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THE INFLUENCE OF CHANGE SOFTWARE OF ENGINE CONTROL UNIT ON CHOSEN PARAMETERS OF ITS WORK

Summary. In this work was presented the influence of changes software of engine control unit Fiat Stilo 1,9 JTD on chosen parameters of its work: maximum power, engine torque, acceleration, maximum speed and average fuel consumption.

WPŁYW ZMIANY OPROGRAMOWANIA STEROWNIKA SILNIKA NA WYBRANE PARAMETRY JEGO PRACY

Streszczenie. W pracy przedstawiono wpływ zmiany oprogramowania jednostki sterującej silnikiem Fiat Stilo 1.9 JTD na parametry jego pracy: moc maksymalną, moment obrotowy, przyspieszenie, prędkość maksymalną oraz średnie zużycie paliwa.

1. INTRODUCTION

The change of the software of the engine control unit has a direct influence on the fuel feed, the result of which is the change of the maximum power, engine torque and fuel consumption. Currently used methods of changing the engine controllers' software (ECU-Engine Control Unit) proceed in two ways:

- in the first method, the software is changed in real time directly on the weight test house by means of so called emulator stuck into a diagnostic socket ECU,
- in the second method, the software is changed in the engine control, removed from the car beforehand.

The software of the control of contemporary charged engine contains about 15,000 multidimensional maps of fuel injection steering depending on work conditions of the driving unit i.e. engine speed and load. [1]

2. THE OBJECT OF RESEARCH

The object of research was a charged four-cylinder engine of Fiat Stilo 1,9 JTD with the power of 120 HP (88 kW) at 4000 rpm and the torque 280 Nm at 2000 rpm.

For the above drive unit the software of its controller characterized by maps of the power supply which are responsible for, among others, the dose of the fuel, has changed. Figure 1 shows its sample structure.
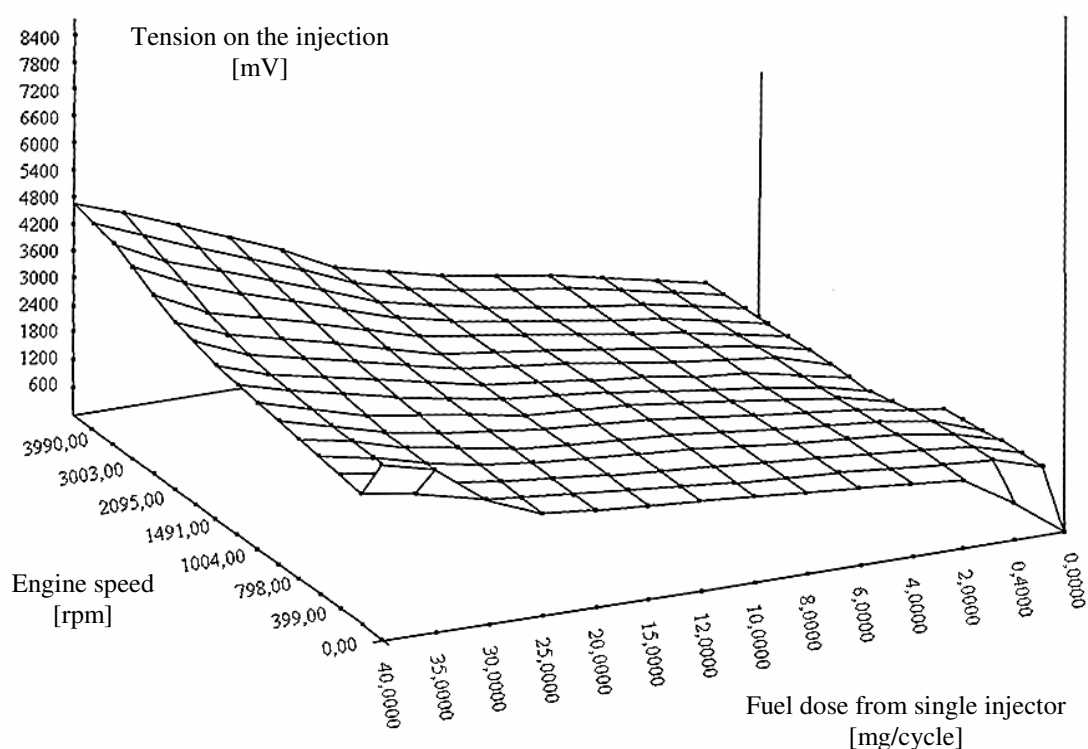
Fig. 1. Multidimensional feeding map
Rys. 1. Wielowymiarowa mapa sterowania

Carrying out the research of the car consisted in appointing external characteristics of the engine on the chassis test house Hofman Dynatest 300 for three types of the control unit software i.e. serial, individual and sports. Measurement time of each value of power and torque was about 10 seconds. The measurement results obtained took into consideration the loss of power and torque coming from the drive transmission system.

