Academicia Globe:
Inderscience Research

ISSN: 2776-1010 Volume 4, Issue 3, Mar., 2023

NOISE GENERATED IN THE EXHAUST SYSTEM OF THE ENGINE

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Abstract
This paper presents an analysis of the acoustic characteristics of exhaust gas cleaning devices used in the exhaust systems of automobile engines, which should be taken into account in order to comply with the current standards for harmful substances emitted from automobile engines.

Keywords: car, engine, efficiency, fuel, ecology, noise sources.

Introduction

Currently, the automobile industry of our country is developing widely. Along with the improvement of our national automobile industry, the amount of Republic's automobile fleet is also growing sharply. Because of this, city roads are full of cars and traffic jams are occurring. In addition, cars pollute our streets and environment with various exhaust gases and acoustic noise. Because of this, now there are more complex and huge tasks to solve the above problems [1-3].

The Main Part

The exhaust system of modern passenger car internal combustion engines (ICE) has several noise-reducing and absorbing elements. It is a multi-tasking complex system that includes other means such as a muffler of exhaust gases and elements of chemical cleaning of toxic substances (CO, CH, NOx) and solid particles (soot) contained in these exhaust gases. One of the typical constructions of the exhaust system of internal combustion engines of such small and medium-class modern passenger cars is shown in the figure below [4].

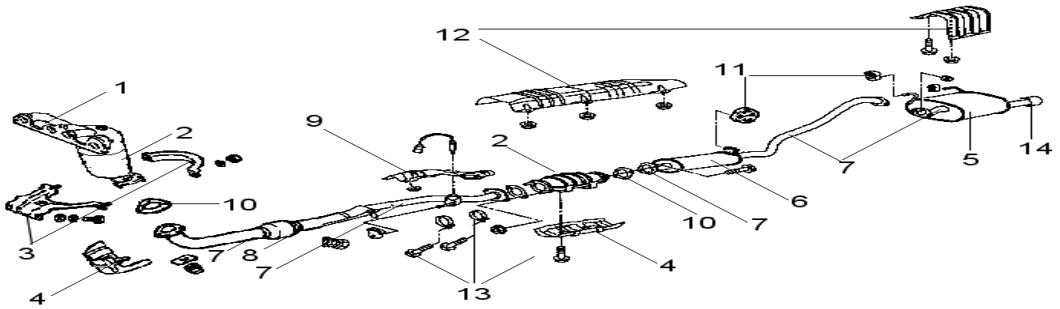

Figure 1. A schematic diagram of one of the typical designs of the exhaust gas discharge system of ICE models of modern passenger cars of small and medium class

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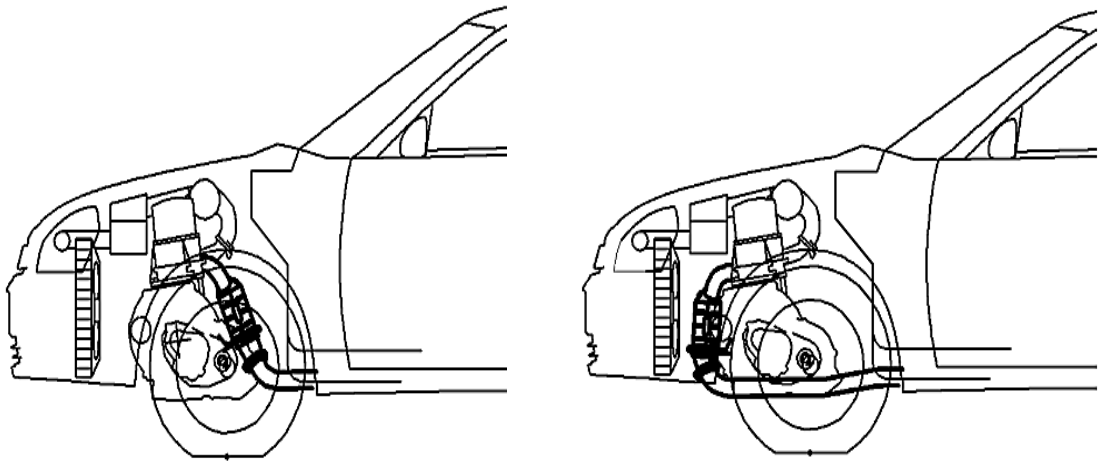
ISSN: 2776-1010 Volume 4, Issue 3, Mar., 2023

