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IMPACT OF AN EXTERNAL, SO CALLED BOX, MODULE ON GASES COMPOSITION OF THE ROVER 2.0 CDTI ENGINE

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Abstract

Environmental impact of the motor vehicle has been felt in every stage of the motor vehicle operation. In the initial phase of the operation, when the vehicle is new, the amount of pollutants getting into the environment is less than at the end of its life, before the scrapping. This is connected with wearing the engine during its operation. However, the need for better performance through the chiptuning or the Box type devices are quite common nowadays, but the impact on the environment may not exceed the permitted emission limits.

The article describes the external, so-called Box, module and its impact on the change of the injector opening time, and also on the change of the ROVER 2.0 CDTi engine power and torque. The simplicity of this device lies in the fact that such a modification can be made by everyone who follows the installation instructions. It is not necessary to conduct the program reading, like in the case of a program exchange in the EEPROM or programming via the diagnostic connector EOBD. The external module (box) is connected between the ECU and the Common Rail injectors. Thus, the control program does not change, but the injector opening time is adequately increased.

Keywords: *combustion engines, impact on power, torque, composition of the gases, chiptuning*

1. Introduction

The launch of vehicles equipped with fuel injection systems with the electronic control system EDC (Electronic Diesel Control) allowed to make changes into the factory engine management control program. This enables an accurate and diverse development of combustion process.

Gradual development of EDC has influenced the emergence of various methods of intervention in the engine control program including exchange program in EEPROM, connecting external modules, so called boxes, and currently the most popular programming via diagnostic connector EOBD (European On Board Diagnosis).

The Department of Motor Vehicles Use during the tests on the 2.0.CDTi Rover 75 engine used the box to change the time of injection in the Common Rail injector system. This module was installed between the injector connector and the injector. This way, the electrical system was not damaged and there was no direct interference in the fuel injection maps.

The use of boxes in vehicles under warranty has advantages and disadvantages, depending on the service or user's perspective. When using external modules in vehicles under warranty and damaging an assembly, it is not possible to prove to the user that the box had been applied in order to increase the engine power and torque.[4]

2. Test bench

Research centres in order to determine the actual motor parameters bearing the name of the engine operating parameters such as power, fuel consumption etc., perform particular experiments in a special laboratory bench, called an engine dynamometer, by direct measurement on the engine crankshaft or indirect measurement with the chassis dynamometer to measure the parameters at the

wheel and to take into account losses in the drive system.

Depending on the requirements, the test coverage can be very diverse: from the primitive measurements of power and fuel consumption, to complex scientific problems depending on the equipment in the engine or chassis dynamometer.

Fig. 1 VT-2 chassis dynamometer at V-tronic company

The tests were conducted on the V-techVT-2 chassis single-axle dynamometer at the V-tronic company in Szczecin (Fig. 1). Such a dynamometer allows measuring the power and torque in the inertial mode and presenting the parameters using the DynaVTECH program.

Tab. 1 V-tech VT-2 chassis dynamometer description[9]

Type of dynamometer	inertial
Size (L x W) [mm]	1200 x 3300
Max./min. track of wheels[mm]	2200/900
Minimum diameter of the tire [mm]	400
Maximum axle load [kg]	3000
Number of axles	1
Eddy current brakes	optional
V_{max} [km/h]	300
Test mode	inertial
P_{max} [KM]	450
Measurement accuracy [%]	0.1

During the tests the interface and TestBook T4 software have been used to measure the actual parameters of the Rover 2.0 CDTi motor controller (Fig. 2). However, for the measurement of opacity the MAHA MDO2 opacimeter and IMR 1500 gas analyser have been applied (Fig. 2).

The tests were conducted using the Rover 75 car type with the 2.0 CDTi diesel engine and the Common Rail power supply system (Tab. 2).

