IMPACT OF AN EXTERNAL, SO CALLED BOX, MODULE ON POWER AND TORQUE OF THE FIAT 1.3 JTD MOTOR

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Abstract

With the emergence of vehicles equipped with fuel injection systems with EDC electronic control system (Electronic Diesel Control) on the market, there appeared opportunity to make changes within the factory program of engine control management. This enables precise and differentiated shaping of the course of combustion. With the gradual development of the EDC different methods of intervention in the engine control program appeared, including exchange of the program in the EEPROM, connecting the external modules, so called Boxes, and programming via the EOBD diagnostic connector (European On Board Diagnosis).

The article presents the external module, so-called Box and its impact on the variation in pressure in the Common Rail high pressure cell, and also on the power change and torque of the Fiat 1.3 JTD MultiJet engine. It is both the simplest and least effective method of increasing vehicle performance. Its simplicity lies in the fact that such a modification may be made by anyone who follows the installation instructions. There is no need to carry out program reading like in the event of program exchange in the EEPROM or programming by the EOBD diagnostic connector. The external module (box) is connected between the EDC and the fuel pressure sensor in the Common Rail cell. Thus, the control program does not change, but it is „cheated" by the module forcing from the EDC other values of signals controlling the actuators.

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

1. Introduction

With the emergence of vehicles equipped with fuel injection systems with the EDC electronic control system (Electronic Diesel Control) on the market, a possibility of change within factory engine management control program appeared. This enables precise and differentiated shaping the course of combustion.

With the gradual development of the EDC, different methods of interference in the engine control program appeared, i.e. exchange of the program in the EEPROM, connection of external modules, so called boxes, and the most popular current programming through the EOBD diagnostic connector (European On Board Diagnosis).

At the Institute of Automotive Maintenance and Operation during the tests on 1.3 JTD engine, there was used a box changing the pressure sensor parameters at the high pressure cell of Common Rail fuel. This module was connected between the pressure pick-up and the connector of that sensor. This way the electrical system was not damaged and there was not any direct interference in the fuel injection map.

Application of boxes in the vehicles under warranty has either advantages or disadvantages, depending on the point of view of a service or a user. In case when the external modules in vehicles under warranty are used and any set is damaged, it is not possible to prove that the user used the box in order to increase power and torque.

2. Test stand

Research centres in order to determine the actual engine parameters such as power, fuel consumption, etc. named the engine operating parameters, perform specific experiments in

a special laboratory test stand, called the engine test bench.

In accordance with the needs, the scope of testing can be very diverse: from the primitive measurements of the power and fuel consumption to complex scientific problems depending on the equipment of the engine test bench.

At the Institute of Automotive Maintenance and Operation, West Pomeranian University of Technology in Szczecin, the experiments on a test stand illustrated in Figure 1 were conducted.

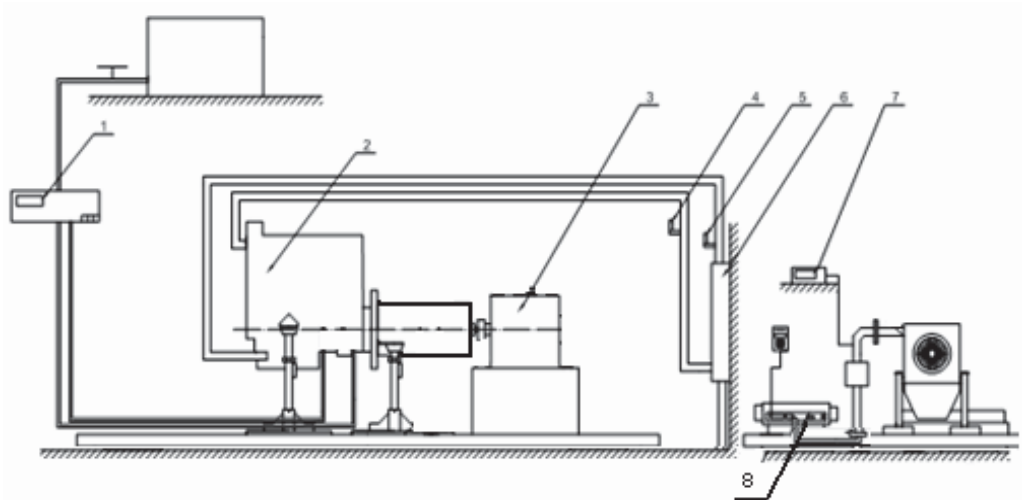

Fig. 1. Scheme of the test stand with the FIAT 1.3JTD MultiJet engine; 1 - AMX212F gauge, 2 - 1.3JTD engine, 3 - AMX 100 brake, 4 – coolant thermometer, 5 – coolant thermometer, 6 – coolant tank, 7 – exhaust gas temperature gauge, 8 –MDO 2 smokemeter with the control desk

One of the most important elements on the test stand is the brake burdening the 1.3JTD Fiat MultiJet combustion engine with the liquid control of values of a given load. During the tests the eddy-current brake of AUTOMEX AMX 100 and the mass meter of AUTOMEX AMX 212F were used.

