infrastructure of the city or by choosing a vehicle more adapted to the existing traffic conditions. The developed software can be used to analyze and improve the city's transport infrastructure, in order to ensure economic and environmental safety, as well as to select the most suitable vehicle in terms of fuel efficiency for specific urban operating conditions.

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