Fig. 2 Read of the controller data via TestBook T4 and IMR 1500 exhaust gas analyser

Tab. 2 Technical data of the Rover 75 2.0 CDTi engine[7]

Number of cylinders / valves	4/16
Engine displacement [cm^3]	1951
Maximum power [hp/ rpm]	131/ 3500
Maximum torque [Nm/ rpm]	300/ 1900
Type of control (box)	Control with extended injection time
Supercharging	TD025L3-08T-3.3 turbocharger
Gearbox applied	automatic
Manufacture year	2005
Milage [km]	181 045

3. „Box" type external module

It is both the easiest and least effective way to increase a vehicle performance. Its simplicity lies in the fact that such a modification may be made by anybody following the installation instructions. It is not necessary to read the program as in the previously described methods. The external module (box) is installed between the EDC controller and the injection pump. Thus, the control program is not changed but it is "cheated" by the module where EDC forces other values of control signals using the executive devices.

Taking into account the fact such modules have a fixed loaded setting, the effect is not noticeable in each case. The increase in power and torque ranges from 2-10% in the case of supercharged engines, while in normally aspirated units the performance increases will be even smaller.

It results from the way of the implementation of the modified program. Not all the bitmaps actuators are subject to change but only some of them, such as injection dose or charge air pressure. Moreover, the adjustments in the modified maps necessary for the correct engine operation are not made either. Low performance growth is adequate for the low price of a module [3].

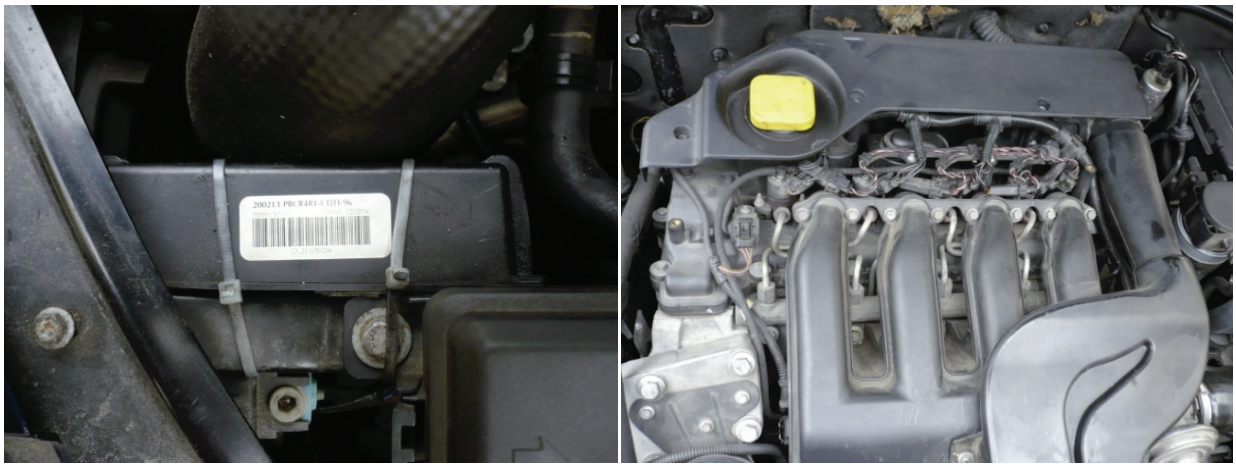

Fig. 3. View of the PBCR4B1-CDTI 96 box and its connection to the injectors

In this case, it is a module dedicated to this particular engine that is Rover 2.0 CDTi, which does not interfere with the engine control program. The box control program introduced changes during the injection time, and precisely it prolonged that time.

4. Analysis of the results

During the tests there have been conducted modifications of the parameter of the opening time extension of the Common Rail injector compared to the starting time of the motor controller using classical external device, so called box (Fig. 3) in order to increase power and torque throughout the rev range.

On the basis of the measurements obtained by using a chassis dynamometer the results of the measurements have been done (Tab. 3), as well as a graph comparing the external characteristics (Fig. 4).

