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VALUATION OF NOXIOUS AT A SINGLE CYLINDERED GASOLINE MOTOR

V. D. Negrea , Adriana Tokar, G. Dragomir, Ileana Negrea, L.I. Rafan, Adela Filip
Universitatea Politehnica Timişoara, Departamentul MMUT, negrhometm@yahoo.com
Universitatea Politehnica Timişoara, Departamentul MMUT, adriana_tokar@yahoo.com
Universitatea Oradea, georgedragomir@yahoo.com
Universitatea Politehnica Timişoara, Departamentul MMUT, i_negrea@yahoo.com
Universitatea Politehnica Timişoara, Departamentul MMUT, mariana_dora@yahoo.com
Universitatea Politehnica Timişoara, Departamentul MMUT, adela_fillip@yahoo.com

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Summary: In this paper it is presented the result of measurements on a testing stand with dynamometer type T200 of scale TQ that allows the valuation of performances at gasoline engines. It is exposed the experimental installation, the working method, the engine speed characteristic and the variation of the temperature of exhaust gas and of noxious according to the engine speed. The stand, by means of the soft VDAS allows the tracing of the diagram shown at each engine speed condition. The registration of exhausted gas was done with the gas analyzer MOTORX 777, with whose help there was achieved their valuation for the motor Robin-EH 17-2D, type TD 211.

1. Introduction

The most dangerous effects of pollution produced by gasoline engines are demonstrated at the level of the atmosphere by the emissions of harmful gases.

The road transports achieved with vehicles equipped with gasoline engine do have a significant importance on the environmental pollution, affecting practically all eco-systems. The main effects are the worsening of the health condition, the production of troposphere O_3, the increase of the Pb emission, acoustic pollution, contamination with salts, additives and solvents of water, acidifying by SO_2 and NO_x, change of hydrological systems, erosion of soil, problems with the depositing of old vehicles and their component parts.

The percent contribution of the road transport at the environmental degradation is, according the last appreciations:

-climate changes:
- -by the reduction of the greenhouse effect 17%
- -by the reduction of the ozone layer 2%

-acidifying 25%
-eutrofication with nitrogen 5%
-eutrofication with phosphorus 2%
-noise 90%
-smell 38%

From the analysis of measurements on the pollution of air performed and reported at sources, as well as to the vehicle park, there might be done a series of appreciations. The public transport means produce 74% CO, 61%NO_x and 21%CO_2, their contribution to the emission of SO_x and particles. It is concluded that the emission of CO and HC is especially due to the asynchronous motors and the emission of SO_x and particles is produced entirely by the gasoline engines, while the assembly emission for NO_x is relatively equally divided between the asynchronous motor and the gasoline engine.

2. Experimental installation and work method

Measurements were performed on a testing stand with dynamometer type T200 from range TQ. This, together with the set of instruments allows the valuation of the performances at single cylindered motors.

The motor used at the performance of the measurements has following technical characteristics:

Model - Robin-EH 17-2D
Type - TD 211-four-cycle engine
Power - 4,4kW
Engine speed – 4000rot/min
Bore - 67mm
Diameter of the cylinder - 49mm
Swept volume – 172cm^2
Degree of compression – 8,5:1
During tests was used gasoline ECO 3 CO 95 without lead.

The stand allows the use of a motor form range TQ, or any other motor, with the condition that it doesn't exceed the tolerance and performances imposed by the constructor.

Measurements were performed with the shutter valve opened at 1-1,5mm from the maximum span.

With the help of measured values, there was experimentally raised the engine speed characteristics (Fig.1) and the variation of exhaust gas temperature according to the engine speed (Fig.2).

