ASPECTS OF TRAFFIC NOISE REDUCTION

Paper No.324/2021

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Abstract: *The level of noise in modern cities is growing every year, the main source of it is motor transport, the number of which is constantly increasing. This study examines the main sources of noise from a running car, as well as methods for reducing it. The results of the study can be applied in the design of gas exchange and cooling systems of cars, in addition, they can be used in urban planning to reduce traffic noise in the cities.*

Keywords: *noise, car, noise reduction*

DOI: *10.36336/akustika20213925*

1. INTRODUCTION

Modern transport is one of the main factors of man-made threats in modern society [1-5]. Thus, it is motor transport that is currently one of the main sources of noise pollution in the cities, while the main type of automobile noise is aerodynamic noise [6, 7].

The need to analyze the sources of the origin of the aerodynamic motor vehicle noise, for the purpose of developing new methods for its reduction, is primarily due to the need to preserve the health of people living in the areas with saturated automobile traffic.

2. ANALYSIS OF THE ORIGIN OF AERODYNAMIC NOISE FROM MOTOR VEHICLES

Aerodynamic noise during the operation of the car engine occurs primarily due to fluctuations in the pressure of the exhaust gases and as a result of the engine cooling system operation.

Measurements made using a portable noise meter at a distance of 10 centimeters from the measurement points in the gas exchange system of a light motor vehicle (Fig. 1) Toyota Corona allowed us to identify elements with the maximum noise level (Tab. 1).

No.	Elements of the gas exchange system	Elements with the maximum noise level (+)
1.	Air Filter	89 dBA
2.	Turbocharger	87 dBA
3.	Catalyst	75 dBA
4.	Particulate filter	69 dBA
5.	Silencer	65 dBA
6.	Air flow sensor	69 dBA
7.	L-probe	74 dBA
8.	Exhaust gas temperature sensor	75 dBA
9.	Inflatable air cooler	75 dBA
10.	Exhaust gas recirculation valve	91 dBA

Tab. 1: The main sources of aerodynamic noise in the car

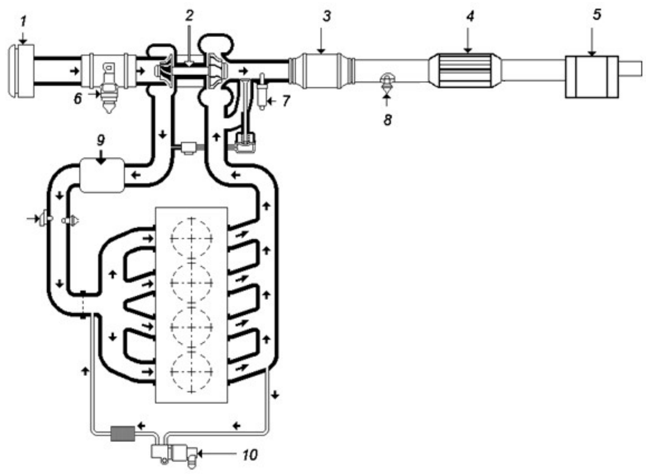

*Fig. 1: Points of the aerodynamic noise measuring in the gas exchange system of a light motor vehicle engine (the numbering corresponds to the numbering in Tabl.1)**

**A graphic template of the gas exchange system from the source [7] was used when preparing the figure.*

3. METHODS FOR AERODYNAMIC NOISE REDUCTION

The measurements showed that the main noise-absorbing elements of the gas exchange system account for 50% of the absorption of the aerodynamic noise from the running car engine, including 23% for air purifiers, and 27% for exhaust silencers, primarily with a frequency of >600 Hz. At that the aerodynamic noise of the <500 Hz spectrum is not reduced effectively enough.

Reducing the aerodynamic noise of the <500 Hz spectrum can be implemented by means of increasing the structural volume of the gas exchange lines, or by installing silencing structural elements into the system, including:

1) **Active silencers** (Fig. 2), which transform the noise into heat energy by way of sound waves passing through grids and perforated sheets of heat-resistant alloys, as well as sound--absorbing materials.

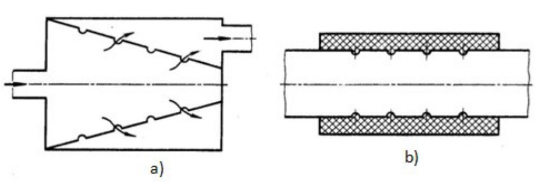

Fig. 2: The active silencer: a-with a perforated body; b - with a sound-absorbing material [7]

The measurements showed that the efficiency of a silencer with perforated sheets is higher than that of a silencer with a sound-absorbing material by 15-20%.

2) **Reactive silencers**. This type of silencers consists of one or more expansion chambers or a series of resonant chambers (Fig. 3), in which the amplitude of the gas oscillations decreases due to the expansion of the exhaust gas flow and resonance [7].

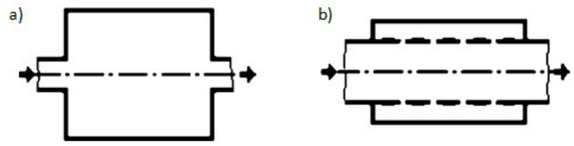

Fig. 3: The reactive silencer: a - with an expansion chamber; b - with resonant chambers [7]

The measurements also showed that using a hybrid silencer with elements of both types will achieve a noise reduction rate by 15-20% more than that of a standard silencer.

In addition to the gas exchange system in the car, the second main source of noise is the engine cooling system. Thus, the fans in the cooling system are a source of noise, the level of which is equal to 30-35% of the engine noise level.

The greatest noise level is generated in the engines with an air cooling system, measurements have shown that the noise of such a system exceeds the noise in engines with a liquid cooling system by 25-35%, the reason for this is the use of more powerful fans.

Reducing the noise load generated by the fan of the engine cooling system by 25-35% is achieved by using a fan with an uneven blade pitch (Fig. 4).

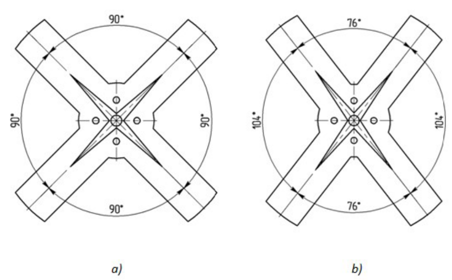

Fig. 4: The cooling system fan: a) with a uniform blade pitch; b) with an uneven blade pitch [7]

The integrated application of the considered methods of noise reduction will increase the efficiency of reducing aerodynamic noise, the source of which is the gas exchange system of the light motor vehicle engine by 17-25%.

4. CONCLUSION

The analysis of the sources of noise from the vehicle operation and possible tools of its mitigation indicate that existing tools allow you to create a system for reducing the noise with damping capacity reaching ~70...80 dBA (from 90...100 dBA to 20...30 dBA).

At that, a current constraint is the need to provide an acceptable size and weight of the devices reducing the car noise, as well as a factor of reducing the efficiency of the engine.

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