Tab. 3. The results of measurements on the test bench

	Torque		Power		Losses in the drive		Smoke	
Revolutions	with box	without box	with box	without box	with box	without box	with box	without box
n [rpm]	T_{tqB} [Nm]	T_{tq} [Nm]	P^d_B [hp]	P^d [hp]	[hp]	[hp]	k_B [m^{-1}]	k [m^{-1}]
1800	85.20	88.60	21.50	22.30	9.20	9.20	0.00	0.00
2000	179.50	136.60	50.30	39.10	10.50	10.50	0.01	0.00
2200	231.40	191.10	71.30	58.90	11.60	11.60	0.00	0.00
2500	261.90	240.90	91.60	86.00	13.40	13.30	0.00	0.00
2700	272.00	254.30	105.20	96.70	14.70	14.70	0.00	0.00
2900	274.50	254.00	111.40	101.50	16.10	16.10	0.00	0.00
3000	272.30	248.90	114.40	104.60	16.40	16.70	0.02	0.00
3300	257.50	239.10	115.10	109.10	18.80	18.80	0.02	0.00
3500	244.80	211.20	115.60	103.50	21.20	21.20	0.03	0.09
3800	221.20	190.00	117.00	95.30	24.00	24.00	0.06	0.09
4000	199.80	152.50	111.90	85.50	26.50	26.00	0.08	0.10
4500	147.80	138.70	89.00	82.20	29.20	28.10	0.18	0.18

The results show that the modification objective brought the desired effect in the form of increasing the maximum torque throughout the rev range, whilst increasing engine power and maintaining the opacity at the same level.

