SOME ASPECTS OF ON BOARD DIAGNOSTICS SYSTEMS (OBD) IN POLAND

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Abstract

An object of the paper is development process of on-board systems diagnostic which can be divided into the historic phase (defined as OBD I), the present term - OBD II and OBD III, and the destination regulation. Established OBD II requirements use allowable the driving emission level limits of the FTP test, however its European EOBD equivalent, effective in Poland, uses limits (together with suitable coefficients of the enlargement) in the NEDC (New European Driving Cycle) test. The research programme of homologation is based on standard driving cycles of characteristic courses of the speed. Conditions of the realization of procedures are selected, so that their meeting in driving cycle is confident and so that its realization secures the correct result. Results of the procedure are illustrated with the original coefficient of the cover of the cycle time by found similar fragments driving cycles. In particular inter alia main criteria of damages according to Californians' CARB OBD II regulations, vehicle performance record during FTP75 test on chassis dynamometer, implementation of oxygen sensor monitor marked with vertical line, RPM, engine loading, engine temperature, speed, NEDC (UDC + EUDC) driving test, temperature chamber and chassis dynamometer stand control devices, dilution exhaust gases device, exhaust gases analyzers are presented in the paper.

Keywords: *transport, vehicle, chassis dynamometer, OBD, exhaust emissions*

1. Introduction

The OBD system is an integral element of the vehicle connected with the control system of the engine. The efficiency test of systems of the on-board diagnostics in different applications is one of basic problems connected with the OBD technology. The implementation of the efficiency test method of the OBD system belongs to main questions connected with this problem.

Actually one or two modules steering realize this system: the central module of the steering propulsion system PCM (Powertrain Control the Module) and in case of the vehicle equipped with the electronically controlled, automatic gearbox, also through control equipment of this box. The system OBD in the future will also take over all basic subsystems of the body and the chassis, what will mean that to the realization of the function of the system will be included also remaining controllers of the vehicle. Therefore, it is necessary estimation of the operation efficiency of OBDE (On Board Diagnostic Efficiency) of operation of the OBD system. Development process of on-board systems diagnostics can be divided into the historic phase (defined as OBD I), present phase - OBD II and OBD III and destination regulation. Fig. 1. presents schematically the development of on-board diagnostic systems.

2. Requirements for exhaust gases emissions of OBD system

Accepted OBD II requirements use acceptable limits of the FTP emission level of road test, however its European equivalent, EOBD, obligatory in Poland, uses (together with suitable coefficients enlargement) NEDC (New European Driving Cycle test). In according with the directive 98/69/EC EOBD, for vehicles with spark ignition engines (SI) is in operation for vehicles of car categories M1 from 1.01.2000 for new types (new homologations), and from 1 January 2001 year for all new registrations. From 29 March 2001, according to the ECE R83.05 regulations, the EOBD system was established in all European countries, in this in Poland.

OBD I On-board diagnostics of elements of injection-ignition system, signalling of damages
1984 Absence of standardization of diagnostic procedures and codes of damages, absence lawful guarantee of the access to diagnostic information
OBD II Active diagnostics emissive elements and components of powertrain system of vehicle
1996 Global standardization within the range diagnostic procedures and the access to the information, lawful guarantee of the access to the information
OBD III Inspection of the emission of vehicles through the diagnostics OBD II, automatic informing of suitable services
Initiation of new regulations by law connected with the automatic detection and the identification of vehicles

Fig. 1. Onboard diagnostic systems development

Tab. 1. Main criteria of damages according to Californians' CARB OBD II regulations

