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COMPARISON OF MILEAGE FUEL CONSUMPTION WITH THE NATURAL OPERATION OF THE THREE DIFFERENT CYCLES

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Abstract

In the automotive industry in the world continuously being sought universal driving cycle. The test should closely match the fuel consumption and emissions of toxins in the fumes of the test vehicle in its real operating conditions [4]. However, in the previously developed solid driving tests established velocity profiles differ significantly from actual driving conditions. The difference in fuel consumption, comparing the natural operation of the NEDC test reaches an average of 18%. The new version of the driving cycle should be more realistic to the everyday use of additional equipment and gadgets that are installed in modern vehicles [1].

The impact on fuel consumption by vehicles may be conditioned not only by its size and weight, but also by the geometry of the track motion, forces causing the motion and the forces acting on the car when driving on curved tracks. The vehicle encounters and overcomes all the forces that act on it while driving-resistance movement. In the energy intake through the vehicle runs in the motor changes at the expense of the energy of fuel consumed. The driving force performs work on a given stretch of road balancing (predominant) friction. On the basis of the calculated resistance movement and the energy consumption of the movement in the selected object was a comparison of the actual consumption of fuel in the vehicle with the ignition spark. Analysis was performed and found differences in three cycles: urban, extra-urban and combined.

***Keywords**: Fuel consumption, mileage fuel consumption, resistance to motion, energy consumption of traffic, vehicle operation, SI engine*

1. Introduction

The car, which defeats the point profile of the route is subject to dynamic and its parameters such as speed and direction depend on the spatial arrangement and the forces acting on it. Therefore, it can be concluded that the parameters of the vehicle motion determines layout: driver-vehicle-environment. The driver with the tools they are steering, propulsion or braking causes the formation or disappearance of the driving force and the braking. In addition to the driver, a significant impact on the vehicle to external forces, due to the state of the surface and the wind. These forces are called traffic disruptions, because they rely on random. The driver wanting to maintain a specific traffic profile must make deliberate changes to the motion parameters. This action is referred to the process of driving. This process depends on the individual conduct of the driver (skills, mental state and physical). While the car is a tool for the operation. It is of advantage to this type of task characteristics determine construction and movement, i.e. the dynamic aspects (steerability, gradeability, braking, acceleration, maximum speed, stability) and energy (energy consumption, drive efficiency, fuel consumption). It must be remembered, however, that the technical condition can have a significant impact on vehicle ownership [6, 7].

Impact on fuel consumption by vehicles may be conditioned not only by its size and weight, but also by the geometry of the track motion, forces causing the motion and the forces acting on the car when driving on curved tracks. The road cars are involved with different structures and unequal conditions of use. It is difficult for the clear identification of the traffic model of the vehicle and therefore is needed to simplify such as:

– concentrating the whole mass of the vehicle in its centre of gravity,
– applying all the forces acting on the vehicle in its centre of gravity,
– an expression by a single force the sum of all forces arising on the surface of the tire contact with the ground
– neglect of additional revenue, such as the instantaneous load changes lane.

Factor responsible for imparting the vehicle in motion is the driving force. Is transmitted from the engine through the drivetrain to the wheels. The magnitude of this force must be overwhelming on rolling resistance and air force of inertia of the vehicle, rotating masses and the resistance of the hill, to move the car [2].

2. Fuel Consumption

A significant volume of vehicle traffic is consumed fuel in relation to the distance travelled, called on pass fuel consumption. With the discovery that energy intensity is the sum of the energy supplied to the drive wheels only in phases drive, run the fuel consumption for this phase is:

$$Q_N = \frac{1}{S_C}\left(\frac{1}{W_O}\sum\frac{E_R}{\eta_N} + G_J\sum T_J\right), \text{[l/100 km]}, \quad (1)$$

where:
S_C – the total distance travelled by the vehicle [km],
W_o – the calorific value of the fuel used for fuel amounting Pb95 31570 [kJ/m^3],
E_R – energy consumption of traffic [J],
η_N – the average value of propulsive efficiency during the drive phase dependence expressed $\frac{E_R}{E}$ [-],
E – the value of energy consumption [J],
G_J – amount of fuel consumed while idling [ml],
T_J – time the engine is running at idle [s].

