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ENVIRONMENTAL PROTECTION FROM THE AUTOMOTIVE TRANSPORT

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Abstract. This paper outlines the general lay-out of the Rousse region in-use cars before introduction of the so-called Inspection/Maintenance Programme. The main emphasis of the paper, however, lies in the practical experience gathered during the time spent in field testing phase that would proceeded the introduction of the programme. The paper also describes the results obtained by real time measurement of car's exhaust emissions and fuel consumption during urban driving conditions.
Keywords: automative transport, motor engine, exhaust emissions, tailpipe inspection, inspection/maintenance.

AIMS AND BACKGROUND

Concern over the environmental effects of pollutant emissions from transport has increased to such an extent that it is now one of the main constraints on transport developments. The key location of Bulgaria on the Balkan Peninsula as a link between Europe and Asia is the reason which gives a high priority to automobile transport not only in Bulgaria but also in international aspect.

In Bulgaria the use of fuel tends to be very inefficient and damaging to the environment. As a result, the average specific energy consumption is almost twice of that of the European Union and the levels of polluting emissions are significantly higher. Our country is lagging behind considerably in the technological field and the European standards in the environmental protection.

Air pollution, however, knows no borders or boundaries. It has become a critical problem affecting human health, social stability and economic welfare of most major industrial countries. The change in the political situation in Bulgaria allows for more freedom and mobility between countries, resulting in more vehicles crossing the border, thus underscoring the need for uniform vehicle emissions laws, vehicle inspections and mechanic's training to assure clean running vehicles and reduced pollution throughout the world.

On 15th May 1996 The Clean Air Law was adopted by the Bulgarian National Assembly, but we are faced with introduction of standards for on-road and off-road vehicles. Scientific workers dealing with the automotive exhaust emissions also have to take part in the preparation of such standards.

Because Bulgaria has not own production of engines and cars and in order to put into practice of some scientific development, the aim of the laboratory re-

search work is connected with the in-use vehicles and more precisely is oriented toward its exhaust emission estimation and reduction.

In Bulgaria during the last 40 years were sold vehicles produced in the former Eastern Block (USSR, DDR, Poland, Czechoslovakia, Hungary, Romania and Yugoslavia) but the main importer of the cars and heavy trucks was the former Soviet Union. About 50% of the private cars are second-hand cars bought in recent 4-5 years from the Western European countries (mainly from Germany and Austria) and form a huge variety of different models and mileage's. The increase of motor vehicles leads to a necessity of promptly solution of measures concerning the exhaust gas emissions.

In University of Rousse, as a result of our participation in an educational Trans-European Mobility Scheme for University Studies (TEMPUS) Joint European Project (JEP-4714) and the gained experience, we established the first Research Laboratory on Ecological Problems of Engines. Our laboratory is the only national university based laboratory and it have the possibilities to do some research work concerning the reduction of exhaust emissions of cars, buses, tracks, etc.

With the funds received from the European Union the laboratory has recently upgraded its emissions equipment (BOSCH Four-Component Exhaust Gas Analyser ETT 008.36, SIGNAL 3000 THC Analyser, BOSCH Diesel Smokemeter RTT 110, BOSCH Diesel Engine Tester ETD 019.02, Mini-Dilution Tunnel for diesel particulate measurements, PEISELER Test System for measuring fuel consumption data related both to time and distance travelled, etc.).

In Bulgaria practically all vehicles are not computer-controlled and their emission-related components operate on a continuum characteristic of mechanical devices. For example, if the air – fuel mixture at idle is too rich, then the air-fuel mixture is likely to be too rich across much of the operating range of vehicle (i.e., cruise, acceleration, deceleration). For this reason a test performed only at idle is likely to identify to a sufficient degree these vehicles which considerably contribute to air pollution.

Bulgaria has had a periodic, safety related technical inspection of all motor vehicles for more than 35 years.