Device	Criteria decisive for inefficiency
Catalytic reactor	**LEV:** • for models made in 1998 the road-emission HC greater than 175% emissions in the test FTP (introduction in 1998 for 20% all vehicles, and in next years properly 40/60/80/100%) **TLEV, LEV, ULEV:** • road emission HC exceeding 2 times for standards TLEV, 2,5 time for LEV and 3 times for regulations ULEV emission of the vehicle of course of 4000 mileage Discussed introduction since 2004 criterion NO_x emission
Misfire of ignitions	• HC road emission exceeding 150% emissions determined in the FTP test • inspection at maximum rotational speed
Sensor of oxygen concentration, EGR, secondary air, supply system	• HC road emission exceeding 150% emissions determined in the FTP test
EVAP	• at equivalent leakage from diameter hole of 0.04" (1 mm) • for 2000–2003 year models (20/40/70/100%) leakage from hole of 0.02" (0.5mm)
PCV	• integrated control system. For 2002–2004 year models (30/60/100%)
Thermostat	• possibility temperature measurement of coolant liquid. For 2000–2002 year models (30/60/100%)
Data protection against removal	• according to SAE J 1979 in 2002 for all vehicles

Established obligatory OBD II system from 1 January 2003, as the optional equipment of engines compression-igniting (CI), on standard Euro III, for cars of personal categories M1 and cars of weight categories N1 of the class I, but from 1 January 2004 - for cars of weight categories N1 of the II and III class. There one plans the extension term of the efficiency of all elements having influence on the emission of combustion gas to rundown 100 000 km. Main criteria of damages according to Californians' CARB OBD II regulations are presented in Tab. 1.

3. Development of the OBD system

New diagnostic procedures, monitors, have a character sequential development of the OBD system. The system specification of the on-board diagnostics does not limit to the certain strictly determined number of monitors, and nor only to systems connected with the of exhaust gases emissions. The leading influence complies American State of California, where there are initiated latest conceptions of regulations and solutions, to be taken over with the certain delay by federal authorities USA, and then by European countries. The effective elimination of damaged vehicles is a primary object of the introduction of the OBD II system. Thereby activities making to supplement of the system OBD II for technical and according to law tools making possible achievement of this target were undertaken. The whole of these activities is known in the literature as OBD III. The introduction OBD III as the system of methods and resources of the telemetric failure sensing of issue vehicles during their exploitation seems to be very favourable. A measure of the efficiency of the system OBD is the operating time of the vehicle in typical service conditions, assuring the suitable probability of the realization of all diagnostic monitors.

The variety of the implementation of systems OBD is not large, thus proposed divisibly systems OBD for the kind of applied decision strategy on two groups is sufficient.

4. Simulation drive on chassis dynamometer according to emission cycle

The method is based on accomplishment on chassis dynamometer of the suitable cycle emissive, connected with the registration of exploitive parameters of the vehicle (e.g. travelling speed, rotational engine velocity, temperature and engine load) and changes of codes of the readiness of individual monitors OBD. Fig. 2. shows example-recording for this test. The vertical line on Fig. 2. indicates time accomplishment of the sensor of monitor oxygen concentration.

Behind its and three continuous monitors (system subgroups, misfire of ignitions, fuel supply system) in examined vehicle were installed additionally monitors: the catalytic reactor, the system of fumes depose from fuel tank (EVAP), the system of the recirculation of exhaust gases (EGR) and the radiator of the oxygen concentration sensor.

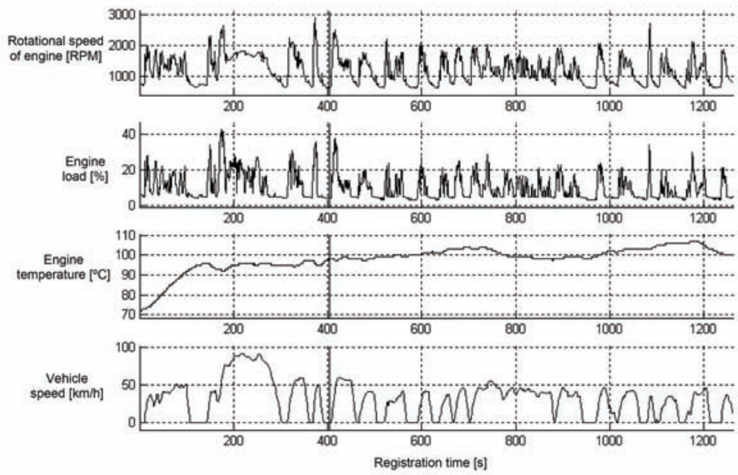

Fig. 2. Vehicle performance record during FTP75 test on chassis dynamometer, implementation of oxygen sensor monitor marked with vertical line, RPM, engine loading [%], engine temperature [^0C], speed [km/h]