Fig. 2. Pressure gauge for testing Common Rail high-pressure on FIAT 1.3JTD engine

During the study there were used a pressure gauge (Fig. 2) to measure the actual fuel pressure in the Common Rail high pressure cell and CDIF2 interface with the program, in order to view the parameters on the controller of the FIAT 1.3 JTD MultiJet engine (Fig. 3).

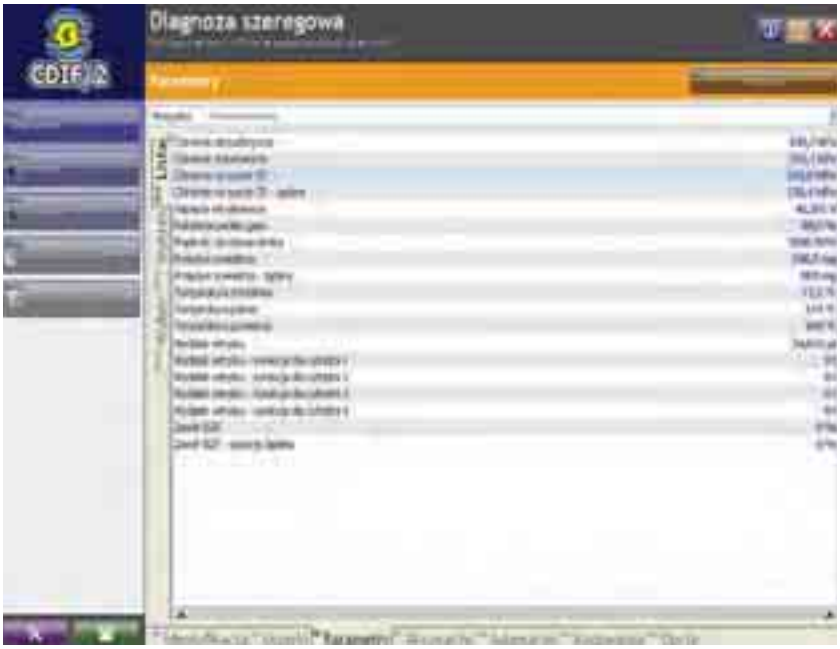

Fig. 3. Picture of data readout of Magneti Marelli 6.JF.S1 1.3 JTD controller

3. External modules of "box" type

This is the simplest and least effective method of increasing vehicle performance. Its simplicity lies in the fact that such a modification can be made by everyone who follows the installation instructions. There is no need to carry out the reading of the program as in the case of the methods described earlier. The external module (box) is connected between the EDC controller and the injection pump. So the control program does not change, but it is „cheated" by the module which forces from the EDC other values of signals that control actuators.

As the modules possess permanently loaded settings, the effect is not noticeable in any case. The increase of power and torque ranges from 2-10% in case of supercharged engines (Fig. 4), in normally aspirated units the increase of performance will be even smaller.

The result comes from the way of implementation of the modified program. However, not all bitmaps of actuators are subjected to change, but only some of them such as the dose of injection and the pressure of the supercharged air. Corrections in the modified engine maps necessary for the correct engine operation are not made either. The low increase of performance is adequate for the low price of the module.

Fig. 4. Graph of power and torque on the example of Fiat Stilo 1.9 JTD 115 KM with the use of external module [7]

Digital Power Pack - DPP can be an alternative to the classic Boxes (Fig. 5). It is still an external module connected the same way, but the difference is in the structure itself. This device has a built-in FLASH memory that is why it is programmable what allows individual adjustment of its settings to particular requirements. Modifications are limited only to the basic parameters (fuel delivery, supercharge air pressure, torque limiter), but this is a quite big change compared with the classic external modules [7].

Fig. 5. Box of the Digital Power Pack type (DPP - left) and classic box (right) [7]

The biggest drawback of the boxes and Digital Power Packs is their impact on the durability of the drive unit. Engines with heavily modified boxes are prone to failure mainly due to exceeding the critical values of the turbocharger speed and wrong fuel delivery [7].

4. Analysis of the results

During the test there were performed parameter modifications of the fuel pressure on the Common Rail fuel cell for the Magneti Marelli 6.JF.S1 1.3 JTD controller with a classic external device, so called Box (Fig. 5) to increase power and torque throughout the speed range.