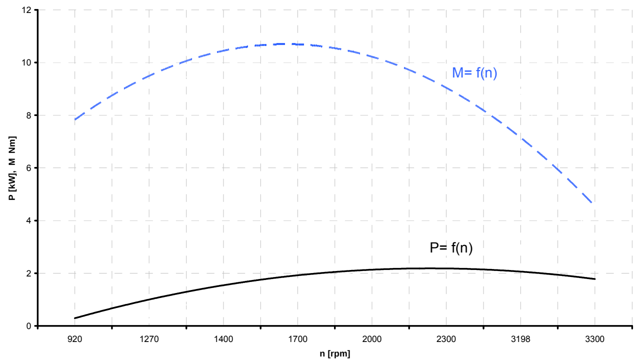


Fig.1 The engine speed characteristics for the motor TD 211

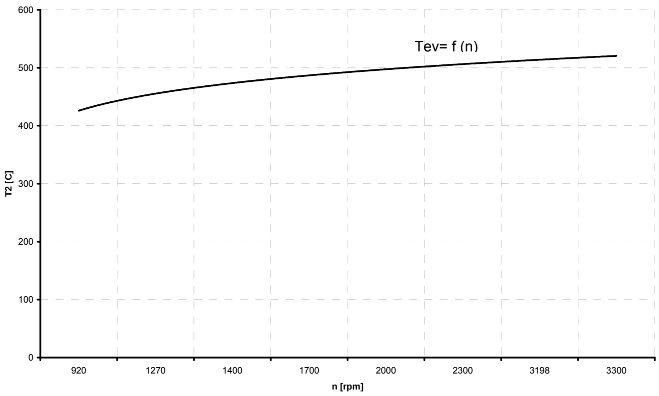


Fig.2 Variation of the exhaust gas temperature versus engine speed

2.1 The component parts of the testing stand for heat engines

The stand is formed of two main parts:
- the test bank with dynamometer (Fig.3)
- an electronic equipment for the acquisition and processing of signals, mounted on a metal frame and connected to an PC (Fig.4)

Fig.3 Test bank with hydraulic dynamometer

The test bank is formed of a movable frame suspended on four wheels with hydraulic dynamometer, with a side coupling and an air box with a plane membrane. For testing motors on duty it is used a hydraulic dynamometer through which the power of the motor is dissipated in the water that crosses it, in form of heat and the hydraulic resistance developed in it is proportional with the water flow and the water level in the case, controlled by a needle valve. The torque is measured by an electric transducer and the engine speeds are electronically measured by an optic sensor.

Fig.4 Test stand for heat engines TD 200

The environmental temperature is measured by a temperature plug mounted on the air box, where is also situated a pressure sensor that registers the measures needed for the calculus of the air flow at the motor entrance.

The tested motor is fixed on the bank in line with the dynamometer and it is coupled at the shaft by a half flexible couple.

The system for the acquisition and control of data by means of the electronic equipment assures in real time, with raised precision the acquisition, processing, monitoring, display and storage in the data base of the measured and calculated values, as well as their graphic representation.

The stand is foreseen with three modules:

- the module for the determination of the torque and the engine speed DTS 2: displays the measured value at the dynamometer and the calculated engine speed based on impulses obtained from optical sensors, the power being calculated;
- the module for the determination of the entrance parameter and of the air exhaust parameters: displays the environmental pressure and temperature, as well as the pressure inside the air box. The air flow at the entrance of the motor is calculated as a function of the size of the hole in the air box and of the pressure difference between the environment and the one inside the air box (Δp);
- the volumetric fuel indicator AVF1: for the measurement of the volumetric fuel flow it is used a hand driven pipette and an adequate seconds counter.

The motor cycle analyzer - ECA 100 is formed of two parts:

- A unit with component elements with a circuit amplifier with conditioned signals;
- The soft VDAS for the registration of data, calculation of the displayed average pressure and the creation of displayed diagrams: pressure versus rotation angle (p-α) and pressure versus volume (p-V).

