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Automatic Engine Shutdown Function as an Innovative Technology Allowing to Reduce CO2 Emission

Z. Łukasik , J. Kozyra & A. Kuśmińska-Fijałkowska
University of Technology and Humanities in Radom, Radom, Poland

ABSTRACT: An automatic engine shutdown function at idle running was approved as an innovative technology, which is mounted in the vehicles of M1 category equipped with conventional power transmission system, automatic gearbox or manual gearbox and automatic clutch. The reduction of CO2 emission as a result of application of an automatic engine shutdown function at idle running is determined using a method determining the level of reduction of emission. The main goal of this publication was to present a method of determining CO2 savings obtained thanks to the use of an automatic engine shutdown function at idle running.

1 INTRODUCTION

The reduction of fuel consumption is one of the priorities for car manufacturers because the goal for a specific car is to achieve success on the market, and which cars saving fuel are appreciated by the clients. Technologies allowing to save fuel are becoming more and more applied by car makes. The current regulations, norms and legislative and tax restrictions in Europe cause that ecology and petrol saving are the first determinants of the designs of new cars. Within 15 years, some harmful substances generated by the car engines were limited by 80% and it seems that automotive industry will no longer be accused of being the biggest polluter of our planet.

One of the new technologies allowing to improve greenness of cars is limiting the time of working of an engine at idle running. This new function eliminates long-lasting work of an engine at idle running and control system automatically turns the engine off after the lapse of programmed time fulfilling necessary conditions.

The basic principle of thatinnovative technology is to decouple the combustion engine from the drivetrain and prevent deceleration caused by engine braking. The function should be automatically activated in the predominant driving mode, which is the mode automatically selected when the vehicle is switched on. Thus coasting can be used to increase the rolling distance of the vehicle in situations where no propulsion or a slow reduction of speed is needed. When ‘coasting’, the kinetic and potential energy of the vehicle is directly used to overcome driving resistance and, as consequence, to decrease fuel consumption. To obtain less deceleration the engine is decoupled from the drivetrain by opening a clutch. This is done automatically by the control unit of the automatic transmission or by means of an automated clutch in case of a manual gearbox. During the coasting phases the engine is running at idle speed.

The autors have provided a methodology for testing the CO_2 reductions from the use of the engine idle coasting function, which includes a modified NEDC test cycle to offer the possibility for the vehicle to coast.

2 THE MAIN ASSUMPTIONS OF CO_2 SAVINGS IN NEW TECHNOLOGY OF AUTOMATIC ENGINE SHUTDOWN AT IDLE RUNNING

A key element in determining the CO_2 savings is the proportion of the distance travelled by the vehicle over which the coasting function is activated, taking into account that the coasting function may be deactivated in other driving modes than the predominant driving mode. In order to take into account the diversity of the vehicles on the market, it is considered appropriate to establish a usage factor that is representative of the rate of activation of the technology for a wide range of vehicles in real world conditions. Based on data provided by the applicants, it is clear that the activation of the engine idle coasting technology is dependent of certain speed limits that may vary between different vehicles. Based on the database provided, it is appropriate to consider the coasting function to be active at speeds above 15 km/h.

In order to determine the CO_2 savings achieved, the vehicle fitted with the engine idle coasting function should be compared with a baseline vehicle where the coasting function is not installed, not available in the predominant driving mode or disabled for testing purposes. In order to achieve a robust comparison the baseline vehicle should be tested on the standard NEDC under hot start conditions, while the modified conditions applicable for the vehicle equipped with the eco-innovation should be taken into account by a conversion factor being applied for the calculation of the CO_2 savings. It is considered appropriate to maintain the conversion factor at the value of 0,960 in line with the conversion factor set out in Implementing Decisions (EU) 2015/1132 and (EU) 2017/1402.

