A COMPARISON OF FUEL CONSUMPTION BETWEEN THE NEW EUROPEAN DRIVING CYCLE TEST AND THE NATURAL OPERATION OF A VEHICLE

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Abstract: *There are many changes in the automotive industry which leads to improved to safety and reduce fuel consumption. A new design of vehicles are being modernized, reducing aerodynamic resistances and the weight of vehicle units. However it is forgotten about the same time changing and updating the fuel consumption's tests. The cars are tested with New European Driving Cycle test which based on directive 91/441/EEC (26 June 1991). It's been 23 years. NEDC was developed at a time when European vehicles were lighter and less powerful. The test offers a stylized pattern for low speed acceleration (a = 0.89 m / s), speed, ride at idle, but temporary increase is much steeper and more dynamic in practice, in part due to the excess capacity of modern engines.*

This paper presents a comparison of fuel combustion Polish users registered on the famous automotive's forum between factory data vehicles selected. As a result, it is hard for drivers to reach the certified values in practice.

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.

Keywords: FUEL CONSUMPTION, VEHICLES, DRIVING TEST, OPERATING CONDITION, COMBUSTION ENGINE

1. Introduction

Fuel consumption by modern road vehicles is an interesting parameter of all users and producers. This is a consequence of the significant share of fuel costs in total transport costs [1].

In order to standardize the measurement of fuel consumption in the European Union in 1970 line directive 70/220/EEC [2] came into force as a part of the regulation ECE vehicles (the latest version is defined by ECE R83 , R84 and R101) . The New European Driving Cycle (NEDC) test was introduced. It aims to assess the level of emissions from car engines and fuel consumption in cars. NEDC is supposed to represent the typical use of the car in Europe. It consists of four repeated ECE -15 tests - urban driving cycle (UDC) and the Extra Urban Driving Cycles test (EUDC) . The research of cars, weighing less than 3500 kg, which were equipped with engines with spark ignition and diesel engine are performed on a chassis dynamometer - roller dynamometer with DC motor or asynchronous AC motor [3]. The measurement of the test starts with a cold engine and is operated by a well-defined procedure for cyclic acceleration, braking and shifting, using the exhaust gas composition analysis. The nature of its ride from the beginning to the end is clearly defined, the car does not move and goes ~~to~~ the ideal " way " - rolls. In the design of the test methods it is pointed out that the motion characteristic of the vehicle in the natural operation is the variable speed which is mapped by means of its profile during the course of the speed. This profile, in operational conditions , has a random character .

2. Dynamometer tests

Urban Driving Cycles (UDC) has been designed to represent typical driving conditions busy European cities. It is characterized by a low engine load, low flue gas temperature and a maximum speed of 50 km/h- Figure 1.

The average speed during the test is 19km/h and the theoretical distance covered during the cycle is 1,013 km.

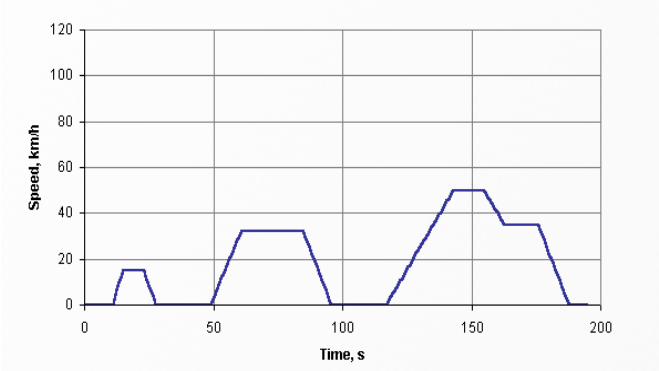


Fig. 1 *UDC test* [4]

In 1990 was introduced EUDC (Extra Urban Driving Cycles). It was designed to represent a more aggressive routes and highways, had high modes determine the speed. The velocity profile shown in Figure 2 below.