2.2 Working method

The working method involves following stages:

- preparing the stand for experimental tests, consisting in the checking of the oil level, checking of the water separator of the exhaust system, checking of the start lever, bringing to zero the torque indicator and the display of the engine speed, of the differential pressure, positioning in line with the fuel pipe of the fuel cocks, checking the functioning of the data acquisition system;
- the water supply of the stand from the dynamometer, the opening of the control valve to the half and of the water exhaust valve;
- starting and running the test engine;
- adjusting the shutter valve to the half;
- fixing the electric contact button to the position ON;
- manipulating the starter lever in order to bring the motor to the beginning of a compression cycle;
- starting the engine and running it a couple of minutes;
- opening the air valve and increasing the engine speed;
- entirely opening the air valve;
- it is waited till the normal running temperature is reached;
- setting the shutter valve at maximum engine speed;
- adjusting the control valve of the dynamometer with the aim of increasing the load and decreasing the engine speed to the stable minimum speed;
- adjustment of the control valve and water exhaust;
- registration of the fuel consumption and of the time needed for emptying 8ml of fuel;
- registration of the results;
- increase of the motor’s engine speed by means of the dynamometer;
- manipulation of the control valve for maintaining the same engine speed and registration of the fuel flow.
- performance of measurements in more engine speed steps;
- stopping the engine and bringing it to the beginning of the compression cycle with both valves closed with the aim to prevent the entrance of wet air in the cylinder during non- functioning.

2.3 The data acquisition system

The system VDAS (Versatile Data Acquisition System) is an instrument that might be used with more TQ products, might register very much data in a short time, data that might be saved electronically, being further on visualized and processed.

This system allows the registration of pressure variations in the combustion chamber, which are vital for the performance of an engine.

The shown diagram reproduces the variation of pressure in the motor's cylinder versus the piston stroke (in coordinates p-V) or versus the rotation angle of the cranked shaft (in coordinates p-α).

The analyzer of the motor cycle ECA 100 measures and displays the signals from the pressure transducers and from the one of the rotation angle of the cranked shaft, them being registered in form of data and aloe the raising of the indicated diagram in coordinates p-V or p-α for the established engine speed condition.

The soft shows the indicated diagram with the data registered when the engine is running and the soft ECA 100 is connected, that is: at the engine speed n = 3198rot/min there was visualized following indicated diagram, raised in coordinates p-V (Fig.5)

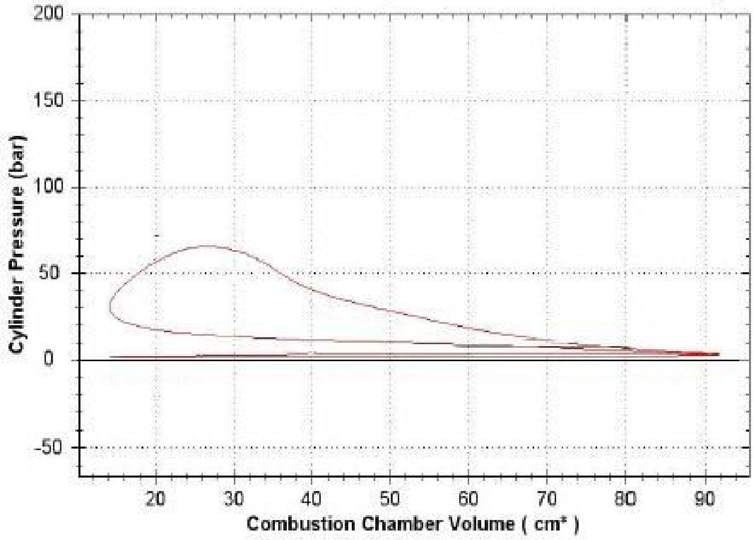


Fig.5 Raising the indicated diagram at a engine speed of n = 3198 rot/min

3. Experimental results

The monitoring of exhaust gases was performed with the help of the exhaust gas analyzer MOTORX 777, with which the testing stand TD 200 of range TQ is equipped.

All functions of the gas analyzer MOTORX 777 are assisted by a microcomputer that allows checking and diagnosis of the exhaust gas. The gas well was introduced at 30 cm in the end of the exhaust pipe.

The monitored noxious are: CO [%vol], HC [ppm], CO_2 [%vol], NOx [ppm], O_2 [%vol].