The order of the numbers in the image above means:
1 – input collector; 2 – catalytic neutralizer; 3 – reinforcing brackets; 4 – thermoacoustic screen of the neutralizer; 5 – main silencer; 6 – additional silencer; 7 – conduit pipes; 8 – vibration compensating element; 9 – thermal screen; 10 – sealing gaskets; 11 – fastening elements of the exhaust system to the body; 12 – thermoacoustic screen for body floor; 13 – hardening compounds; 14 – the last exhaust pipe of the exhaust system.

The composition of the exhaust system of passenger cars' internal combustion engines consists of several (usually 2) silencers (S). Silencers with a large volume and size are called the main silencers, and the rest silencers with small sizes are called auxiliary silencers [5-9].

Opposite the protective walls in the front of the car body, behind the engine compartment in the engine compartment (behind the elements of the internal combustion engine cooling system), the exhaust manifold assembly with a catalytic converter (catalyst) (Fig. 2 a) is its alternative assembly compared with the option located in front of (noise in the engine compartment is transmitted to the passenger compartment due to increased energy) the power unit housing (Fig. 2 b). It complicates the task of solving not only acoustic, but also temperature problems (inefficiency of ventilation of the environment under the hood, deterioration of heat exchange between the internal combustion engine and the collector housing located behind its housing, difficulty in ensuring fire safety) [10-14].



a) b)

Figure 2. Diagram of the location of the collector in the exhaust gas exhaust system of the passenger car internal combustion engines
a) Behind the body of the internal combustion engine; b) In front of the internal combustion engine body

For modern passenger car models, internal combustion engine exhaust system structural elements are designed based on normative indicators aimed at ensuring their noise reduction properties (first of all, achieving gasodynamic noise reduction efficiency of the exhaust system).

ISSN: 2776-1010 Volume 4, Issue 3, Mar., 2023

In addition to the requirements for gas-dynamic content of the exhaust system based on the technical conditions, there are also restrictions on the vibration-induced noise of many thin-walled housing elements in the internal combustion engine exhaust system. The sounds emitted by the last-mentioned noise diffusers may not be very noticeable in the internal and external noise of the car, but it is determined by special experts as one of the factors in the study of noise formation using its acoustic signal.

The used design of the exhaust system should have the ability to limit the internal and external noise of the car generated by several of its elements. If the external and internal noise level of the test ATV exceeds the specifications, appropriate evaluation tests should be conducted to determine the cause of the muffler's ineffectiveness. In the assessment tests, the presence or absence of noise-reducing effects is recorded in relation to the emission of gasodynamic noise of the exhaust smoke (gas) and the structural noise emitted by the body elements of the exhaust system (for example, the collector).

Currently, the evaluation of technical characteristics and indicators of acoustic efficiency of silencers installed in various standardized technical objects is regulated (regulated) by GOST 31324 (ISO 11820:1996), and GOST 31328 (ISO 14163:1998). At the same time, there are no separate regulatory standards that describe the acoustic quality of the muffler and determine the direct regulatory requirements in the tests to assess the capabilities of the moving (operating) components of the ATV.

In the international and national standards for the assessment of acoustic tests, the manufactured constructions of silencers installed in the operational structure of ATVs, the protocols for measuring the external noise of ATVs (through a measuring microphone located at a distance of 7.5 m from the central longitudinal plane of the vehicle) considers that previously confirmed positive results are determined satisfactorily. At the same time, in addition to the noise level of exhaust gases coming out of the exhaust system (measuring microphone exhaust system at a distance of 0.5 m from the cut open part of the last exhaust pipe at an angle of 450 to the axis of this pipe) can also be done.