The additional research actions were the measurements of the vehicle performances carried out by means of accelerometer ACC-2000 (fig. 2) and performed for the above conditions i.e. for three types of steering programs modifications, with the aim to show the changes in the car dynamics. The car acceleration from 0 to 100 km/h and its maximum speed were the parameters measured by this method.

Fig. 2. Accelerometer ACC-2000
Rys. 2. Akcelerometr ACC-2000

The BDM programmer was used to change the engine controller software (fig. 3), while the engine control program was corrected by the editor of power maps [2].
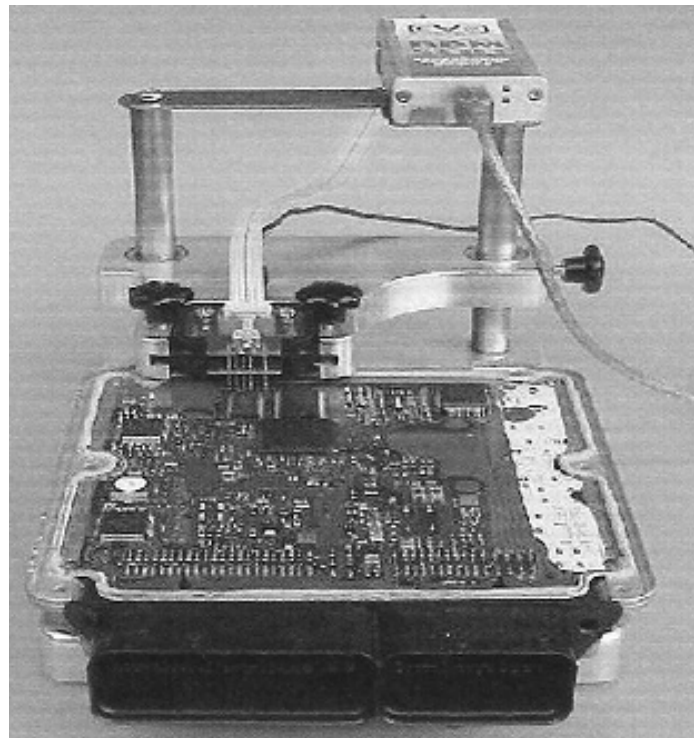

Fig. 3. Engine control unit with the BDM programme connected
Rys. 3. Jednostka sterująca silnika z podłączonym programatorem BDM

3. MEASUREMENT RESULTS

External engine performance obtained in the testing showed significant changes of its work parameters. The course of the changes is presented in fig. 4, 5 and 6. Figure 4 shows the external performance of the engine with the software loaded at the producer's, where the course of engine torque had a great flexibility of the driving unit. Its high value was held in a wide range of the engine rotational speed i.e. 2000 – 3000 rpm.

The maximum value of the torque for this program was 257 Nm at 2330 rpm, while maximum power was 118 HP (87 kW) at 4240 rpm (fig. 4). The significant range of rotational speed at which maximum values of the above parameters were obtained shows the good dynamics of the car, which was also shown by the direct measurements of the vehicle performance. The acceleration from 0 to 100 km/h was registered at the level of 10,7 seconds and the measurements of maximum speed gave the result of 191 km/h.

For the individual controlling program of a driving unit controller followed the narrowing of the range of rotational speed at which practically steady high torque value was obtained. After loading the individual program, a great difference between rotational speeds adequate to maximum power and torque values was held. In this case maximum torque was 319 Nm at 2300 rpm, while maximum power was 133 HP (99 kW) at 3900 rpm (fig. 5).

The above changes of the engine work parameters had an impact on the researched unit performances. The individual controlling program had an influence on the reduction of the time of the vehicle's acceleration from 0 to 100 km/h to 9,1 seconds and on the increase of its maximum speed to 200 km/h.