5. European programme of homologation research

The programme divides on two phases: preliminary and basic. The preliminary phase is preceded a preparation of the vehicle, containing the electric simulation of damages of elements propulsion system or their exchange on elements used on suitable properties. During the preliminary phase on chassis dynamometer drive cycle NEDC (Fig. 3.) is realized. In basic phase drive test, the measurement of the emissions from exhaust system and the observation of the reaction on-board system on real or simulation damages of elements are realized.

The conditioning of the vehicle with the CI engine consists in execution at least two immediately following itself driving tests NEDC (UDC + EUDC). For vehicles with CI engines the execution additionally two parts of EUDC is realized. Vehicle maker can also propose homologizing centre other conditioning procedure.

Following damages can put in or simulated in the first phase for vehicles with SI engines:

- substituting worn out or electronic simulation of work of worn out catalytic reactor, through the suitable formation of signals from the oxygen concentration sensors,
- simulation of empty cycles of the engine (misfire of ignitions) enforced by controlled interference into activity of ignition system.

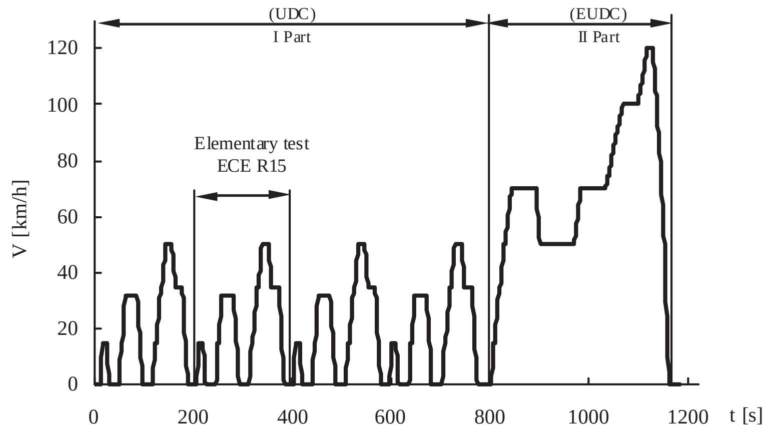

Fig. 3. NEDC (UDC + EUDC) driving test

6. Researches on chassis dynamometer

Researches of the Renault Megane II car in simulated conditions on chassis dynamometer (Fig. 6.) were carried out in the European driving cycle, according to the ECG UNO 83.05 regulations.

The one-roll chassis dynamometer equipped in electric simulation of the inertia (Fig. 4. and 5), system CVS to collection (Fig. 7.), the set of exhaust emission analyzers to the measurement of CO, CO_2, HC, NO/NO_x, and O_2 concentrations (Fig. 8.) was applied to the basic research. Moreover, to research in low temperatures the two-roll dynamometer chassis (Fig. 9.) was applied.

Reading apparatus of information from on-board diagnostic systems, OBD II/OBD, were applied.

These researches are based on the initiation or electric simulation of emission elements damages of propulsion system, which includes the inspection on-board diagnostic system.

The research homologation programme is based on standard driving cycles of characteristic speed courses. Conditions of the realization of procedures were selected in order to their appearing in driving cycle were determined and for it realization secure the correct results.

Procedure results are illustrated by a coefficient of the cycle time cover by found of similar fragments of driving cycles. This coefficient is defined by an equation:

$$W_P = \left(\frac{n_{FP} \cdot S_F}{t_r} \right) \cdot 100\% , \tag{1}$$

where:

n_{FP} – number of found similar fragments,
S_F – length of one fragment,
t_r – registration time.

One should to notice that the coefficient value can be greater than 100% - it is connected with this that found similar fragment can answer in excess of one fragment of the standard-cycle.