Based on measurements obtained with the use of an engine dynamometer, the results of the measurements (Table 1) and a graph comparing the external characteristics (Fig. 6) were made.

Tab.1. The results of measurements on an engine dynamometer

1.	1000	94.0	12.7	0.0	1.0	0.12		237.1		700	300	300	3.77	3.12
2	1500	154.1	128.0	24.7	20.3	1.73	1.44	257.1	257.1	1000	770	750	6.98	7.85
3.	1700	165.0	145.8	29.4	25.5	1.95	1.69	259.1	258.5	1000	900	755	1.20	9.65
4.	1900	170.1	145.7	35.9	28.6	2.15	1.78	258.5	273.8	1050	816	800	0.86	0.96
5.	2000	162.5	140.7	35.6	30.5	2.20	1.80	256.0	253.1	1100	940	940	0.28	0.33
6.	2200	150.7	130.9	36.2	31.7	2.32	2.00	257.1	252.0	1400	920	920	0.00	0.20
7.	2400	163.8	136.5	41.3	34.4	2.75	2.24	250.5	254.5	1400	1060	1075	0.75	0.50
8.	2600	151.1	131.6	45.2	39.8	2.76	2.26	254.0	255.2	1450	1104	1150	0.00	0.31
9.	3000	127.0	121.7	45.0	43.3	2.23	2.11	250.3	250.4	1400	1090	1200	2.23	0.24
10.	3600	146.4	130.9	62.3	47.8	2.86	2.56	260.7	266.0	1455	1060	1300	4.06	0.00
11.	4000	127.0	110.2	57.0	50.7	2.21	2.39	260.0	275.1	1300	1127	1950	2.17	1.12

The results show that the established purpose of the modification gave the expected effect in the form of the maximum torque increase throughout the speed range, and the engine power increase and the increase of the fuel consumption per one hour.