As a result of the performed measurements and of the protocols registered with the gas analyzer there were achieved the variation histograms of the monitored noxious versus the engine speed of the engine, as follows:

- variation CO [%vol], CO_2 [%vol], O_2 [%vol] versus engine speed (Fig.6);
- variation HC [ppm], NOx [ppm] versus engine speed (Fig.7).

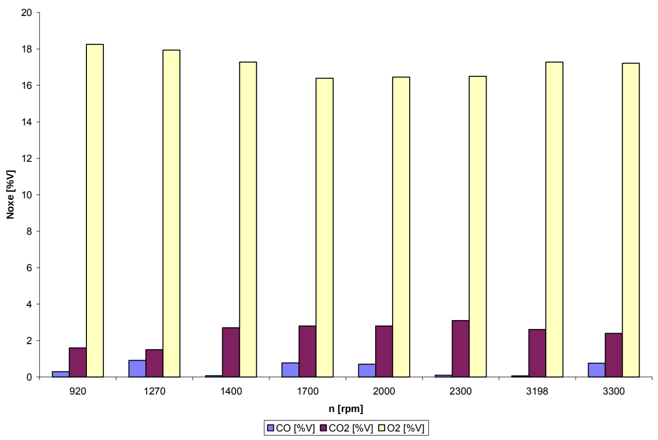


Fig.6 Variation CO [%vol], CO_2 [%vol], O_2 [%vol]

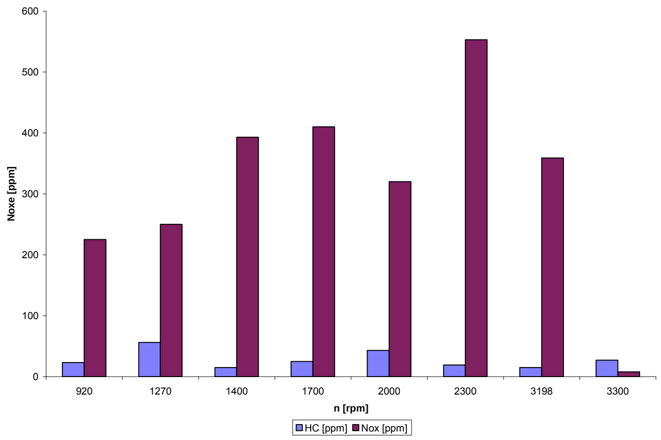


Fig.7 Variation HC [ppm], NOx [ppm]

During measurements, as well, there was monitored also the load coefficient λ. These registrations allowed the raising of the graph LAMBDA, on which there are represented the values of the emissions of CO [%vol], HC [ppm], CO_2 [%vol], NOx [ppm], O_2 [%vol] versus the stoichiometric ratio air – fuel (Fig.8).

