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CONTRIBUȚII LA CERCETAREA EXPERIMENTALĂ A SPECTRULUI DE ZGOMOT LA MOTORUL 1.6 L DE FORD ÎN LABORATORUL TESTECOCEL CU TEHNICI AVANSATE ÎN INGINERIA AUTOVEHICULELOR

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CONTRIBUTIONS TO EXPERIMENTAL RESEARCH OF NOISE SPECTRUM ON THE 1.6 L FORD ENGINE IN TESTECOCEL LABORATORY WITH ADVANCED TECHNOLOGIES IN AUTOMOTIVE ENGINEERING

The present paper develops a research plan and specialized protocols in the noise determination process on the spark ignited engine with 1.6 liters displacement installed in TESTECOCEL laboratory. The high-tech equipment and test-bed allows researchers to measure a wide span of parameters in operation while simulating in real time some drive maneuvers. During this sequence beside many other determinations there were recorded some actual values concerning engine noise emissions at different crankshaft speeds. The importance for monitoring the noise level at different operating regimes consists in the effect that sounds has on the living beings, on the environment and even upon the road travel security. Further tests and improvements of the noise control are also considered in the engine operation and study.

Keywords: Ford, engine, sound, noise, Testecocel
Cuvinte cheie: Ford, motor, sunet, zgomot, Testecocel

1. Introduction

Engine testing equipment allows the researchers to highlight the performances and limits of each component individually and the

systems as integrators of multiple parts in order to better understand their operating capacity and proper work destinations [1][2].

Noise determination is quite important in these days in the field of automotive components and systems due to the high number of their applications and negative effect if the level is higher than acceptable. Configuration of the test-bed in the TESTECOCEL Laboratory (figure 1) from Technical University from Cluj-Napoca, comprise a four cylinder Ford engine [3] with spark ignition system configured for essential parameters determination and for maximum force analysis with a dynamometer coupled to the crankshaft by an angular transmission [4].

The main objective of this work consists in experimental measurements of noise level on a considerably wide engine-speed range.

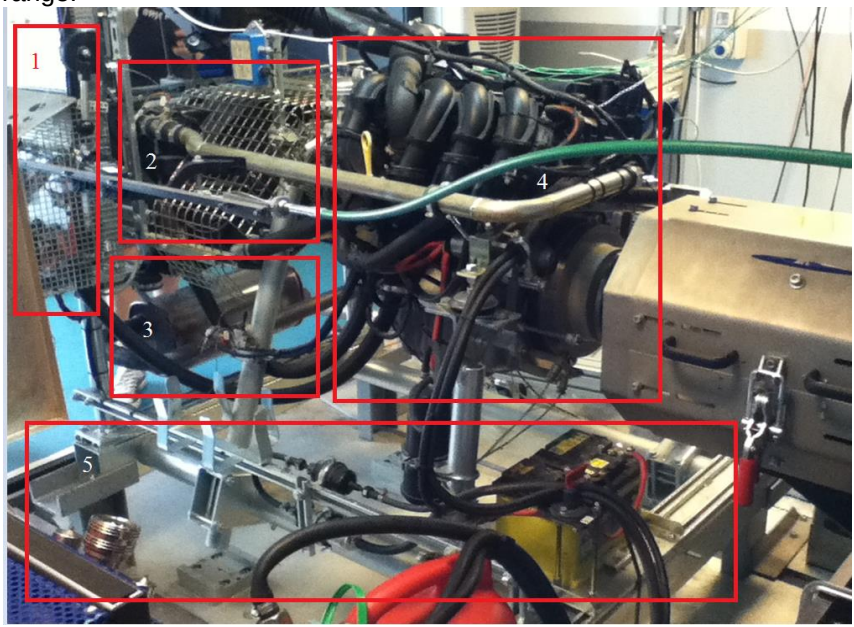


Fig. 1 Engine specific configuration on Testecocel testbed infrastructure
1-engine control panel; 2-engine cooling system; 3-gas exhaust system; 4-engine equipped with all auxiliary important systems

Specific objectives to reach during the research development and laboratory operations consist in the following measures:

- setting up the engine for experimental measurements;
- calibrating and installing the phono-meter in the testbed area in order to get accurate results;

- making the specific measurements on a wide span of engine speeds in order to highlight the noise spectrum configuration.