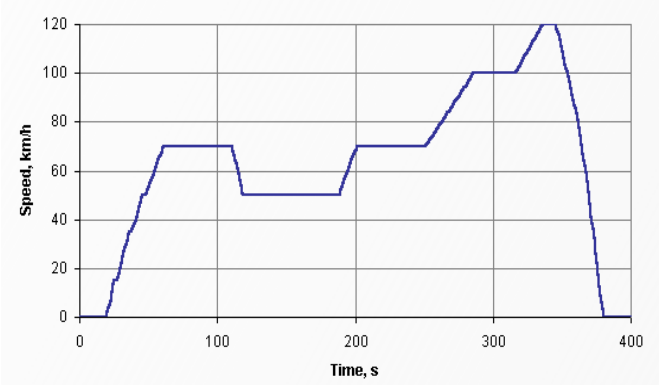


Fig. 2 *EUDC test* [4]

The Effective running time of test is 400 s while theoretical distance traveled in one cycle is 6,955 km it follows the average speed during the test: 62, 6 km/h.

The combined effect of the two tests UDC and EUDC was the New European Driving Cycles (NEDC). It consists of a recurring cycle of four ECE-15-UDC and one EUDC cycle, Figure 3.

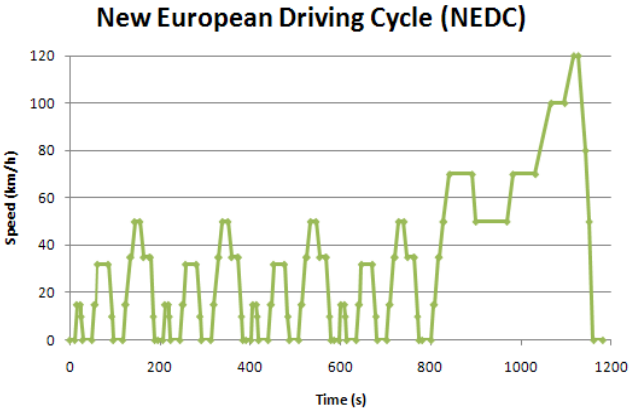


Fig. 3 *NEDC test*

The above-described tests are used all the time in the determination of secondary and urban vehicle fuel consumption . The car is tested at a temperature of about 25 ° C, no air resistance and for any possible additives are excluded , which may further increase consumption of energy and fuel , in which the vehicle is equipped , for example: lights , heating and an air conditioning.

3. Investigated objects and the results

Fuel consumption determined in a test on a chassis dynamometer is not determined by measurement (weight or volume) of fuel actually consumed by the engine , but analytically based on calculations made taking into account the emission of exhaust components .

Referring to the sentence above the analysis has been subjected to attempt a population of 85 different models of cars with the most popular engine in its model, the weight of which does not exceed 3500 kg. Vehicles are assigned to the appropriate classification of vehicles . It was compared to the average consumption declared by the carmaker to the natural operation of the vehicle. Actual fuel consumption was measured by more than 8106 users of the analyzed vehicles.

Based on the analysis of fuel consumption has been shown that the difference in fuel consumption between vehicle specifications given by the car companies and the actual driving is about 18,4 % higher- table 1 and figure 4.

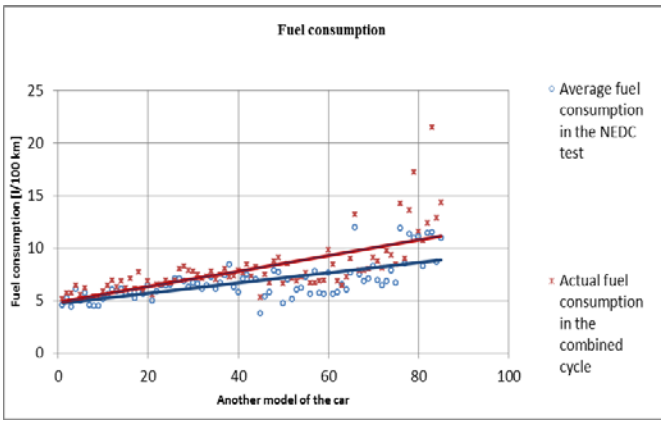


Fig. 4 *A-segment mini cars*

As the following analysis shows that in each segment vehicle classification exceeded consumption rates. The smallest indication to B-segment vehicles, or small vehicles. In contrast, the greatest indication are the most expensive cars of the segment, the segment F. The following are shown examples of graphs for the small and the medium segments.