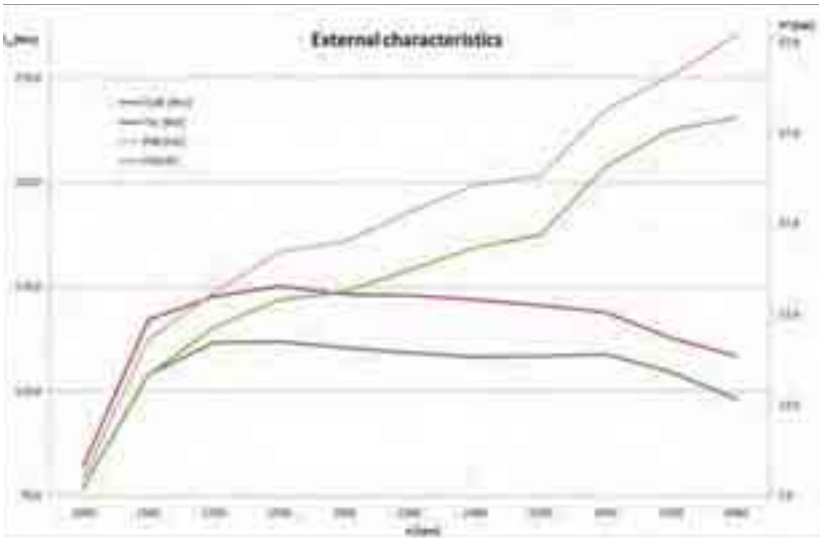

Fig. 6. Graphs of external characteristics

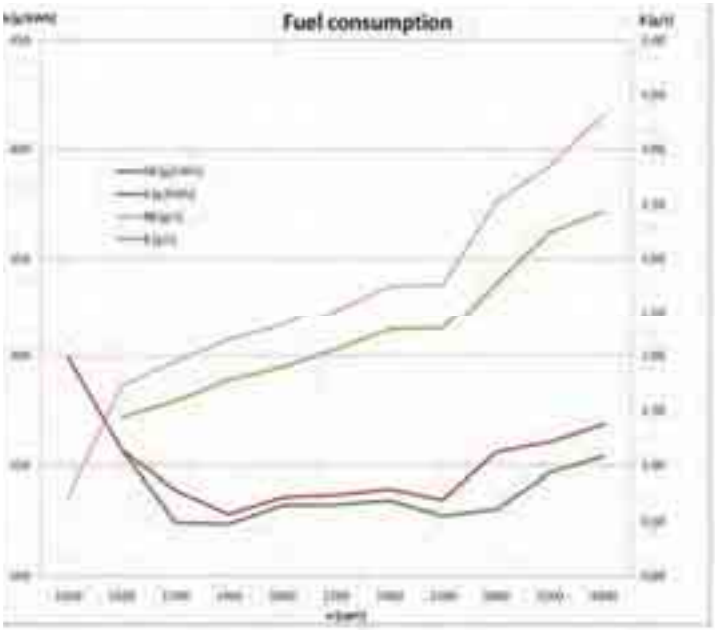

Fig. 7. Graphs of hourly and unitary fuel consumption

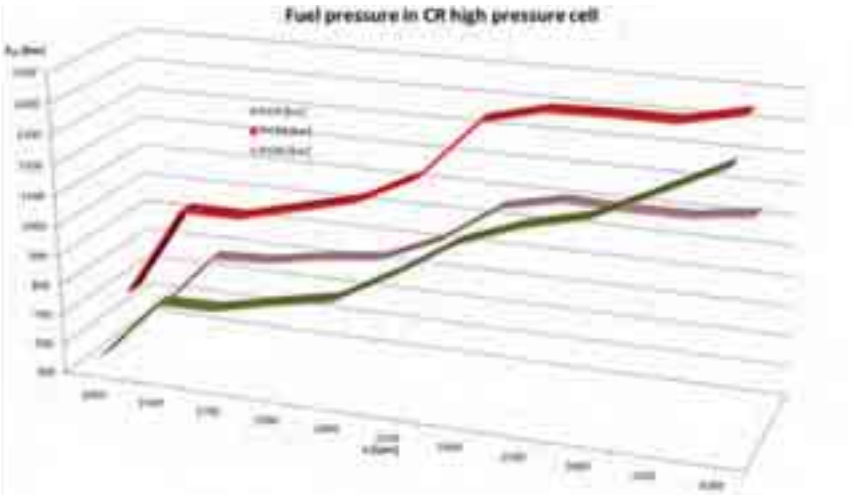

Fig. 8. Diagram of fuel pressure in the Common Rail high pressure cell

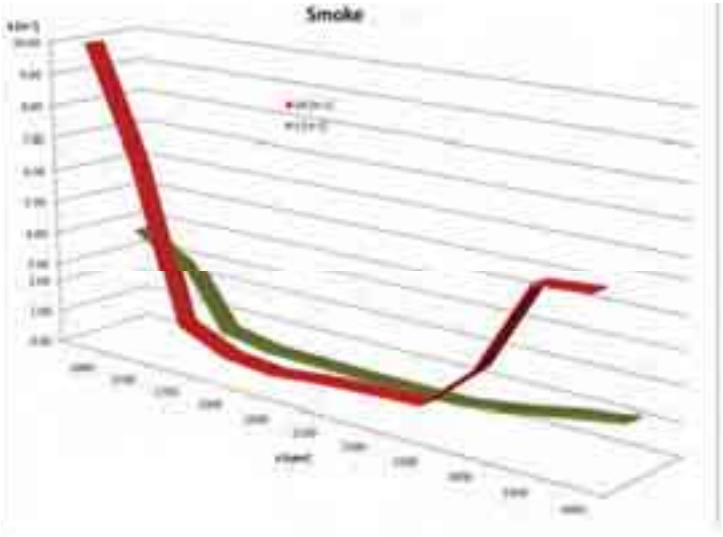

Fig. 9. Diagram of smoke

5. Conclusion

The article describes the external module, so called box and its impact on the pressure change in Common Rail high pressure cell, and also on the increase of capacity by about 18.7% and the torque by 18.37% (Fig. 6) of the Fiat 1.3 JTD MultiJet engine with a slight increase in specific fuel consumption (Fig. 7) with 2 to 6% at 1000-2500 RPM and 14% at 4000 RPM. It is also the simplest and quite effective method of increasing the measure of vehicle performance. Its simplicity lies in the fact that such a modification can be made by everyone who follows the installation instructions. There is no need to carry out reading of the program as in the case of program exchange in the EEPROM or programming by the EOBD diagnostic connector. The external module (box) is connected between the EDC controller and the fuel pressure pick-up the in Common Rail cell. So the control program does not change, but it is „cheated" by the module forcing from EDC other values of signals controlling the actuating devices.

Using the box which changes the parameter of pressure in the Common Rail high fuel pressure cell, the increased fuel consumption and the increase in smoke (Fig. 7 and 9) in the low and high rotational speeds can be seen. The EDC controller was cheated by this module which sent other parameters of the fuel pressure than they are in reality (Fig. 8).

With such a large increase of the fuel pressure in the cell, much larger amount of fuel is delivered into the combustion chamber during the fuel injection. That allows a significant increase in pressure and a rise in combustion temperature, which in the long-term use can lead to the engine damage.

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