The list of urgent tasks for the technical development of efficient constructions of silencers includes not only reducing acoustic energy by them to the required level (first of all, gasodynamic noise, which is a component of exhaust gas noise) but also minimizing their total volume and cost indicators, To facilitate the cleaning of internal combustion engine cylinders and to provide low resistance to the flow of transported gas, to reduce toxic emissions in the exhaust gas and fuel consumption, as well as to remove particles blown by the exhaust gas flow using fibre sound-absorbing materials (if the noise (if the sensor is part of the chamber elements) include air pollution removal. Because of this,

An ATV with a total noise level of 74 dB (the approximate total noise level specified in the specifications for passenger cars today) is a technically and economically reasonable value of the noise level emitted from the exhaust system, which is a constituent of the acoustic balance equation, to the change in the total noise level of the ATV can be determined based on almost unaffected conditions (when the noise level that may exist there is not greater than 0.1 dB).

It is known that when calculating the total noise level of two non-adjacent sound emitting sources, which differ from each other by at least 15 dB, the additional contribution of the other, which emits more noise than one, does not exceed 0.1 dB.

ISSN: 2776-1010 Volume 4, Issue 3, Mar., 2023

If it is based on the condition that the noise level of two unrelated sources (one of which is exhaust gas noise, and the other is the combined noise of other sources of the ATV) does not exceed 74 dB (normative limit value), then the noise level coming from the exhaust pipe of the internal combustion engine equal to 58.9 dB, it has little effect on the increase of the overall external noise of the ATV.

In fact, according to the rule of adding the volume of two uneven noise sources, their total level is determined as follows:

$$L\Sigma = 10lg\left(10^{0,1L}{}_1 + 10^{0,1L}{}_2\right), dB$$

Here, L1 and L2 are the noise level of the sound emitting sources, respectively, in dB.

Thus, a source that is part of such multi-part noise sources in the open environment, for example, the noise level of a car internal combustion engine exhaust system with a total noise level of 74 dB, does not exceed the indicated value (L1 ≈ 59 dB) of the actual ATV can be considered as the main goal to ensure compliance with the requirements of the law.

If we consider the standard that may be imposed in the future, then its total noise level corresponding to the exhaust system corresponds to L1 ≈ 56 dB. Achieving the recommended values of noise reduction during the development and improvement processes of the muffler design is one of the main goals in the development of a high-performance muffler that can be adjusted on one side or the other. One of the great achievements in this direction is to further reduce the consumption costs of the vehicle exhaust system and its noise, taking into account meeting the current and future requirements. This is primarily

Of course, vehicle manufacturers are obliged to follow the acoustic requirements of the standards, but also to find other technical tasks and instructions, as well as ways to ensure them. In this case, the requirements of consumers regarding the technical conditions provided to the customer by certain car manufacturers for achieving the specified acoustic characteristics of the engine exhaust system may be more serious than the current legal restrictions require.

Removal of Vehicle Engine Exhaust System Components - The unmitigated noise emitted directly into the atmosphere by the spent gases from the combustion engine exhaust manifold makes the combustion engine the highest emitter of all other sources of noise emission. When the noise generated by a car equipped with internal combustion engine parts, which is not reduced, was measured at a distance of 7.5 m from the longitudinal plane of the car, its total external noise was 100...110 dB. This is exactly the case,

Based on the generalized results of the research and the pre-achieved technical parameters of certain serial models of cars that are close to the main technical indicators of the object under study, it is possible to make a comparative assessment of the acoustic properties of the structural structures of the studied exhaust system. First of all, this means that the exhaust system is considered a gasodynamic acoustic distributor of the main technical parameters of the engine.

Research studies on acoustic characteristics were conducted by certain researchers on 50 models of various passenger car manufacturers. Most of the passenger car models studied in these studies were selected from different classes. Of the total number of cars that participated in this study, 4% were of

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ISSN: 2776-1010 Volume 4, Issue 3, Mar., 2023

"A" class (according to the European standard classification), 28% were of "B" class, 46% were of "C" class, 12% were of "D" class and 10% were full leading cars. organized classes of light cars.
In the conducted study, the total external noise level during the movement of 50 different types of passenger cars was ≤74+1 dB and the range of variation of the average standard noise level was 70...75 dB.