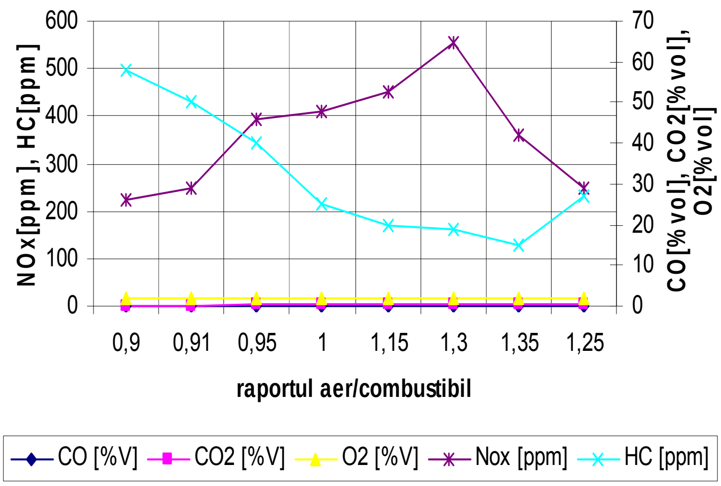


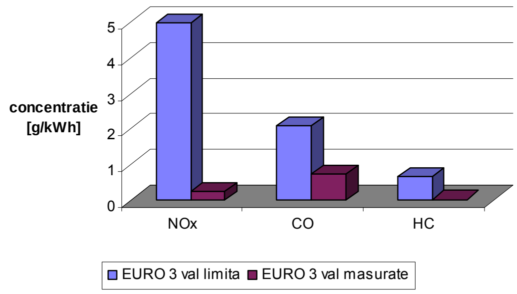
Fig.8 Graph LAMBDA

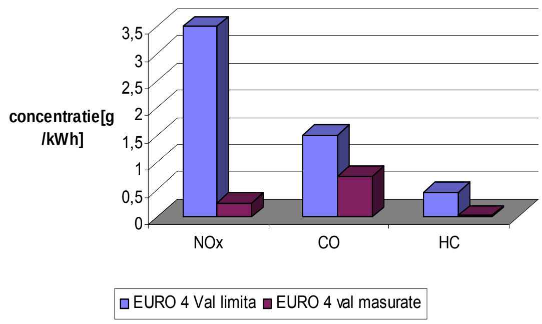
A comparative study between the measured values and the limit values imposed by the pollution norms EURO 3, EURO 4, EURO 5 is presented in Fig.9.

The application of the norms EURO 4 and EURO 5 impose the limitation of the polluting emissions, as follows:

Euro 4: 1,5 CO g/kWh; 0,46 HC g/kWh; 3,5 NO_x g/kWh; 0,02 PM g/kWh

Euro 5: 1,5 CO g/kWh; 0,46 HC g/kWh; 2,0 NO_x g/kWh; 0,02 PM g/kWh,





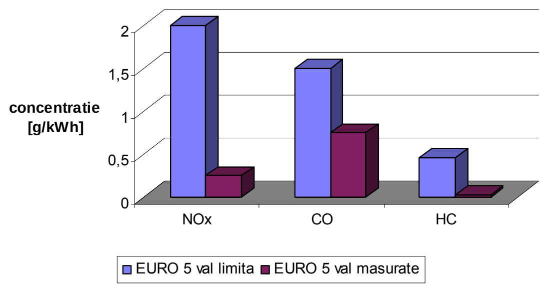


Fig.9 Comparative histograms of Nox, HC, CO between the measured values and the limit values

As a result of measurements and of the comparison performed for Nox, HC and CO, between the measured values and the values imposed by the pollution norms it is concluded that the imposed limits aren't exceeded.

3. Conclusions

At the use of the exhaust gas analyzer MOTORX 777 with which is equipped the test stand TD 200 of range TQ it is necessary that at the end of the test AUTOZERO, when the program controls the residue of HC, in the suction systems to be checked if it doesn't exceed the value of 20 ppm. In the situation that this value is exceeded, the well must be taken out and there are checked the filters and the system to be sampled.

From the analysis of the graph LAMBDA it is concluded that the values for CO, HC and NOx are normal, while for O_2 there are registered raised value (over 5%), and for CO_2 reduced values (under 10%).

The causes of these incorrect values might be of different nature.

The reduced values of CO_2 might be caused by the sealing of the exhaust system or by the incorrect values of CO and HC. The values measured for CO and HC do have normal limits, thus, we've supposed that the measured values of CO_2 are caused by the faulty sealing of the exhaust system.

The increased values registered by $O_{2,}$ might appear as a result of an incorrect adjustment of the carburetor or as a result of a faulty sealing of the exhaust system.

Carbon dioxide CO_2 is the natural product of the complete burning of the hydrocarbon mixture with O_2, therefore the better combustion is, the bigger the presence of CO_2 in the exhaust gases.

As a conclusion, the faulty sealing of the exhaust system, appears as cause of the incorrect values in case of O_2, as well as in case of CO_2.

The registration of the reduced values for CO_2, under 10%, at the same time with the raised values for O_2, over 5%, is a consequence of the poor mixture.

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