In 1982 the Bulgarian government introduced a CO emission standard for cars with gasoline engines (Table 1). Limit values are set by the vehicle age and test type is one speed idle test.

Table 1. Bulgarian Standard (BDS 17.2.4.16-82) for gasoline cars at idle

Model year	CO (%)
Up to 1978	4.5
1978-1980	3.5
1981-1983	2.5
1984 →	1.5

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EXPERIMENTAL

In April and May 1996 in town of Rousse a group from Laboratory on Ecological Problems of Engines performed a study concerning the tailpipe emission of CO. It was done during periodic technical inspections of all private and state cars. Carbon monoxide concentration is measured by gas analyser BOSCH ETT 008.36 0 684 100 836, which also measures the concentrations of unburned hydrocarbons, carbon dioxide and oxygen. A total of 335 in-use Russian made vehicles were tested. All vehicles were with gasoline engines and without emission reduction devices and the number of cars and models were as follows:

- 110 cars model VAZ 2101 (1200 cm^3);
- 105 cars model VAZ 2103 (1500 cm^3);
- 120 cars model MOSKVICH 2140 (1500 cm^3).

In Fig. 1 is shown a schematic diagram of an equipment used for assessment of exhaust emissions and fuel consumption efficiency. The fuel consumption is measured by a flow-meter PLU-116H (1) manufactured by Pierburg (Germany). The information for distance, acceleration and deceleration is received from fifth wheel transducer. The fifth wheel is HP 500 SP (6), manufactured by Peiseler (Germany). The data from the flow-meter and fifth wheel are processed in display unit VZW-2E (2) manufactured by Peiseler (Germany). The processed data are logged in Parallel PAD-data acquisition unit (3), manufactured by Computer Instrumentation (United Kingdom).

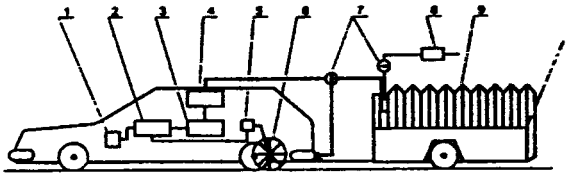

Fig. 1. Schematic diagram of the test equipment

The exhaust gas emissions are collected in balloon (9). When the balloon is filled up the exhaust emissions are evaluated by means of gas analyzers (4). The concentration of nitrogen oxide is measured by a gas analyzer Radas-1G (Germany). Hydrocarbons, carbon monoxide, carbon dioxide and oxygen concentrations are measured by a gas analyzer BOSCH ETT 008.36 0 684 100 836. In order to measure the volume of collected exhaust gases the vacuum pump with flow-meter (8) is used. Figure 2 represents the scheme of the block diagram showing the connections between all the apparatus and test equipment.

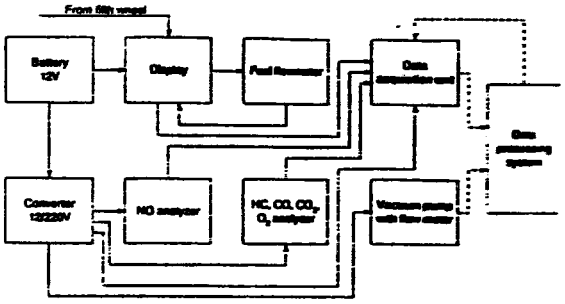

Fig. 2. Schematic block diagram of all apparatus and test equipment

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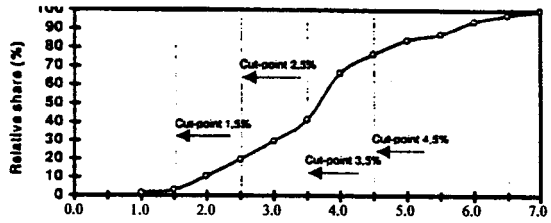