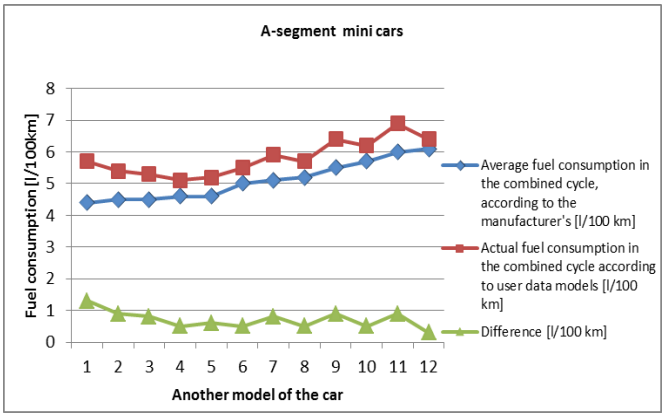


Fig. 5 *A-segment mini cars*

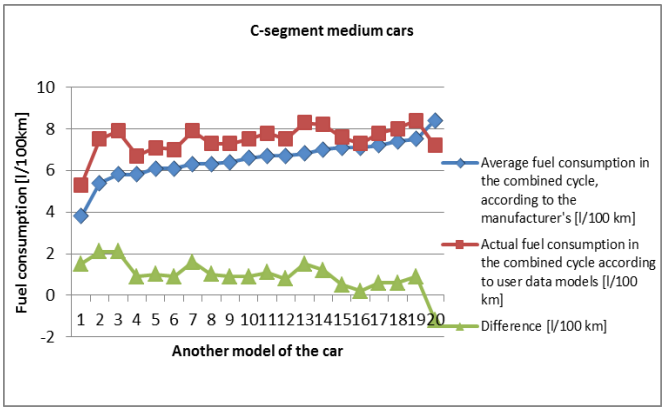


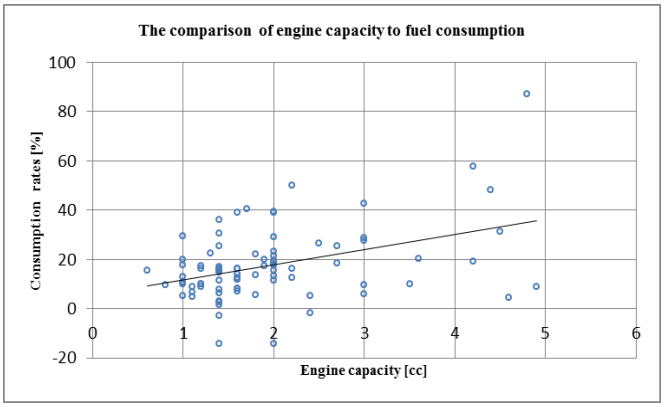
Fig. 6 *C-segment mini cars*

Table 1: *Comparison of results*

Car classification	A-segment mini cars	B-segment small	C-segment medium	D-segment large	E-segment executive	F-segment luxury
Number of analyzed models	12	15	20	17	11	10
The sum of opinions vehicle users	8106					
Average fuel consumption in the combined cycle, based on vehicle specifications [l/100 km]	5,10	6,07	6,53	6,35	7,64	10,45
Actual fuel consumption in the combined cycle according to user data models [l/100 km]	5,81	6,66	7,48	7,49	9,04	13,74
Difference [l/100 km]	0,71	0,59	0,96	1,14	1,40	3,29
The percentage difference between NEDC test and natural operation[%]	14,3	10,1	16,1	19,3	19,3	31,2
The average percentage of the difference between the NEDC test and natural operation [%]	18,4					

