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STATISTICAL ANALYSIS OF GAZ-3110 VEHICLES NOISE

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Abstract

This work presents the results of the statistical analysis of noise in several points of GAZ-3110 vehicles. There are also the dependences between the loudness of noise and speed of an engine or useful life of a car.

It is difficult to confuse the noise of jet engine with reciprocating internal-combustion engine. Random factors also influence much the power level. Mechanism adjustment has its limits and so it can have different influence on its vibration and noise. Finally during the process of operation sliding surfaces do wear, screwed connections do loosen, other things happen and these lead to the changes in spectrum and level of noise. In this work we tried to evaluate the dispersion of GAZ-3110 vehicles' noise levels according to the results of acoustic measurements in the immediate field of random acoustically active constructive assemblies. The range of noise loudness for the specific car model is defined at the level 20-25 dBA. The GAZ-3110 vehicles are characterized by the significant dispersion of noise level. The differences of noise level of individual cars are exceeding 20-25 dBA. Vehicles' noise considerably increases with the augmentation of useful life and rpm speed. The noisiest element of GAZ-3110 vehicles is internal combustion engine, then main gear even when first gear is operated.

***Keywords**: Vehicle, statistics, noise sources, dimension, mean-root square dispersion, noise level, regression equation, engine rpm speed, useful life*

The noise of any mechanism is primarily defined by the mechanical design, character of operational process and operational conditions. These create the conditions for recognizable noise appearance, which characterizes the special type of mechanism and its technical characteristics. So, it is difficult to confuse the noise of jet engine with reciprocating internal-combustion engine. Diesel engine and gasoline-engine have also different range. The noise of axle drive gear of rear-driven car is significantly different from transmission noise. But random factors also influence much the power level, these factors are figured on during designing, manufacturing and specific regulation of each mechanism. It is impossible to find two absolutely identical mechanisms, even if they were manufactured on the same assembly line at the same time.

First of all, all the mentioned above is connected with the piece limits, set by design engineers. Even if the transmission is the same the pitch of transmission teeth might be different (within the technical limits). It is evident that the reaction of teeth will be irregular then. This is true for axes, bearings and other pieces.

Further, the process of assembling implicates the irregular torquing of joining by transverse bracing (again within the technical limits), but this will appear individual for each piece. And this will certainly influence the elasticity and dampen conditions of assemblage and its resonant frequencies which have a significant impact on the noise spectrum.

Mechanism adjustment has its limits and so it can have different influence on its vibration and noise.

And finally during the process of operation sliding surfaces do wear, screwed connections do loosen, other things happen and these lead to the changes in spectrum and level of noise.

All of these are true for vehicles. That’s why the noise levels of vehicles of the same model and of the factory might significantly differ from each other [1-3].

Unfortunately, the expenses and time needed for the standard checking of noise level make impossible the checking of each new vehicle’s acoustic characteristics.

In this work we tried to evaluate the dispersion of GAZ-3110 vehicles’ noise levels according to the results of acoustic measurements in the immediate field of random acoustically active constructive assemblies.

The noise level of 21 vehicles was measured in the conditions (in a pit, where there were not any noise sources and the background noise was 25-30 dB lower the levels in the points of measurement). The vehicle was cocked on the elevator after the engine warm-up and the needed engine rpm speed was set when the low gear was on. The microphone was placed successively at the distance of 5-6 cm from the valve cover (point 1) or transmission case (point 2), rear hinge of propshaft (point 3) and main gear (point 4).

For example the table 1 shows the results of general level’s measurement according to the scale **A** of the sound level meter in the point 2.

It is visible that mean-root square dispersion of noise levels in this point at any engine rpm speed lies between 22 and 26 dBA.

Tab. 1. The noise level at the point 2 (transmission)

***L*, dBA at *n*, rpm** Model year	1000	2000	3000	4000	5000	6000
2004	53	58	66	71	71	74
2006	50	53	60	62	68	69
2006	50	54	57	60	61	64
2005	51	55	60	66	69	78
2007	49	50	53	58	60	67
2005	50	56	77	82	84	92
2003	51	54	63	71	73	76
2004	47	49	53	56	56	66
2007	42	47	54	55	55	61
2002	66	70	74	83	84	92
2000	78	83	87	88	91	97
2004	56	59	65	73	76	81
2006	45	46	51	64	65	72
2005	39	42	50	54	54	57
2006	42	46	46	51	55	78
2004	40	43	41	52	53	63
2004	41	48	49	54	57	63

L, dBA at ***n***, rpm Model year	1000	2000	3000	4000	5000	6000
2002	45	69	77	77	78	80
2003	52	61	64	68	68	75
2000	59	73	77	79	85	87
2003	68	70	74	89	90	90
Arithmetic mean ***L*, dBA**	52.23	57.50	63.00	68.27	70.14	76.27
Mean-root square dispersion ***σ*, dBA**	10.91	11.77	13.21	12.75	12.99	12.02

Figure 1 demonstrates the dependence of mean-root square dispersions of noise levels form the rpm speed in all points of measurement. The equations of noise levels' regression depending on the rpm speed:

For the point 1 $\boldsymbol{L_1} = 65.52 + 0.004 \cdot \boldsymbol{n_1}$ dBA. (1)
For the point 2 $\boldsymbol{L2} = 48.227 + 0.004 \cdot \boldsymbol{n_1}$ dBA. (2)
For the point 3 $\boldsymbol{L3} = 48.616 + 0.004 \cdot \boldsymbol{n_1}$ dBA. (3)
For the point 4 $\boldsymbol{L4} = 58.263 + 0.004 \cdot \boldsymbol{n_1}$ dBA. (4)

Picture 2 shows the mean statistical values of the noise levels in the point 2 at different rpm speed depending on the useful life of the vehicle. Corresponding regression equation

$$\boldsymbol{L_2} = 52.59 + 3.558 \cdot \boldsymbol{x} \text{ dBA}, \tag{5}$$

where x – useful life of vehicle.