Fig. 3. CO concentrations effect on relative share of car model VAZ 2101

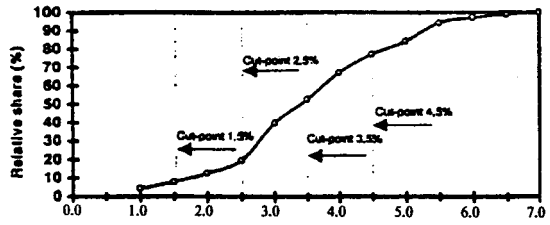

Fig. 4. CO concentrations effect on relative share of car model,VAZ 2103

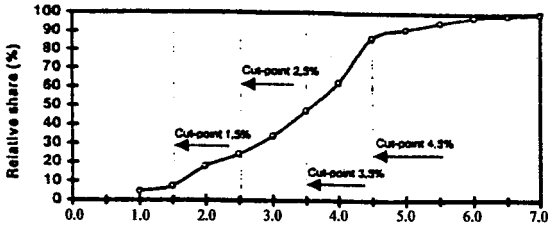

Fig. 5. CO concentrations effect on relative share of car model MOSKVICH 2140

RESULTS AND DISCUSSION

Figures 3, 4 and 5 illustrate the results of the CO concentration measurements made to the three car models.

It can be seen that setting the cut-points to a certain level (i.e. 4.5, 3.5, 2.5 and 1.5% CO) can impose a stricter requirement to the engine technical conditions. For example for model VAZ 2101, only 8.2% of cars (for cut-point 1.5% CO) can pass the standard and 77.3% of cars (for cut-point 4.5% CO) can pass the standard. For VAZ 2103 model cars these numbers are, respectively, 7.6 and 86.7% and for MOSKVICH 2140 model cars they are 3.3 and 76.7%.

It is evidentl that the EU Directive 92/55/EEC (Table 2)[1] is better to be used for I/M programme, because most of the Bulgarian cars are made before 1986.

Table 2. Directive 95/55/EEC

Model year	Year of introduction	Test method
Without cat. converter:	01.01.1994	n_{min}
– before Oct. 1986		CO = 4.5%
– after Oct. 1986		CO = 3.5%
With cat. converter	01.01.1997	n_{min}
		CO ≤ 0.5%
		$n \geq 2000$ min^{-1}
		CO ≤ 0.3%

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REAL TIME MEASUREMENT

For a particular type of car, fuel consumption and exhaust emission rates are mainly a function of the car's way of using (journey type, frequency, etc.), and of the car's operating conditions (speed, rates of acceleration and deceleration, temperature conditions, etc.) and depend on both the traffic conditions and the individual behavior of the driver. Thus, a realistic assessment of emission, pollution reduction methods and the effectiveness of emission control technologies cannot be carried out without taking into account the actual operating conditions of the car. Driving the car in urban conditions is characterized by frequent unsteady accelerations and decelerations. There are numerous periods of idling and decelerating and only very little constant speed driving. For certification purposes of the cars the exhaust emissions and fuel consumption are determined by driving the car on chassis dynamometer over a specified operating sequence which represents the car's driving cycle. There are European, USA and Japanese cycles. Clearly, the properties of the cycle strongly influence the amounts of the exhaust emissions produced during the test. Some of the main parameters are the average test speed, the distribution of speed, the rates of acceleration and deceleration, the proportions of time or distance during the test spend in these different driving modes.

CONCLUSIONS

Further reduction in exhaust emissions cannot be achieved without actions focused to in-use vehicles. With nowaday big economic crisis, lack of proper maintenance can seriously hurt the performance of the engine with substantial rise in emissions. Hence, the need to control individual vehicles in circulation becomes almost evident.

We have to introduce the so-called Inspection/Maintenance (I/M) programme. With this programme tailpipe emissions have to be checked from every registered vehicle periodically. Furthermore, maintenance and repair have to be performed, if vehicles are found to exceed limit values.

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