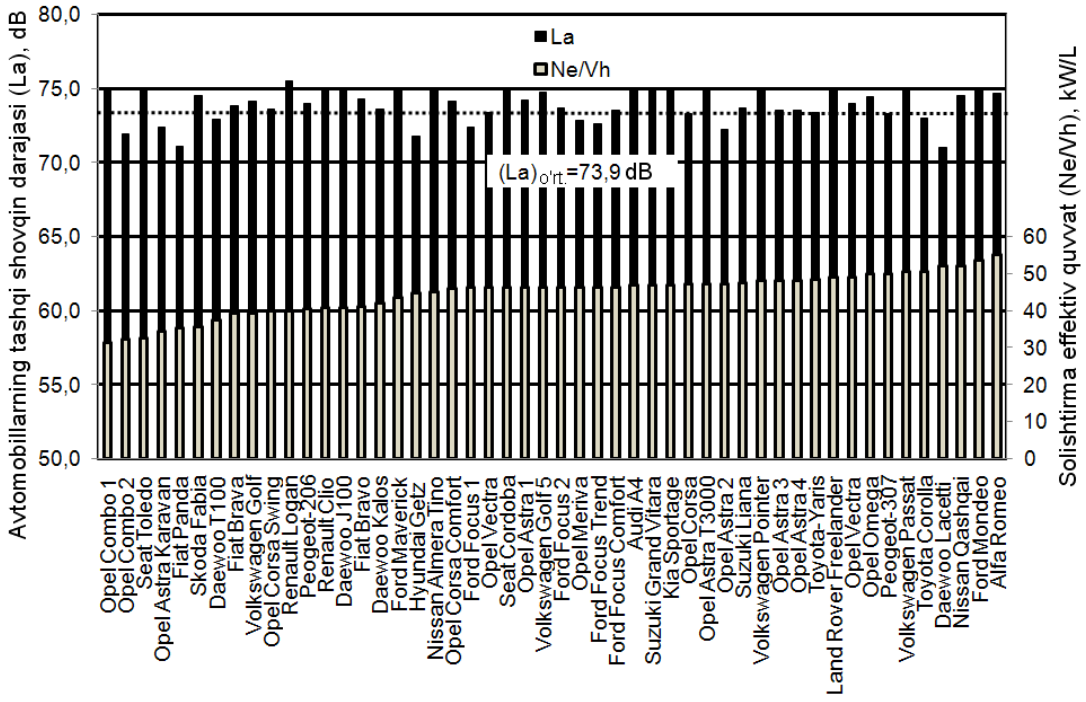

Figure 3. General external noise levels (La) of modern models of passenger cars as a function of their relative effective power (Ne / Vh) growth under the same conditions of rapid acceleration

The internal combustion engines of the models of passenger cars involved in the above study are all in-line 4-stroke engines with full working volumes of cylinders from 1.0 to 2.2 L, effective power of 44...108 kW (comparative effective power of 32...55 kW /L) used internal combustion engines.
The set of statistical data of the results of the experimental study of the acoustic properties of the car engine exhaust system is the mathematical probability (M), which is determined by the following formulas, the distribution of the average levels of the reliability interval area with the size of the upper (+X) and lower (-X) limits in dB means

Conclusion

Based on the information in this article, it is possible to think as follows:
1. On the basis of the statistical analysis of the results of the control of the noise level of the examined models of passenger cars, it is possible to determine the linear dimensions and geometric parameters of its elements, which are related to the power characteristics of the engine and are used in the initial

ISSN: 2776-1010 Volume 4, Issue 3, Mar., 2023

stages of the construction of the exhaust system that meets the requirements of the technical conditions. it is.

2. Engine intake system is an important energy source of internal combustion engine noise in proportion to the exhaust system, which requires the creation of effective devices to reduce its noise. According to the results of checking the acoustic properties of the intake system and exhaust system of modern passenger cars, it is possible to make recommendations for the development of technically based prospective intake and exhaust systems of passenger cars.

3. As a result of theoretical studies, it was determined that collectors in the exhaust system of internal combustion engines are the main source of internal combustion engine noise, which forms the overall external noise of a passenger car.

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