3 METHODOLOGY TO DETERMINE THE CO_2 SAVINGS THE USE OF THE ENGINE IDLE COASTING FUNCTION

To determine the CO_2 savings that can be attributed to the use of the Engine Idle Coasting Function, it is necessary to specify the following:
– The test vehicles;
– The procedure to precondition the vehicle;
– The procedure to perform the dynamometer road load determination;
– The procedure to define the modified testing conditions;
– The procedure to determine the CO2 emissions of the eco-innovative vehicle under modified testing conditions;
– The procedure to determine the CO2 emissions of the baseline vehicle under Type 1 hot start conditions;
– The calculation of the CO2 savings;
– The calculation of the uncertainty of the CO2 savings.

3.1 *Test vehicles*

Baseline vehicle: a vehicle with the innovative technology deactivated or not installed. For that vehicle, it shall be verified that the coasting function is not activated during the NEDC test (i.e. the test run to obtain $B_{MC} = (B_{TA_{hot}})$.

Eco-innovative vehicle: a vehicle with the innovative technology installed and active in default or predominant mode. The predominant driving mode is the driving mode that is always selected when the vehicle is switched on regardless of the operating mode selected when the vehicle was previously shut down. Engine-on coasting function may not be deactivated by the driver in the predominant driving mode.

3.2 *Vehicles preconditioning*

In order to reach the hot testing conditions of the powertrain, one or more complete preconditioning NEDC or mNEDC driving cycles shall be performed.

3.3 *Road load determination*

The dynamometer road load determination shall be carried out on a chassis dynamometer as follows:
– initial preparation of a vehicle in accordance with NEDC or mNEDC.
– Performing the dynamometer road load determination, according to the procedures defined in the UN/ECE Regulation No 83 Annex 4a — Appendix 7.

3.4 *Definition of the modified testing conditions*

The procedure of determination of variability of test conditions requires to: determine coasting curve, determine changed speed profile NEDC (mNEDC) and profile of gear change for the vehicles equipped with a manual gearbox.

The determination of the coast down curve in coasting mode shall be carried out on a chassis dynamometer and following these two compulsory steps:
– Bringing the vehicle to operating temperature using the preconditioning procedure;
– Executing a coast down in coasting mode from 125 km/h to either a standstill or to the lowest possible coasting speed.

The speed profile of the mNEDC shall be generated according to the following rules:
– The test sequence is composed of an urban cycle made of four elementary urban cycles and an extra-urban cycle,
– All acceleration ramps are identical to the NEDC-profile,
– All constant speed levels are identical to the NEDC-profile,
– The deceleration values when coasting function is deactivated are equal to the ones within the NEDC-profile,

- The speed and time tolerances shall be in accordance with paragraph 1.4 of Annex 7 to UN/ECE Regulation No 101,
- The deviation from the NEDC profile shall be minimised and the overall distance must comply with the NEDC specified tolerances,
- The distance at the end of each deceleration phase of the mNEDC-profile shall be equal to the distances at the end of each deceleration phase of the NEDC-profile,
- For all phases of acceleration, constant velocity and deceleration, standard NEDC tolerances shall be applied,
- During coasting phases the ICE is decoupled and no active correction of the vehicles velocity trajectory is permitted,
- Lower speed limit for coasting vmin: The coasting mode has to be disabled at the lower speed limit (15 km/h) for coasting by pressing the brake pedal,
- Minimal stop time: The minimum time after every coasting deceleration to a standstill or constant speed phase is 2 seconds (t_{min}^{stop} in Fig. 1),
- Minimum duration for constant speed phases: The minimum duration for constant speed phases after acceleration or coasting deceleration shall be at least 2 seconds (t_{min}^{const} in Fig. 1),
- During the deceleration phases, the coasting mode can be enabled if the speed is below V_{max}, V_{max} being the maximum speed of the test cycl,
- The coasting mode may be disabled for speeds higher than V_{min}.

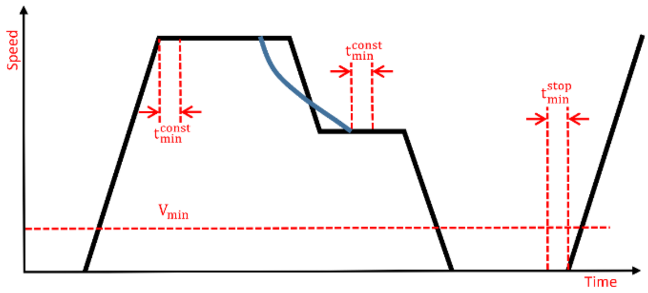

Figure 1. Parameters used to generate mNEDC

For vehicles equipped with manual gearboxes, the gearshift table shall be adapted using the following assumptions:

- The gearshift selection during vehicle acceleration remains as defined for the NEDC,
- The timing for the downshifts of the modified NEDC differ from the one of the NEDC in order to avoid downshifts during coasting phases (e.g. anticipated before deceleration phases).