Fig. 4. Chassis dynamometer stands

Fig. 5. Temperature chamber and chassis dynamometers stand control devices

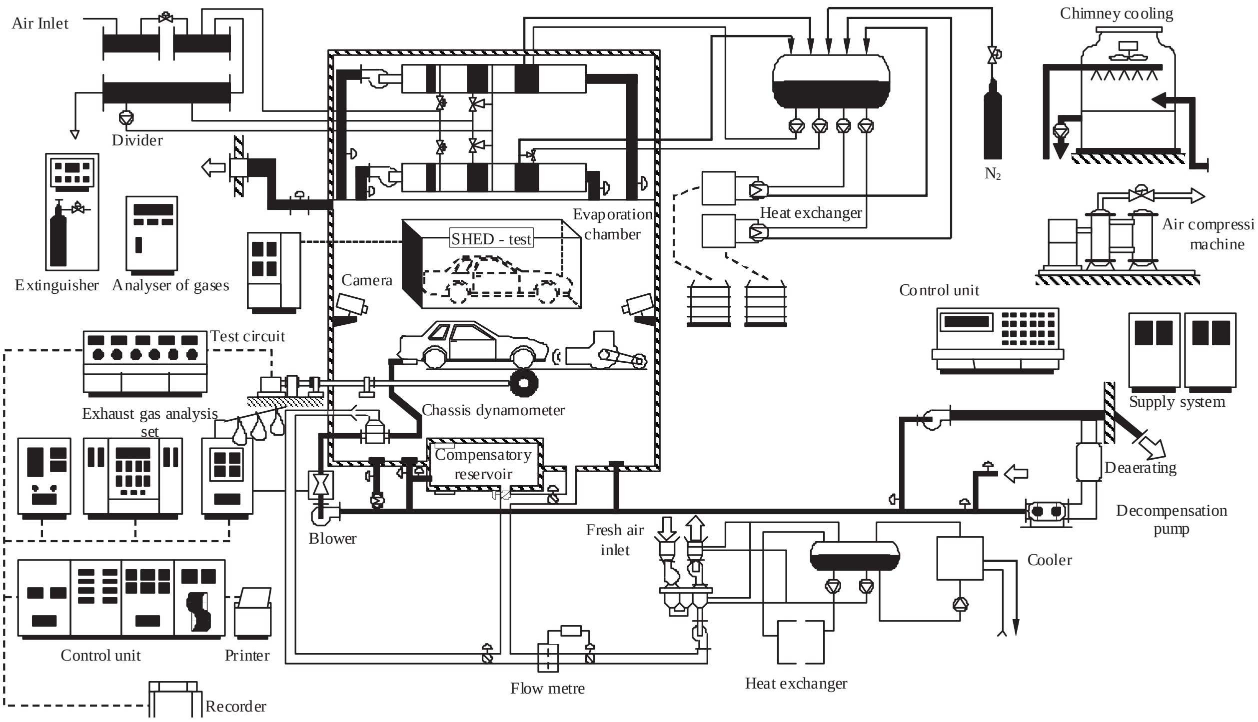

Fig. 6. Scheme of chassis dynamometers stand

7. Conclusions

1. A measure of the quantitative efficiency of the system OBD is the time of the drive $t_{0.9}$ in characteristic operation conditions, securing of 90% a probability, the realization of all diagnostic monitors. The conception of proposed indicator is based on the criterion time, limitary (too the little of the duration of the driving cycle, the small driving speed, little stop in idle run).

2. Diagnostic procedures using decision strategies, based on the statistical data handling SOS, operate considerably slow down than procedures based on the decision strategy SPS.
3. Homologation researches can be used to the legalization of the vehicle, which the system of on-board diagnostics will be a defective system.
4. Introduction of changes in research methodology, consisting in to the introduction to requirements of tests homologation of diagnostic monitors performed in lower ambient temperatures is proper.

Fig. 7. Dilution exhaust gases device

Fig. 8. Exhaust gases analyzers

Fig. 9. Temperature chamber

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