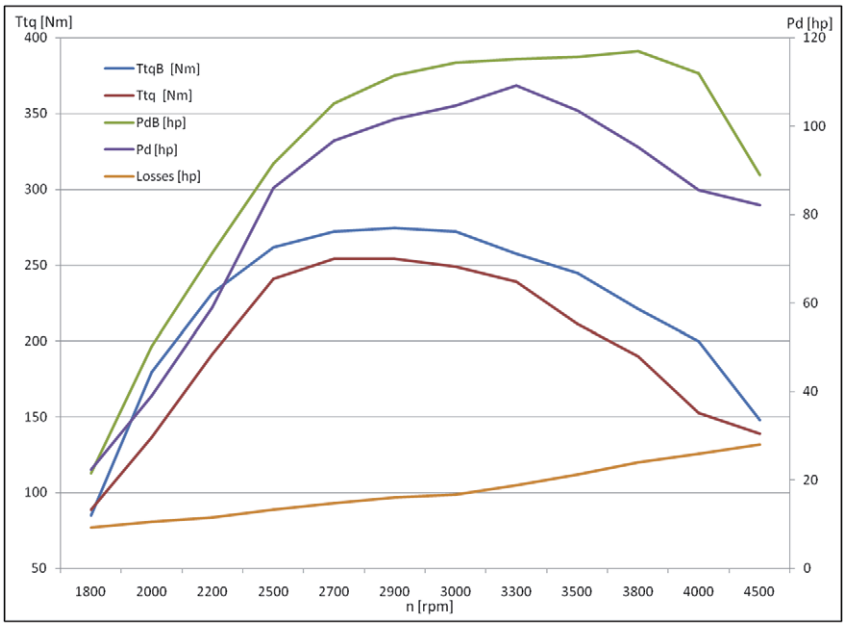

Fig. 4. Summary of external characteristics

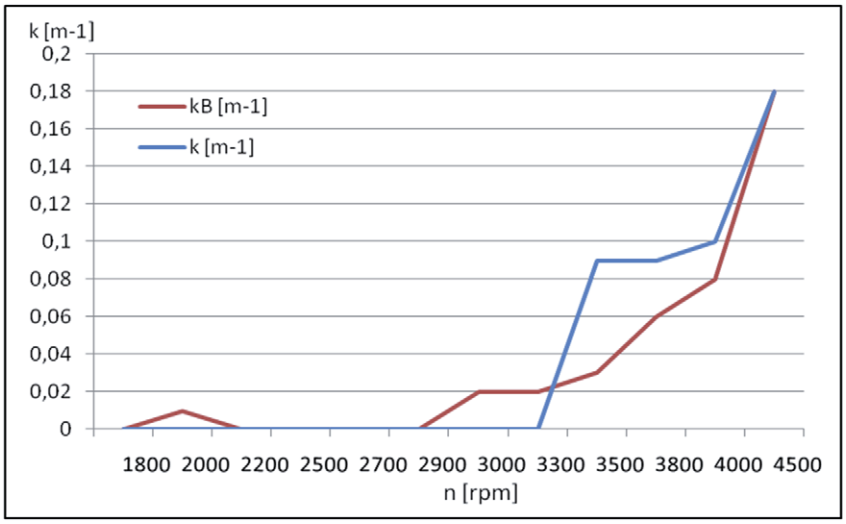

Fig. 5. Graph of smoke opacity

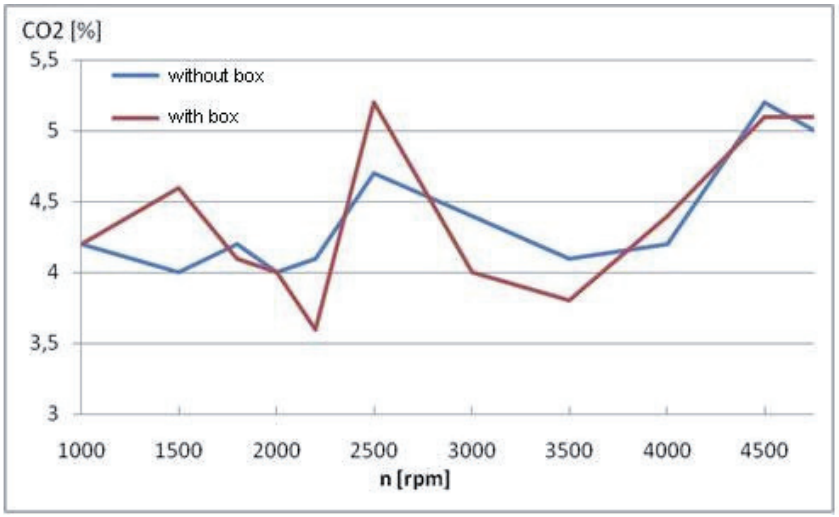

Fig. 6. Graph of carbon dioxide in the exhaust gases

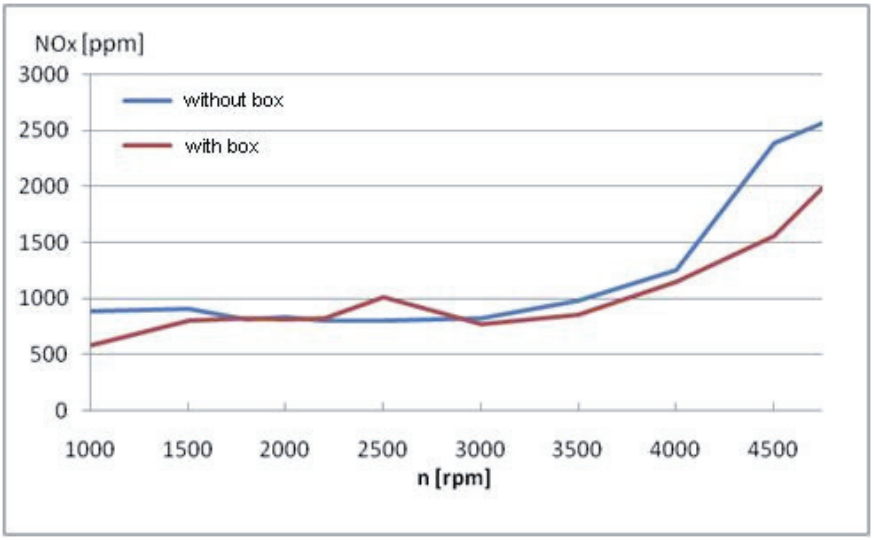

Fig. 7. Graph of nitrogen oxides in the exhaust gases

4. Conclusions

The article described the external module, so-called box, and its impact on the Rover 2.0 CDTi capacity growth of about 7.25% and torque by 7.94% (Fig. 4) with a slight reduction in smoke opacity by an average of 0.11m^{-1} at 3500-4000 rpm (Fig. 5). When accelerating, indeed it was possible to observe a greater change of opacity (both, without box connected and when connected), but it was a variation of ± 0.3 m^{-1}. The difference itself between the two opacity measurements is negligible, actually, it is not observable. The only difference in a car is that when the box is installed the little opacity is perceived already at 2000 rpm, and when the box is disassembled the engine opacity is visible at 3500 rpm. However, after calculating the mean value of these measurements, the same result is obtained, that is 0.06 m^{-1}.

In fact, the conclusion could be made now that the opacity has been changed a little. Such a result may be also evidenced by another parameter that is carbon dioxide (CO_2) emissions. The average value of the carbon dioxide in the exhaust gases before the box installation equalled 4.4% and after its assembly, it was 194.3%. This is a small contribution difference of carbon dioxide only by 0.1%. As it was shown in the graph of carbon dioxide in the exhaust gases (Fig. 6.), the values are different to each other even twice, especially in the range from 2000 rpm to 3000 rpm. In addition, it can be observed that after the box connection the amount of nitrogen oxide (NO) fell by an average of 14.9% and the amount of nitrogen oxides (NO_x) was reduced by an average of 9.3% compared to the measurements before connecting the box (Fig. 7).