The pre-defined shift points for the ECE portion of the NEDC cycle are modified as described in the following table 1.

Table 1. The pre-defined shift points: PM1 = gearbox in neutral, clutch engaged; K1, K2 = first or second gear engaged, clutch disengaged.

Operation	Phase	Acceleration (m/s²)	Speed (km/h)	Duration of each Operation (s)	Duration of each Phase (s)	Cumulative time (s)	Gera to be used in the case of a manual gearbox
Idling	1	0	0	11	11	11	6s PM+5sK_1[1]
Acceleration	2	1,04	0-15	4	4	15	1
Steady speed	3	0	15	9	3	23	1
Deceleration	4	-0,69	15-10	2	5	25	1
Deceleration, clutch disengeged		-0,92	10-0	3		28	K_1[1]
Idling	5	0	0	21	21	49	16s PM+5sK_1[1]
Acceleration	6	0,83	0-15	5	12	54	1
Gear change			15	2		56	
Acceleration		0,94	15-32	5		61	2
Steady speed	7	0	32	t_{const1}	t_{const1}	61+ t_{const1}	2
Deceleration	8	coastdown	[32-dv_1]	Δt_{cd1}	Δt_{cd1}+8-Δt_1+3	61+ t_{const1}+ Δt_1	2
Deceleration		-0,75	[32-dv_1]-10	8-Δt_1		69+ t_{const1}+ Δt_{cd1}+ Δt_1	2
Deceleration, clutch disengeged		-0,92	10-0	3		72+ t_{const1}+ Δt_{cd1} + Δt_1	K_1[1]
Idling	9	0	0	21-Δt_1		117	16s - Δt_1 PM+5sK_1[1]
Acceleration	10	0,83	0-15	5	26	122	1
Gear change			15	2		124	
Acceleration		0,02	15-35	9		133	2
Gear change			35	2		135	
Acceleration		0,52	35-50	8		143	3
Steady speed	11	0	50	t_{const2}	t_{const2}	t_{const2}	3
Deceleration		coastdown	[50-dv_1]	Δt_{cd2}	Δt_{cd2}	t_{const2}+ Δt_{cd2}	3
Deceleration	12	-0,52	[50-dv_1]-35	8-Δt_{cd2}	8-Δt_{cd2}	t_{const2}+ Δt_{cd2}+8- Δt_2	3
Steady speed	13	0	35	t_{const3}	t_{const3}	t_{const2}+ Δt_{cd2}+8- Δt_2+ t_{const3}	3
Gear change	14		35	2	12+ Δt_{cd3}- Δt_3	t_{const2}+ Δt_{cd2}+10- Δt_2+ t_{const3}	
Deceleration		coastdown	[35-dv_1]	Δt_{cd3}		t_{const2}+ Δt_{cd2}+10- Δt_2+ t_{const3}+ Δt_3	2
Deceleration		-0,99	[35-dv_1]-10	7-Δt_{cd3}		t_{const2}+ Δt_{cd2}+17- Δt_2+ t_{const3}+ Δt_{cd3}+ Δt_3	2
Deceleration, clutch disengeged		-0,92	10-0	3		t_{const2}+ Δt_{cd2}+20- Δt_2+ t_{const3}+ Δt_{cd3}+ Δt_3	K_2[1]
Idling	15	0	c	7-Δt_{cd3}	7-Δt_{cd3}	t_{const2}+ Δt_{cd2}+27- Δt_2+ t_{const3}+ Δt_{cd3}+2·Δt_3	7s – Δt_3 PM[1]

Table 1. contiuded: *achieved velocity after 4 seconds with an acceleration of -0.69 m/s2 is 60.064 km/h. This velocity i salso as gear change indicator for modified NEDC cycle. ** dv4 is >= 60.064 m/h.