It seems advisable to clarify why the deviation fuel consumption in operation are greater as those designated in the dynamometer tests vehicles. The reasons could be many but, of course, seem to disregard basic tests on a dynamometer changes occurring in the operation of vehicles. In addition, it is used methodologically inappropriate determination of operational fuel consumption [5,6]. According to the below graph comparing the percentage difference in fuel consumption tests, it can be seen that the trend line is formed ascending towards a higher engine displacement expressed in cubic centimètres .

Fig. 7 *The comparison of engine capacity to fuel consumption*

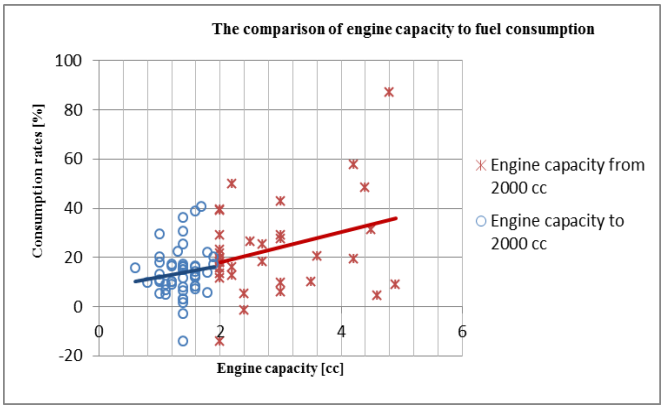


Dependence noted that the larger the displacement the fuel consumption is higher. Vehicle group was divided due to the displacement , is illustrated in table 2 and figure 8.

Table 2: *The comparison of engine capacity to the average percentage difference between the NEDC test and natural operation*

Engine capacity to [cc]	Percent of the vehicles in the sample [%]	The average percentage difference between the NEDC test and natural operation[%]
1600	40	12,5
2000	60	13,8
2500	80	15,1
4900	100	18,4

Fig. 8 *The comparison of engine capacity to fuel consumption*



The increase in fuel consumption with the increase of cylinder capacity is associated with a larger displacement engine, high dynamics and the nature of the operation of such vehicle by the user.

5. Conclusions

The analysis shows that the actual operation of the test vehicle , fuel consumption , significantly different from the test on a chassis dynamometer . Consumption rates in the natural operation are much higher than declare that car manufacturers . The test vehicles consumed a whopping 18.4% more fuel than is in the technical data of their vehicles .

In addition, the relationship was found that the fuel consumption increases with the cylinder capacity of the vehicles tested .

In summary , the actual verification, any work on the fuel consumption should be done only under conditions of natural life . Evidently, it proves the inability of the NEDC test to represent real - natural style of driving and operating a car. It would create new tests measuring fuel consumption and emissions of harmful compounds with the dynamic development of the automotive industry. NEDC was developed at a time when European vehicles were lighter and less efficient. Test features a stylized pattern speeds for low accelerations (a = 0.89 m / s) speed , fixed route and ride at idle , but temporary increase is much steeper and more dynamic in practice , in part due to overcapacity of modern engines. In addition , vehicles are tested without the burden that increase fuel consumption as heating or air conditioning . Also, the temperature during testing on a dynamometer is beneficial for reducing fuel consumption. Therefore, given by the manufacturers of the average fuel consumption should be taken with great caution .

As a result, it is difficult to achieve drivers certified values in practice. The new version of the driving cycle should be more realistic to the everyday use of additional devices and gadgets that are installed in modern vehicles , taking into account the increase in the growth of new car models . Tests should as much as possible to reflect the actual driving . It should be remembered consumption depends largely on driving style , condition of the vehicle , specific conditions of weather and how it is used .

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