General regression equation for point 2

$$\boldsymbol{L_2} = 41 + 0.004 \cdot \boldsymbol{n_2} + 2.35 \cdot \boldsymbol{x} \text{ dBA}. \tag{6}$$

Therefore, the GAZ-3110 vehicles are characterized by the significant dispersion of noise level. The difference of noise level of individual cars can exceed 20-25 dBA.

The mean statistical level of GAZ-3110 vehicles' noise considerably increases with the augmentation of useful life and rpm speed.

The noisiest element of GAZ-3110 vehicles is internal combustion engine, then main gear even when first gear is operated.

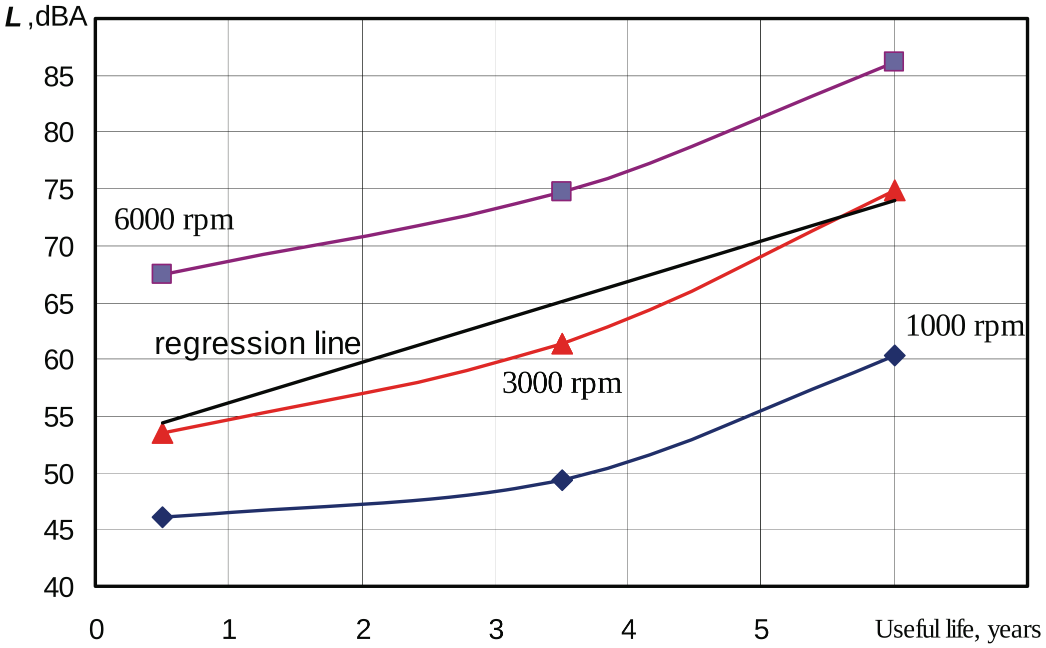

Fig. 1. Mean statistical noise levels in the measurement points

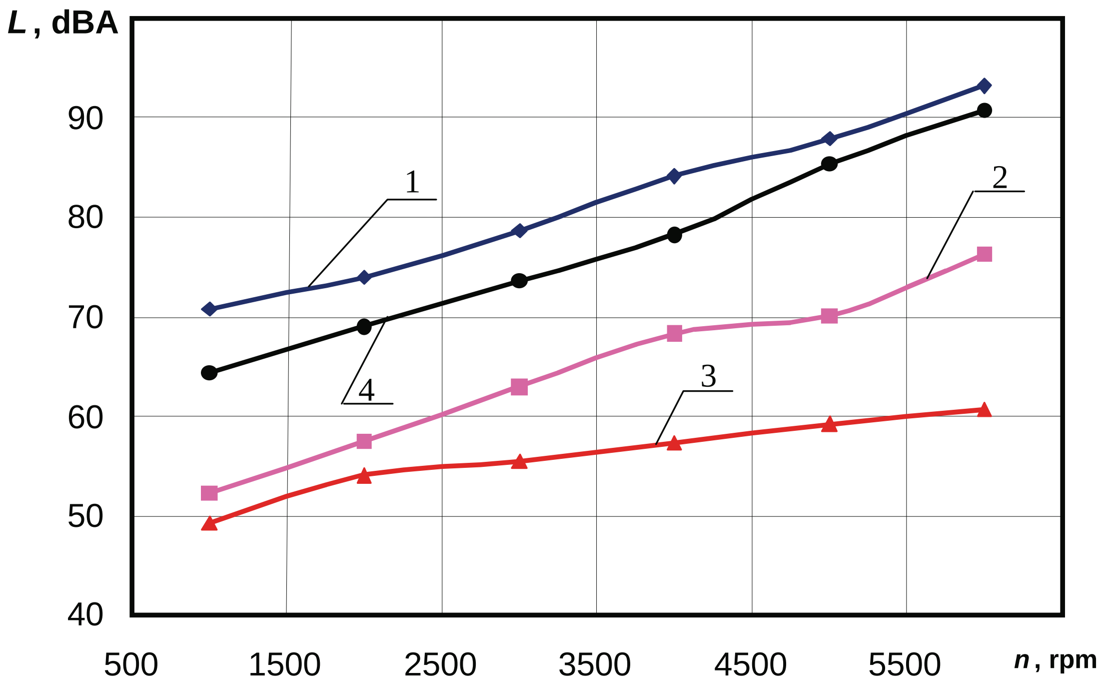

Fig. 2. The dependence of noise level from useful life period

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