	Operation	Phase	Acceleration (m/s^2)	Speed (km/h)	Duration of each Operation (s)	Duration of each Phase (s)	Cumulative time (s)	Gera to be used in the case of a manual gearbox
1	Idling	1	0	0	20	20		K_1[1]
2	Acceleration	2	0,83	0-15	5	41		1
3	Gear change			15	2			-
4	Acceleration		0,62	15-35	9			2
5	Gear change			35	2			-
6	Acceleration		0,52	35-50	8			3
7	Gear change			50	2			-
8	Acceleration		0,43	50-70	13			4
9	Steady speed	3	0	70	t_{const4}	t_{const4}		5
9′	Deceleration	3′	coastdown	70-dv_4**	Δt_{cd4}	Δt_{cd4}		5
10	Deceleration	4	coastdown* -0,69	dv_4**-50	8-Δt_{cd4}	8-Δt_{cd4}		4
11	Steady speed	5	0	50	69	39		4
12	Acceleration	6	0,43	50-70	13	13		5
13	Steady speed	7	0	70	50	50		5
14	Acceleration	8	0,24	70-100	35	35		5[2]
15	Steady speed[2]	9	0	100	30	30		5[2]
16	Acceleration[2]	10	0,28	100-120	20	20		5[2]
17	Steady speed[2]		0	120	t_{const5}	t_{const5}		5[2]
17′	Deceleration[2]		coastdown	[120-dv_5]	Δt_{cd5}	Δt_{cd5}		
18-end								
	If dv5 > = 80							
	Deceleration[2]	12	-0,69	[120-dv_5]-80	16-Δt_5	34-Δt_5		5[2]
	Deceleration[2]		-1,04	80-50	8			5[2]
	Deceleration, clutch disengeged		1,39	50-0	10			K_5[1]
	Idling	13	0	0	20-Δt_5	20-Δt_5		PM[1]
	If 50 < dv5 < 80							
	Deceleration[2]		-1,04	[120-dv_5]-50	8-Δt_5	18-Δt_5		5[2]
	Deceleration, clutch disengeged		1,39	50-0	10			K_5[1]
	Idling	13	0	0	20-Δt_5	20-Δt_5		PM[1]
	If dv5 < = 50							
	Deceleration, clutch disengeged		1,39	[120-dv_5]-0	10-Δt_5	10-Δt_5		K_5[1]
	Idling	15	0	0	20-Δt_5	20-Δt_5		PM[1]

3.5 *Determination of the CO_2 emissions of the eco-innovative vehicle under modified testing conditions* (E_{MC})

The emissions of CO_2 of the eco-innovative vehicles shall be measured in accordance with Annex 6 of UN/ECE Regulation No 101 (Method of measuring emissions of carbon dioxide and fuel consumption of vehicles powered by an internal combustion engine only). The following elements shall be modified:

- The preconditioning of the vehicle (at least one complete initial NEDC or mNEDC is conducted),
- The speed profile (variability of test conditions is determined),
- The number of tests.

The complete test procedure on the test bench shall be repeated at least three times. The arithmetic mean of the CO_2 emission from the eco-innovation vehicle (E_{MC}) and the respective standard deviation of the arithmetic mean $(s_{E_{MC}})$ shall be calculated.

3.6 *Determination of the CO_2 emissions of the baseline vehicle under modified type approval hot start conditions* $(B_{TA_{hot}})$

The CO_2 emissions of the baseline vehicles have to be measured in accordance with Annex 6 of UN/ECE Regulation No 101 (Method of measuring emissions of carbon dioxide and fuel consumption of vehicles powered by an internal combustion engine only). The following elements shall be modified:

- The preconditioning of the vehicle (at least one complete initial NEDC or mNEDC is conducted),
- The number of tests.

The complete test procedure under type approval (NEDC) hot start conditions on the test bench shall be repeated at least three times. The arithmetic means of the CO_2 emission from the baseline vehicle $(B_{TA_{hot}})$ and the respective standard deviation of the arithmetic mean $(s_{BTA_{hot}})$ shall be calculated.