The box installation is the simplest and at the same time quite effective method of increasing the vehicle performance. Its simplicity lies in the fact that such a modification can be made by anybody who follows the installation instructions. It is not necessary to read the program as in the case of a program exchange in the EEPROM or programming via the EOBD diagnostic connector. The external module (box) is connected between the EDC controller and the Common Rail injectors. Thus, the control program is not changed, but only the time of the fuel injection in the injector is extended.[3]

References

[1] Blam, M., *Mocy, przybywaj*, Auto EXPERT Nr 6/2008, Wydawnictwo Vogel Business Media, Warszawa 2008.

[2] Myszkowski, S., *Podstawy tuningu silnika*, auto EXPERT nr 11/2008, Wydawnictwo Vogel Business Media, Warszawa 2008.

[3] Prajwowski, K., *Impact of an external, so called Box, module on power and torque of the FIAT 1.3 JTD motor,* Journal of KONES Powertrain and Transport, Vol. 19, No. 1, 2012.
[4] Słupska, E., Słupski, M., *Chip-tuning*, Auto Moto Serwis Nr 12/2010, Wydawnictwo Instalator Polski, Warszawa 2007.
[5] Staszewski, M., *Kilka słów o chiptuningu*, Serwis motoryzacyjny nr 4/2009, Polska Izba Stacji Kontroli Pojazdów, Warszawa 2009.
[6] Artykuł redakcyjny, *Metody zwiększania mocy silników*, auto EXPERT nr 3/2007, Wydawnictwo Vogel Business Media, Warszawa 2007.
[7] Instrukcja obsługi „ROVER 75" Publikacja, Nr RCL 0548LAN 01/2003, MG Rover Group Limited 2001.
[8] http://www.44tuning.pl/chip-tuning-rover-75-2.0-cdti-131-km.
[9] http://vtechdyno.eu/.
[10] http://www.v-tronic.pl/show.php?element=hamownia.