In figure 2 is presented a frontal view of the testbed with phonometer installed in the right part of the engine.

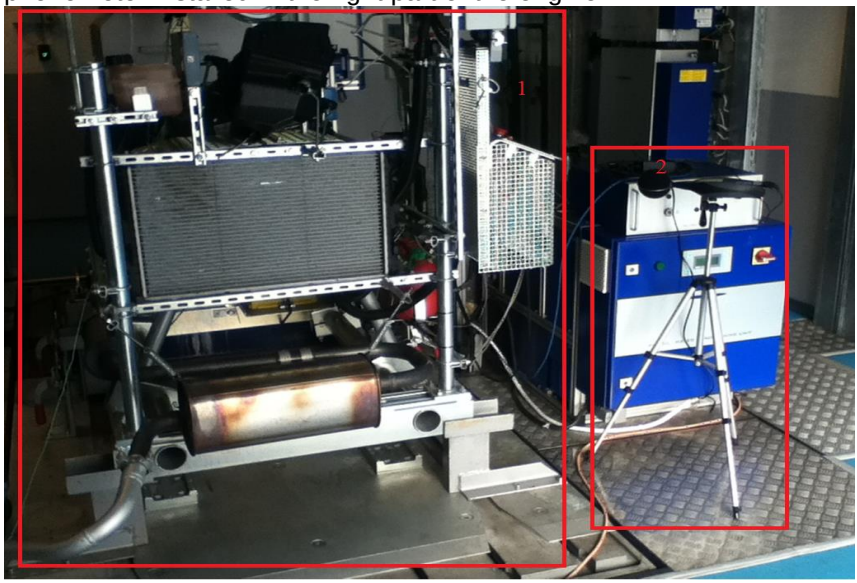


Fig. 2 Installation of the equipment on the engine testbed in Testecocel Laboratory. 1-engine complete testbed with auxiliary systems and measuring sensors; 2-phonometer on support near engine testbed for noise determination during specific stage operation

Due to the fact that the chosen engine for this study is one quite often met in regular cars both in Romania and abroad, being placed in medium class of energy sources powertrains and with good dynamic performances, there was initiated the experimental research of sound emission level in specific conditions and advanced techniques.

In the present paper are offered the summarized aspects from the whole process of sound measuring with advanced technologies in automotive engineering from Testecocel Laboratory from Technical University from Cluj-Napoca.

2. Materials and method

The experimental research is based on the proper configuration of the testbed and accurate calibration of auxiliary systems of the

studied engine. The significant parameters which are considered in calibration of the testbed are specifically the oil level and pressure, amount of cooling liquid, fuel and air supply to the engine, exhaust pipeline, sensors and control units, as well as the coupling with the dynamometer. There are sensors at air intake in order to measure pressure and air flow as well as air temperature before it reaches the engine. The fuel temperature, pressure, density and consumption are measured and monitored by the specific equipment.

Concerning the noise level, there is measured the sound generated by the engine operation and recorded in the area near it spanning between 0.5÷1 meters.