3.7 *Calculation of the CO_2 savings*

The formula to calculate the CO_2 savings is the following (1):

$$C_{CO_2} = (B_{MC} - E_{MC}) \cdot UF_{MC} - (B_{TA} - E_{TA}) \cdot UF_{TA} \quad (1)$$

where:

C_{CO_2} - CO_2 savings [gCO_2/km],

B_{MC} - Arithmetic mean of the CO_2 emissions of the baseline vehicle under modified testing conditions [gCO_2/km],

E_{MC} - Arithmetic mean of the CO_2 emission of the eco-innovation technology vehicle under modified testing conditions [gCO_2/km],

B_{TA} - Arithmetic mean of the CO_2 emission of the baseline vehicle under type approval (NEDC) testing conditions [gCO_2/km],
E_{TA} - Arithmetic mean of the CO_2 emission of the eco-innovation technology vehicle under type approval (NEDC) testing conditions [gCO_2/km],
UF_{MC} - Usage factor of the coasting technology under modified conditions, which is 0,52 for vehicles equipped with a conventional powertrain and an automatic transmission and 0,48 for vehicles equipped with a conventional powertrain and a manual transmission with an automated clutch,
UF_{TA} - Usage factor of the coasting technology under type approval (NEDC) conditions.

Since the innovative technology is not active under type approval (NEDC) conditions, the general equation for calculating the CO_2 savings can be simplified as follows: (2):

$$C_{CO_2} = \left(B_{MC} - E_{MC}\right) \cdot UF_{MC} \tag{2}$$

The term UF_{MC} of the Formula 2 will be hereafter simply written as '*UF*' since it is the unique usage factor thanks to the previous simplification. To determine B_{MC}, the same modified testing conditions should be followed by a vehicle which does not have the coasting function.

The assumption is that the baseline vehicle is able to perform a sailing curve (line 2′ in Fig. 2) without disconnecting the engine from the wheels, although with lower efficiency than a coasting vehicle (able to disconnect the engine from the wheels). Sailing is intended as the hypothetical coasting behaviour of the baseline vehicle.

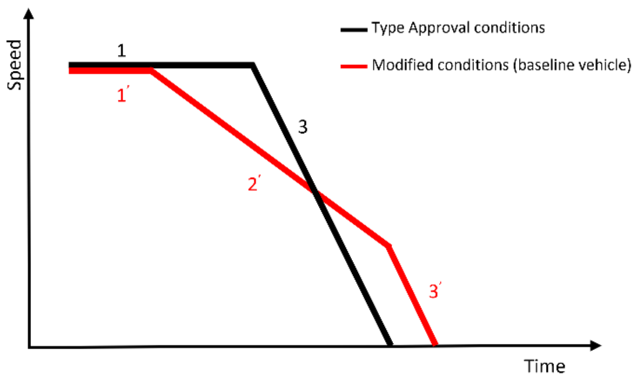

Figure 2. Sailing curve for baseline vehicle

A common characteristic of a baseline vehicle is that, during deceleration phases of the type approval (NEDC) (3) and modified (2′ + 3′) testing conditions, no fuel is used (cut-off). The definition of the coasting curve (1′ + 2′ + 3′) for the baseline vehicle is a complex process since different parameters are involved (e.g. gear range, electric power demand, transmission temperature). Since it would therefore be difficult for the driver to follow this speed trace without exceeding the speed and time tolerances, it has therefore been proposed to use a conversion parameter (i.e. c-factor) to calculate the CO_2 emissions of the baseline vehicle under modified conditions (B_{MC}) from the CO_2 emissions of the baseline vehicle emissions under type approval (NEDC) hot start conditions ($B_{TA_{hot}}$). The relation between $B_{TA_{hot}}$ and B_{MC} is defined using the c-factor, shown on the following formula (3):

$$c = \frac{B_{MC}}{B_{TA_{hot}}} \tag{3}$$

As consequence, formula (2) becomes:

$$C_{CO_2} = \left(c \cdot B_{TAhot} - E_{MC}\right) \cdot UF \tag{4}$$

where:
c - Conversion parameter which is 0,960,
$B_{TA_{hot}}$ - Arithmetic mean of the CO_2 emission of the baseline vehicle under type approval (NEDC) hot start conditions [gCO_2/km],
E_{MC} - Arithmetic mean of the CO_2 emission of the eco-innovation vehicle under modified testing conditions [gCO_2/km],
UF - Usage factor of the coasting technology under modified conditions, which is 0,52 for vehicles equipped with a conventional powertrain and an automatic transmission and 0,48 for vehicles equipped with a conventional powertrain and a manual transmission with an automated clutch.

The usage factor has been defined by formula (5):

$$UF = \frac{RCD_{RW}}{RCD_{mNEDC}} \tag{5}$$

where:
RCD_{RW} - Relative coasting distance under real world conditions [%],
RCD_{mNEDC} - Relative coasting distance under modified NEDC testing conditions [%].

The relative coasting distance RCD under real world conditions is defined as the distance travelled with coasting active divided by total driving distance per trip.

3.8 *Calculation of the uncertainty*

The uncertainty of the total CO_2 saving should not exceed 0,5 g CO_2/km formula (6):

$$s_{C_{CO_2}} \leq 0,5 gCO_2 / km \tag{6}$$

where:
$s_{C_{CO_2}}$ - Statistical margin of the total CO_2 saving [g CO_2/km].

The formula to calculate the statistical margin is (7):

$$s_{C_{CO_2}} = \sqrt{\left(c \cdot UF \cdot s_{B_{TA_{hot}}}\right)^2 + \left(-UF \cdot s_{E_{MC}}\right)^2 + \left[\left(c \cdot B_{TA_{hot}} - E_{MC}\right) \cdot s_{UF}\right]^2} \tag{7}$$

where:
$s_{C_{CO_2}}$ - Statistical margin of the total CO_2 saving [g

CO_2/km],
c - Conversion parameter which is 0,960,
$B_{TA_{hot}}$ - Arithmetic mean of the CO_2 emission of the baseline vehicle under type approval (NEDC) hot start conditions [gCO_2/km],
$s_{BTA_{hot}}$ - Standard deviation of the arithmetic mean of the CO_2 emission of the baseline vehicle under modified testing conditions [gCO_2/km],
E_{MC} - Arithmetic mean of the CO_2 emission of the eco-innovation vehicle under modified testing conditions [gCO_2/km],
$s_{E_{MC}}$ - Standard deviation of the arithmetic mean of the CO_2 emission of the eco-innovation vehicle under modified testing conditions [gCO_2/km],
UF - Usage factor of the coasting technology, which is 0,52 for vehicles equipped with a conventional powertrain and an automatic transmission and 0,48 for vehicles equipped with a conventional powertrain and a manual transmission with an automated clutch,
s_{UF} - Standard deviation of the arithmetic mean of the usage factor, which is 0,027.

The calculated CO_2 savings value C_{CO_2} and the statistical margin of the CO_2 saving $\left(s_{C_{CO_2}}\right)$ must be rounded up and expressed to a maximum of two decimal places. Each value used in the calculation of the CO_2 savings (i.e. $B_{TA_{hot}}$ and E_{MC}) can be applied unrounded or must be rounded up and expressed to a minimum number of decimals which allows the maximum total impact (i.e. combined impact of all rounded values) on the savings to be lower than 0,25 gCO_2/km.

In order to demonstrate that the 1 gCO_2/km threshold is exceeded in a statistically significant way, the following. Formula shall be used:

$$MT = 1gCO_2 / km \le C_{CO_2} - s_{C_{CO_2}} \quad (8)$$

where:
MT - Minimum threshold [gCO_2/km],
C_{CO_2} - CO_2 savings [gCO_2/km],
$s_{C_{CO_2}}$ - Statistical margin of the total CO_2 saving [g CO_2/km].

Where the CO_2 emission savings, as a result of the calculation using Formula 4 are below the threshold specified in Article 9(1) of Implementing Regulation (EU) No 725/2011, the second subparagraph of Article 11(2) of that Regulation shall apply.