For road profile consisting of multiple modules, i.e., acceleration, cruising, deceleration or stop, for total consumption includes the sum of the fuel consumed in driving phases and the total fuel consumed during the engine is idling. Mileage consumption is determined at the time:

$$Q_C = \frac{1}{W_O\cdot\eta_N}\cdot(m\cdot g\cdot f_t + K\cdot\vartheta_N)\cdot S^* + \frac{m\cdot a^*}{W_O\cdot\eta_N} + \frac{G_J}{S_C}\cdot\left(\sum T_H + \sum \Delta T + \sum T_O\right), \text{[l/100 km]}, \quad (2)$$

where:
E_{TPW} – energy expended to overcome the resistance [J],
T_H – the duration of the braking phase [s],
ΔT – time shift [s],
T_O –downtime [s]

The above equations describing the consumption waveforms show that the relationship between energy-intensive traffic (defined only for phase drive) and on pass fuel, consumption (referring also to the phases of braking and stopping) is more complex than in previous cases. Mileage fuel consumption for the complex velocity profile is the size, which consists of:
Q_{OP} – the amount of fuel consumed in driving phases to overcome the resistance,
Q_K – the amount of fuel used to increase the kinetic energy,
Q_J – the amount of fuel consumed during the engine running at idle.

$$Q_C = Q_{OP} + Q_K + Q_J, \text{[l/100 km][2]}. \quad (3)$$

3. Analysis of the results

This paper presents the evaluation of fuel consumption in real traffic, for example, the upper middle class car, compared with the calculated fuel consumption. To determine the route profile was used application Torque Pro connected via OBDII ELM327 Bluetooth adapter.

The test vehicle had a SI engine with a capacity of 3.5 litters. The car was used from the beginning of one driver. Thus, the impact on the results of the driver has been omitted. Drag coefficient takes the value cx = 0.27.

Profile of the route traversed by the tested vehicle consisted of driving both urban and extra-urban. When the analysis was divided into small, enough sections of the road, which results were, omitted any arcs and curves. Altitude entire route ranged from 167 m to 292 m in length was less than 43 km - Fig. 1. The maximum speed that was achieved was equal to 104 km / h.

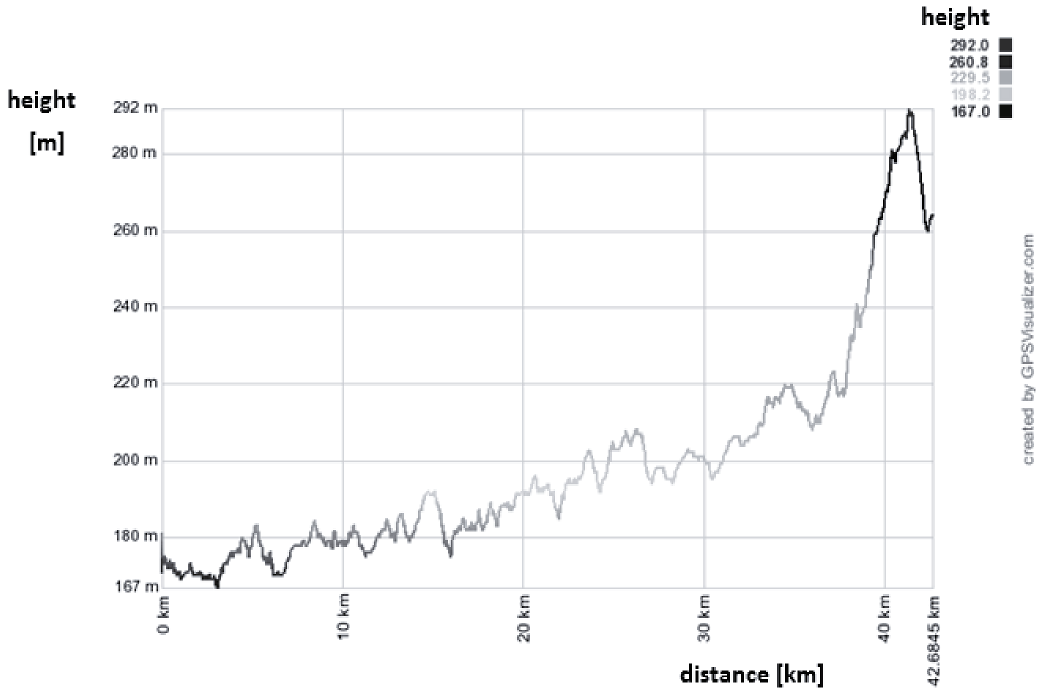

Fig. 1. The difference in level of the path travelled [3]

Route profile and speed profile contains motion phases, such as acceleration and braking (phase transition between different levels of speed) and driving at a constant speed. Profiles with long stretches of roads often consist of multiple-module consisting of a core phase of varying duration and occurring in the order of acceleration, constant speed driving, braking. Often chosen to lead different ways. In this situation, the driver can choose, for example between a shorter route but with many bends or long and straight road. A characteristic feature of the motion profile is frequent changes of direction of movement and speed. This may be caused by the same characteristics of the road or other participants. Urban traffic is characterized by the most common change in these parameters in comparison with the traffic on highways and motorways.