Torque [Nm]   Speed [km/h]   Power [HP]
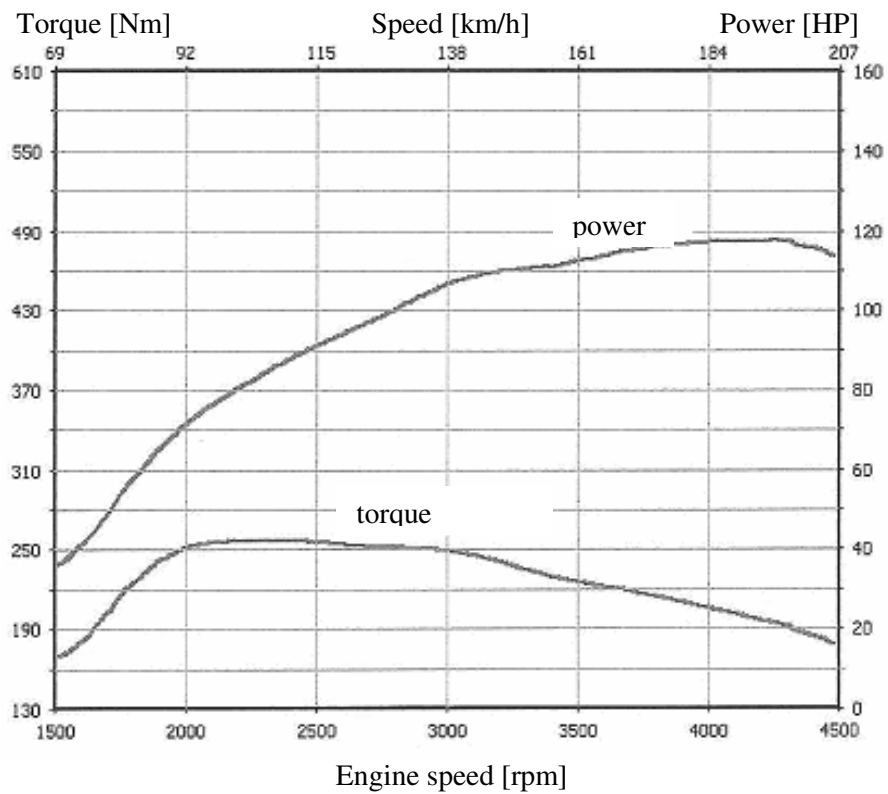

Engine speed [rpm]

Fig. 4. Power and torque characteristics of a car with a serial controlling program
Rys. 4. Charakterystyka mocy i momentu obrotowego samochodu z oprogramowaniem seryjnym

Torque [Nm]   Speed [km/h]   Power [HP]
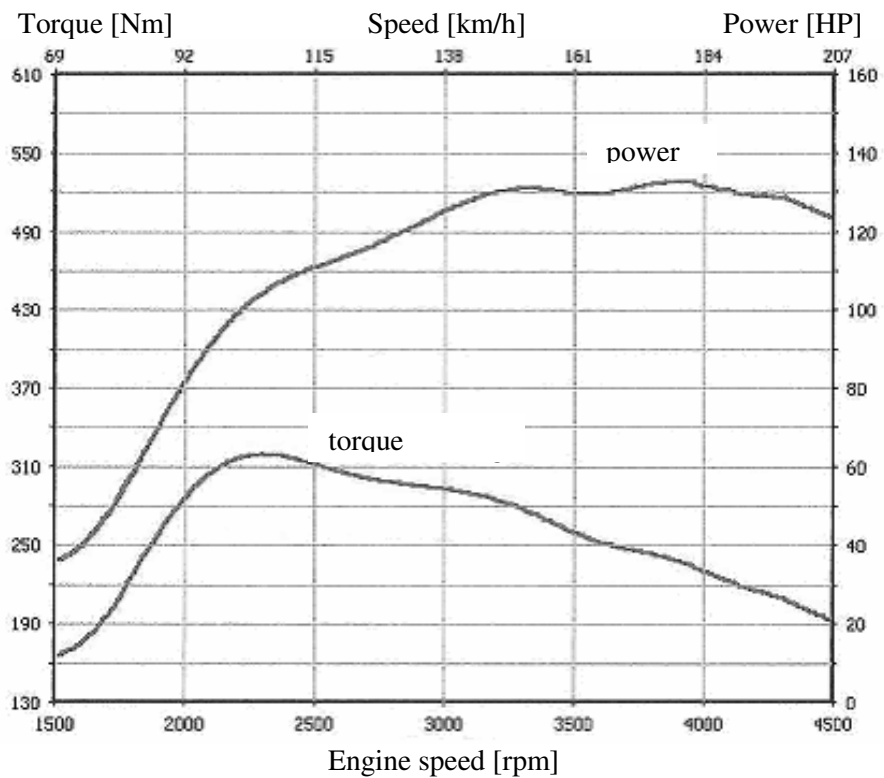

Engine speed [rpm]