4 THE EXAMPLES OF APPLICATION OF AN AUTOMATIC ENGINE SHUTDOWN FUNCTION AT IDLE RUNNING

Coasting ensures low level of emission and noiseless and smooth ride on long stretches. This system turns the engine off during momentum ride, therefore, fuel is not consumed. Therefore, during normal ride, we can save up to 10% of fuel. An engine is turned off without an interference of a driver, when the system recognizes that it is possible to keep the speed during momentum ride, for example, at a slight drop or after removing the foot from the accelerator. When the driver presses accelerator or brake pedal, an engine turns on again. More and more new cars equipped with an automatic gearbox has „sailing" coasting mode. Its essence is controlled declutching. Profit and loss balance is what matters while fighting for every gram of emitted carbon dioxide. While braking an engine, fuel is not consumed, but a car quickly loses kinetic energy. An engine working at idle running burns about 0,7 l/h, however, speed decreases slowly – a car can cover a few hundred meters. According to the producers of Audi A8 48, volt power system enables to „sail" when combustion unit is turned off even for 40 seconds at a speed between 55 and 160 km/h. An engine turning off at a speed of 140 km/h effectively reduces fuel of CO_2 emission. Whereas, after removing the foot from the accelerator at a speed of 60 km/h, Audi A3 equipped with a sailing mode turned on covers a distance of 703m. In normal gearbox operation mode only 239m. Coasting 2.0 is mounted in new VW cars. In accordance with initial calculations, new technology will allow in new cars to burn on the average by 0,4 l/100 km less fuel than version equipped with standard engine and by about 0,2 l/100 km less in comparison with comparable model equipped with current sailing function (with engine turned on). According to the French manufacturer, Peugeot cars equipped with a sailing system burns on the average 15% of fuel less in the city than the versions without an automatic engine shutdown system.

Taking into account that 3,1 kg of carbon dioxide (0,322 kg of fuel must be consumed for 1 kg of CO_2) is generated during complete and perfect combustion of 1 kg of petrol, mass of fuel when the engine works at idling was determined. The intensity of emission of carbon dioxide of the examined engine under such conditions is 0,76 g/s. It was used to assess the mass of fuel during working time unit of the engine formula (9):

$$0{,}76 \text{ g/s } CO_2 \cdot 0{,}332 \text{ g Petrol/g } CO_2 = 0{,}245 \text{ g/s Petrol} \quad (9)$$

Taking petrol density into account (ϱ = 0,745 g/cm^3) volumetric intensity of fuel consumption was obtained (10):

$$0{,}76 \text{ g/s } CO_2 \cdot 0{,}332 \text{ g Petrol/g } CO_2 / 0{,}745 \text{ g/cm}^3 = = 0{,}33 \text{ cm}^3\text{/s Petrol} \quad (10)$$

Assuming reduction of fuel burning by applying the function of turning the engine at idle running off, savings of CO_2 emission at 0,4 l/100 km were calculated. CO_2 saving is 0,94 [kg/100km].

5 CONCLUSION

Thanks to new coasting function, the drivers using the vehicles equipped with an internal combustion engines may ride in the mode of zero emission, without noise and low resistance for most of the driving. This innovative technology stops an engine, when the vehicle is driving allowing to save fuel. Every time that the vehicle can keep the speed simply through sailing, for example, at small inclination - an engine is turned off. The tests made in many research centres showed that internal combustion engines work unnecessarily for about 30 per cent of time, which means that a vehicle may simply cover about one third of every distance. Although these phases are not included in the New European Driving Cycle (NEDC), under real traffic conditions, this function will let a driver to save about 10% of fuel. Coasting function can be bought at an affordable price and can be connected with any type of an internal combustion engine, considerably reducing fuel consumption. According to statistics, average annual covered distance is about 11 500 kilometres. If every new car was equipped with coasting system and emitted only 10 grams lower CO_2 per kilometre, theoretical annual reduction of CO_2 will be more than 30 000 metric tonnes. In the future, we should expect that coasting systems will be mounted in all types of cars, just like an air conditioner.

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