Presented below is the relationship between the mileage fuel consumption and the actual fuel consumption in the urban cycle- Fig. 2. From Fig. 2 can be read as calculated mileage consumption is close to the actual fuel consumption. Differences, which may appear due to the fact that the energy consumption that occurs in formula (1) relates only to the driving phase, and the actual fuel consumption relates to the overall speed, profile. Hence, the proportional relationship between energy consumption and on mileage fuel consumption can result only in cases caused by forcing the drive to the wheels. Below are presented the results Tab. 1.

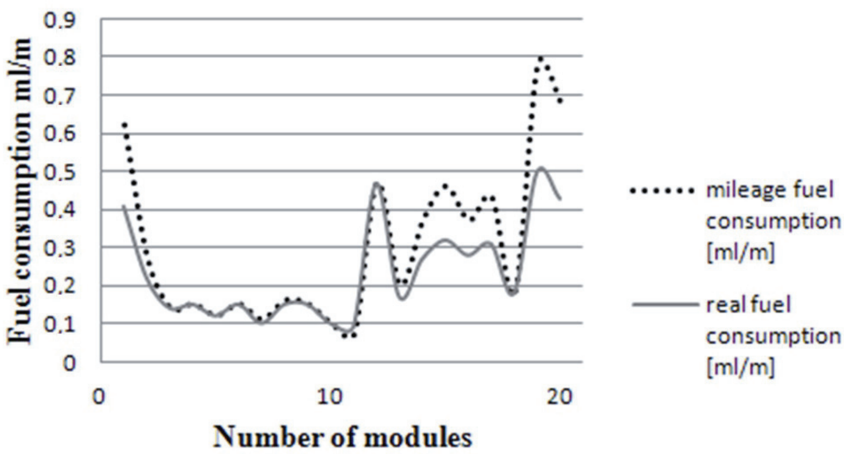

Fig. 2. The relation relationship between the mileage fuel consumption and the actual fuel consumption in the urban cycle

Tab. 1 The results of urban cycle [5]

number of modules	fuel consumption Q [l/100 km]	mileage fuel consumption [ml/m]	the total distance of the module [m]	fuel consumed in the next module [ml]	real fuel consumption [ml/m]
1	11.36	0.62	144.54	59.32	0.41
2	1.28	0.27	249.31	54.67	0.22
3	0.53	0.14	603.06	83.52	0.14
4	0.33	0.15	369.01	55.78	0.15
5	0.36	0.12	585.36	68.37	0.12
6	0.34	0.15	276.76	41.12	0.15
7	0.57	0.11	716.19	73.93	0.1
8	0.15	0.16	208.52	32.15	0.15
9	0.45	0.15	203.73	30.61	0.15
10	1.84	0.1	1007.11	103.99	0.1
11	1.2	0.07	926.01	84.19	0.09
12	15	0.47	72.47	34.22	0.47
13	0.68	0.2	205.31	35.79	0.17
14	2.93	0.37	97.57	26.76	0.27
15	6.87	0.46	110.89	35.71	0.32
16	2.9	0.37	84.57	23.92	0.28
17	3.98	0.43	108.06	34.01	0.31
18	0.12	0.18	103.73	18.42	0.18
19	6.16	0.78	25.35	12.79	0.5
20	17.14	0.68	95.65	41.37	0.43

Then analyses the extra-urban cycle Fig. 3 and 4 mixed. The velocity profile of road cycle, compared with the previous profile from urban cycle, achieves higher speed and has a smaller number of stops. However, even here we can distinguish less than 20 modules to a single profile segments were not different strong fluctuations in speed.