Method in practical testing and research development is structured in dependence with the specific configuration of the testbed and also with the requirements of the testing protocol. Thus it follows specific sequences, as there are mentioned the following:

- choose of engine to be tested;
- mounting the engine on the tesbed structure in order to reinforce the testing position;
- coupling the engine with the dynamometer in order to transfer the torque and power between the two major components in the testing scheme;
- configuration and inspection of auxiliary systems for practical testing;
- measuring the pressure of fuel, oil and cooling liquid;
- preparing the phonometer for testing and experimental research;
- starting the testbed equipment and dynamometer;
- developing the operating stages from the testing protocols;
- measuring the noise level;
- storage the actual values and analyze;
- outlining the risk potential aspects;
- pointing out the maximum levels of noise generated by the engine operation;
- further the development capabilities perspectives and testing possibilities, as well as taking into consideration the idea of measuring other parameters from NVH field.

3. Experimental testing results

In order to make the testing easy and reliable the engine was coupled with the dynamometer through an angular shaft transmission.

Angular transmission shaft was aligned almost perfectly between the engine crankshaft and the dynamometer shaft.

In figure 3 there is presented the engine testbed on the left side coupled through the cardan angular transmission with the dynamometer situated on the right side. Transmission shaft is covered with hard steel case for security and protection reasons. It has also sensors which are preventing the operation of laboratory in case of emergency or damage to the main components. The sensor is placed in middle position right under the locker device, in order to sense very precise closed position of transmission case.

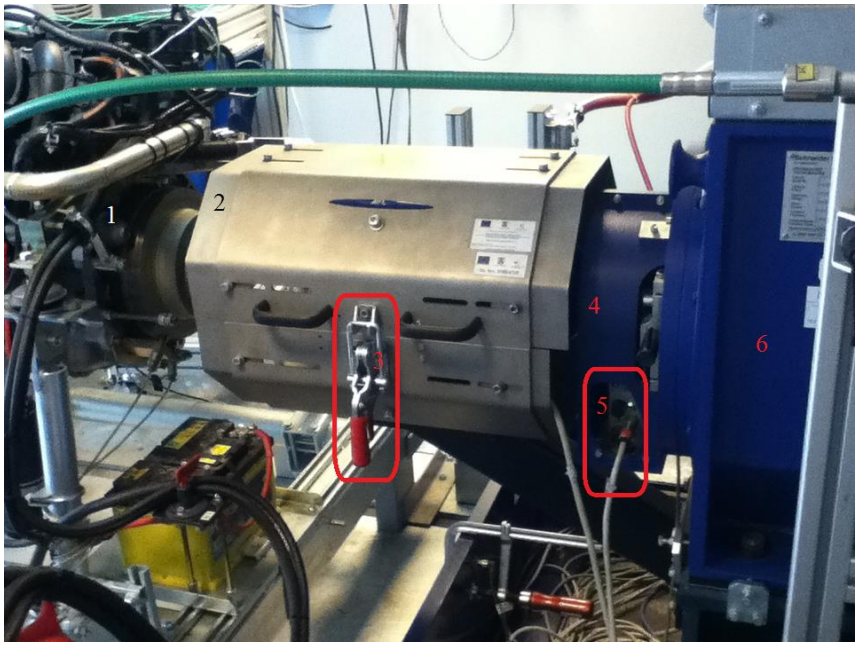


Fig. 3 Transmission connection between the Ford engine and the dynamometer 1-tested Ford engine; 2-transmission cover; 3-case-lock device; 4-support area for the main shaft of dynamometer; 5-dynamometer shaft position sensor; 6-dynamometer body

Basic units and parameters from starting time of the engine to the highest point of engine speed are available as well on the testbed dash panel, according to figure 4.