Fig. 5. Power and torque characteristics of a car with individual controlling program
Rys. 5. Charakterystyka mocy i momentu obrotowego samochodu z oprogramowaniem indywidualnym
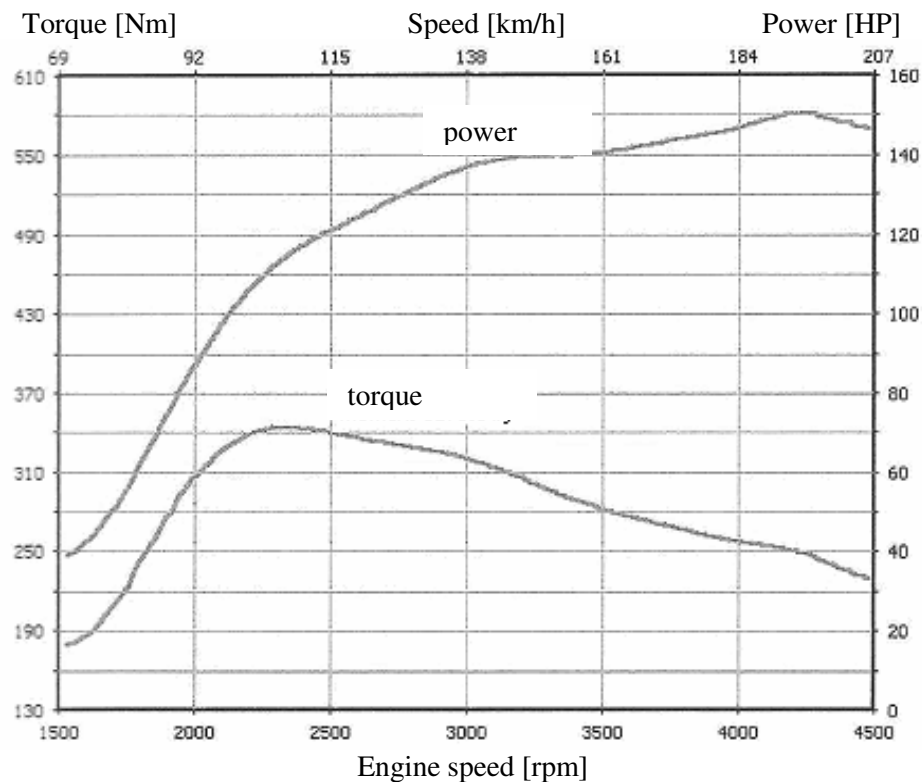
Fig. 6. Power and torque characteristics of a car with sports controlling program
Rys. 6. Charakterystyka mocy i momentu obrotowego samochodu z oprogramowaniem sportowym

The characteristics of the sports modification (fig. 6) of the engine controlling program showed the significant power increase and for this version it was 151 HP (112kW) at 4250 rpm, while the torque was 344 Nm at 2350 rpm. As expected, it caused still greater improvement of the car whose acceleration from 0 to 100 km/h was 8,2 seconds while the maximum speed was 208 km/h.

To compare the quantities of power and torque changes and average fuel consumption for the tested types of software modification of engine controlling unit, the obtained values were put together in Table 1.

Table 1

The table of car performance for all controlling programs

Description	Power/speed [kW/rpm]	Torque/speed [Nm/rpm]	Acceleration from 0 to 100 km/h [s]	Maximum speed [km/h]	Average fuel consumption [l/100km]
Producer's data	88/4000	280/2000	10,7	190	5,4
Serial program	87/4240	257/2330	10,7	190	5,4
Individual program	99/3900	319/2300	9,1	200	5,2
Sports program	112/4250	344/2350	8,2	208	6,2

4. CONCLUSIONS

The characteristic of engine performance described by such parameters as power, torque and fuel consumption can improve significantly thanks to electronic tuning application.

Research has shown the increase of power by about 15% and the torque by about 25% while comparing the parameters of a vehicle with a serial program and an individual one. Besides, after the modification the acceptable level of exhaust fumes smokiness for the tested unit wasn't exceeded and the fuel consumption was kept on the similar level. From the results, one can conclude that the modification on the level of the above values improve the operating performance and allege that they do not cause the faster consumption of parts of the engine.

While comparing the parameters of a vehicle with a serial program and a sports one, research has shown the increase of power by about 30% and the torque by 35%.

The significant increase of power and torque, but also exceeding the acceptable level of exhaust fume smokiness and higher fuel consumption may suggest faster operating consumption of a drive unit and drive transmission system but this type of consequences is included in the above changes as sports modifications have only professional application.

Performances and dynamics of the vehicle are the priorities here and there, as researchers showed, underwent a considerable improvement.

Literature

1. Munday F.C.: *Electronic Engine Management. Reference Manual.* Graffiti Publications Pty. Ltd., 2004.
2. Hartman J.: *How to Tune and Modify Engine Management Systems (Motorbooks Workshop).* MBI Publishing Company, 2003.