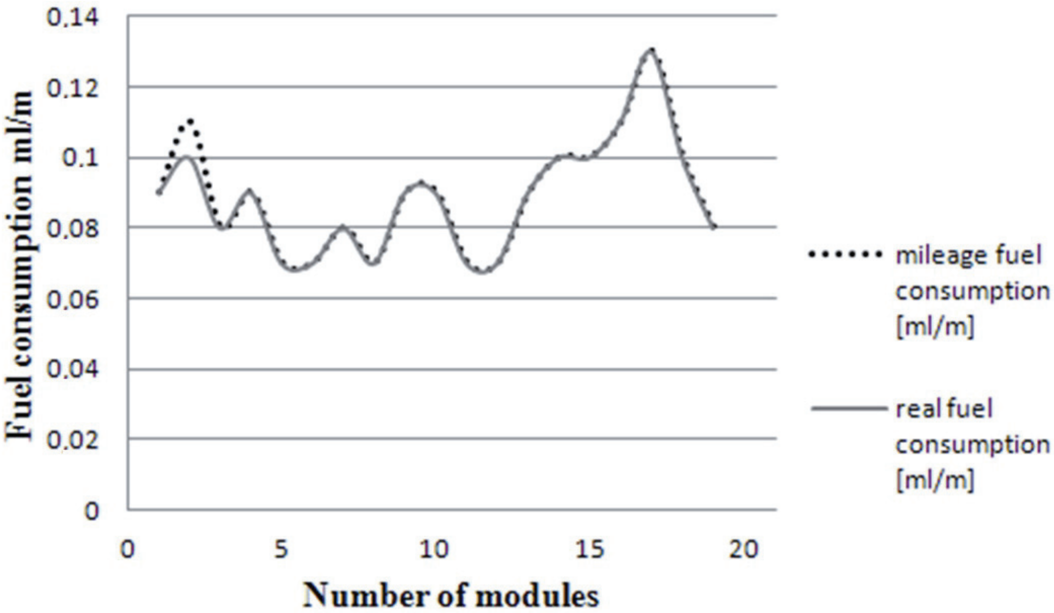

Fig. 3. The relation relationship between the mileage fuel consumption (blue line) and the actual fuel consumption (red line) in the Extra-urban cycle

Road cycle compared to urban cycle has been divided into the same number of modules. They differ among themselves the intensity of acceleration and deceleration, and deceleration. However, the computational runs consumption for road cycle is almost the same as the actual consumption. In the urban cycle, these values have some variation. This may be due to zero speed deceleration frequent and noticeable, change in velocity.

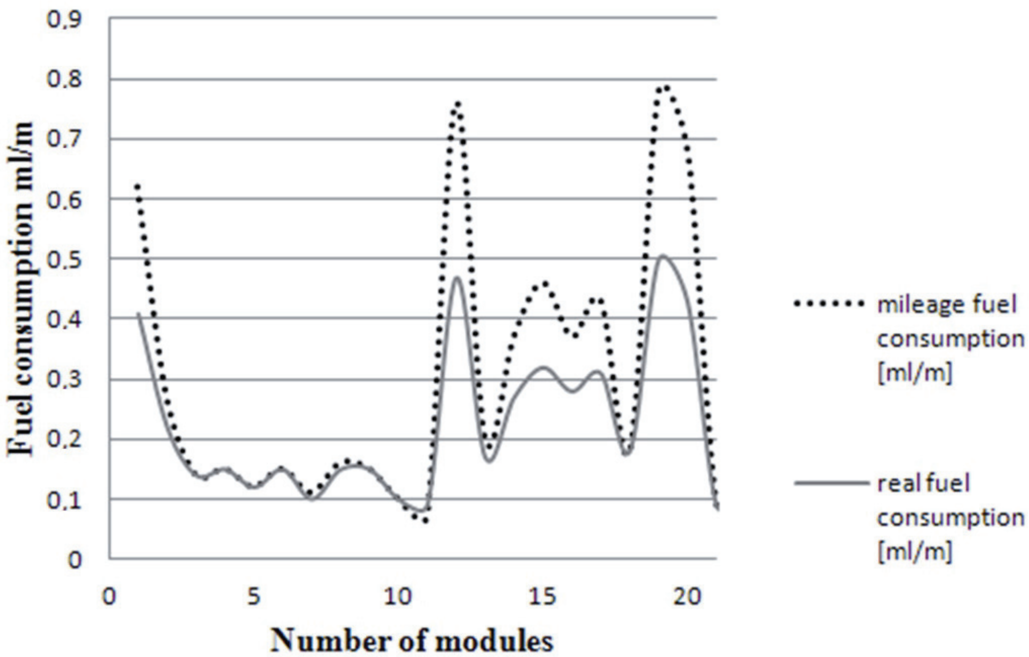

Fig. 4. The relation relationship between the mileage fuel consumption (blue line) and the actual fuel consumption (red line) in the combined cycle [5]

2. Conclusions

Analysed the causes of fuel consumption are only one of many. However, the fundamental value that affects the fuel consumption is the energy intensity of the energy bill. The energy that is needed on the driven wheels to achieving the planned road profile was determined by the resistance. The main factor contributing to resistance was speed, mass and shape of the car, and the angle of inclination of the substrate.

The analysis shows that the greatest differences between the pass system fuel consumption and the real were the urban cycle and combined cycle. Research should now be repeated for the sample, and for compare the results.

However, considering the same profile path one vehicle undergoing change factor is speed. Therefore, we can confidently say that it has a significant impact on fuel consumption. Namely, the rapid acceleration and deceleration have an adverse effect on the fuel consumption of the vehicle, and thus the cost to the driver.

Fuel consumption, in practice, especially in the urban cycle is much higher than those defined by the manufacturers are. The improvement of such data can be obtained, for example by changing the speed profiles in the study. Fuel consumption is a topic constantly perfected and analysed. It is very difficult to determine its value, because it consists of many elements: the individual driving style of each driver, the technical condition of the vehicle or the weather.

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