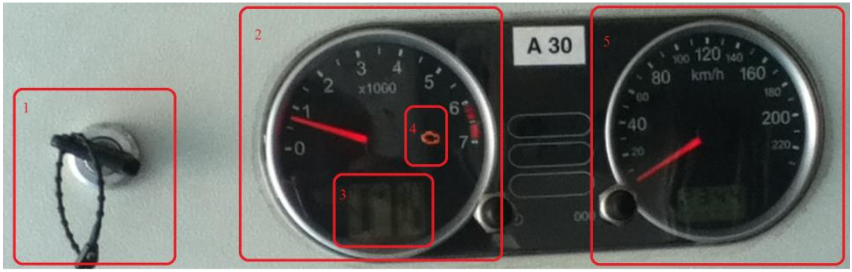
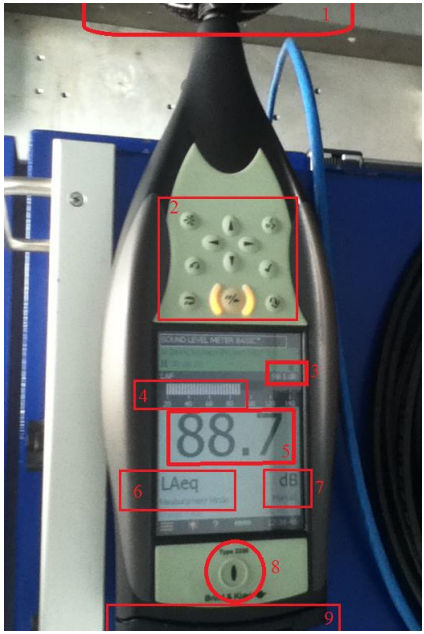


Fig. 4 Basic dash board panel of the test bed
1-ignition key and socket; 2-tahometer indicating the engine speed – at the moment being in idles, which is between 770÷850 rpm; 3-temperature and fuel tank level indicators; 4-exhaust after-treatment dash-board indicator lamp; 5-speedometer and odometer indicators are optional and useless on the testbed operational standard regime



Sound meter or the phonometer is presented in figure 5.

Fig. 5.Sound meter built-in specs
1-microphone area; 2-navigation keys; 3-actual sound level; 4-exhaust after-treatment dash-board indicator lamp; 5-average sound value; 6-measuring and recording regime; 7-unit of measurement; 8-on/off touch-pad; 9-connections hub

In figure 6 is presented the measuring phase of sound level at 1500 rpm, when the average value is 89 dB.

Figure 7 presents the measuring sequence concerning the sound emissions of the engine at 2000 rpm.

It may be observed that there is both an increase and a slight difference between actual value and the average indication (which is made on an interval of at least 20÷30 seconds usually).

Fig. 6 Determining the sound level at 1500 rpm

Fig. 7 Determination of sound level at 2000 rpm on Ford S.I. engine

There is also a measurement conducted at 3000 revolutions per minute, according to figure 8, when the engine is at higher levels concerning both crankshaft angular speed and sound level emissions.

Figure 9 presents average value in measuring the noise level at an engine speed level of more than 3500 rpm.

Fig. 8 Measurement of noise level at 3000 rpm of engine's crank shaft

Fig. 9 Determining noise actual value at approximately 3500 rpm

In figure 10 is presented the measurement made on the studied engine close to 4000 rpm.

Fig. 10 Determination of noise level at ≈4000 rpm

Figure 11 presents the measuring sequence of noise level close by to 4500 rpm of engine's crank shaft.

Fig. 11 Show of basic measurement values concerning noise emissions at 4500 rpm

4. Conclusions

Analyzing through experimental and engineering methods the sound emission level with phono-meter near the 1.6 spark ignited engine from Ford and post-processing of acquired data in the Laboratory for Testing and Certification of Internal Combustion Engines from Technical University of Cluj-Napoca, as well as interpretation of results in the frame work of developed paper, have facilitated the issuing some conclusive ideas, as it is shown in the followings:

- at the engine speeds around the 1000 rpm noise level is somewhere between the 75÷88 dB;
- the actual data measurements at the lower speeds of the engine were affected by the laboratory ventilation system which was turned on during the bulk measurement sequences;
- experimental research and the developed study lead to the need of continuing and perfecting the studies concerning the noise level determination in various conditions in order to gain valuable information about operation and possible solutions for engine's optimization and exploitation in the case of Ford configuration or other manufacturers.

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