Noise absorbing composite materials applied in domestic trucks

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Abstract. One of the basic indicators of the modern automobile is the low noise level. Noise level decrease is reached due to: 1) sources of noise elimination due to change of a design of elements and automobile systems; 2) application of modern noise insulation and noise absorption materials. The following noise absorption materials in domestic trucks are applied: fiberglass plastic, basaltic fireproof roll material (BFRM), ААSMT, AL-aramino, isomat.

1. Introduction
Modern automobile represents the complex technical object consisting of many subsystems to which inconsistent demands are often made. Salon or a cabin noise level is an important consumer indicator of the automobile. Manufacturers of automobiles direct considerable amount of money and manpower on improvement of salon noise insulation and elimination of noise sources.

Drivers of buses and trucks are mostly subjected to influence of harmful sound effects as their intensity several times exceeds rate. Maximal possible admissible noise level in Russia is considered 74-75 dB (at frequency of 1000 Hz). In France, for trucks the admissible limit is 90 dB [1; 2].

Loud sound effects substantially influence fatigue of the driver (organs of hearing, nervous system) that can lead to reaction and attentiveness deterioration. Long stay in a truck cabin in which negative noise constantly act on a person, can lead to increase in the latent period of impellent reaction, decrease in stability of clear vision, easing of twilight sight, infringement of concentration of attention, coordination of movement and function of a vestibular mechanism, fast fatigue. As a result, the risk of occurrence of road accident increases several times.

2. Noise absorbing composite materials
The basic sources of noise in a truck salon are: the working engine causing vibration, transmitted through elements of fastenings on motor transport body; elements of torpedo parts at their poor-quality assembly, poor-quality plastic in the truck design, badly fixed things in salon; sliding of tyres leading to a noise, getting into salon through apertures and cracks in a body, or through the poor-quality (or damaged) glass cover.

For a noise insulation of any mean of transport special screens are used, representing designs, consisting of fiberglass plastic frame and noise absorption layer on an adhesive basis, metal elements of fastening.

The technology of a noise insulation of trucks includes application of sound - and vibro-absorbing materials, and also protective casings. These materials are divided in two groups: vibro-
dampers, working as weighting compounds, and struggling with vibration of body material; sound-insulators, having low heat conductivity and weak sound conductivity. The given materials perfectly absorb a sound, and also isolate a cabin of the truck from noise which arises in a motor compartment. First, vibro-dampers are fixed, and then sound absorbers are installed [3, 4, 5].

Noise insulation materials are applied at processing of wheel arches, a cabin floor, and its partition with a motor compartment. Nonflammable materials for sound insulation are used under the hood of the truck, having a special heat-reflecting layer, minimizing risk of ignition. Noise insulators are materials having closed cell structure, allowing absorbing noise in a wide range of sound frequencies. The most widespread noise insulation material is bitoplast, being also a good thermal insulator. Some materials possess ability to push away a sound - isolon or splan [6].

Visomat, vibroplast, bimast, etc. are referred to vibro-damper group.

Noise insulation quality of the truck depends on quality of applied materials. All materials which are applied in a truck noise insulation, should meet certain requirements: at a noise insulation of under hood space materials are required which have increased resistance to hostile environment (lubricating oil, fuel, other chemical substances applied in the truck); adhesive ability of a material (influences on reliability of gluing of a composite to a surface of a part); dampers and noise insulators should possess low water absorption; small relative density of vibro-dampering materials; safety of applied materials - should not emit harmful evaporations and bring harm to health of the person; low inflammability of the materials applied to a noise insulation of engine compartments and a subsystem of an electric power supply; high degree of damping is a factor of losses within 0.001÷0.01 [7].

KAMAZ truck was used as a considered motor vehicle in which the following kinds of noise insulation screen are used: the screen of the top part of the engine; the screen of the bottom part of the engine; the screen of a gearbox.

The following noise insulation composite materials are applied: fiberglass plastic, basaltic fireproof roll material (BFRM), AA SMT, AL-aralamino, isomat [8; 9; 10; 11].

The basic characteristics of considered materials are presented in table 1.

Table 1. Materials applied for manufacturing of KAMAZ truck screens

| Indicator         | Thickness, mm | Density, kg/m³ |
|-------------------|---------------|----------------|
| fiberglass plastic | 3.0           | 1750           |
| MBFR-C-5          | 5.0 (3 layers are used) | 125-200 |
| MBFR-5F           |               |                |
| AL-aralamino      | 15.0          |                |
| FN 043-72-84      | 25.0          |                |
| isomat PN 027-72-88 | 12.5        |                |
| AA 2.5 SMT TC 2292-001-4250002-00 | 25.0 |                |
| AA 2.5 SMT TC 2292-001-4250002-00 | 25.0 |                |
| Heat conductivity $\text{Watt}/(\text{m} \cdot \text{K})$ at 25±5 °C, 125±5 °C, 300±5 °C | Coefficient, $\text{Watt} \cdot \text{m}^{-1} \text{K}^{-1}$ | Heat conductivity at 20 °C, $\text{Watt/m} \cdot ^\circ \text{C}$ | Specific heat conductivity $0,036$ | Has low factor of heat conductivity |
|---|---|---|---|---|
| 0,300-0,500 | 0,045 | 0,038 | 0,041 | |
| 0,065 | 0,090 | |

| Combustibility | Ignition temperature, °C | Self-ignition temperature, °C | Almost nonflammable according to GOST 12.1.044-89 | Nonflammable | It is possible to use without protection up to 100 °C, which corresponds to A-degree of combustibility - nonflammable | 290-300 | 390-400 | according to GOST 25076 (self-extinctive) | according to GOST 25076 (self-extinctive) |
|---|---|---|---|---|---|---|---|---|---|
| Combustibility | Combustibility | Ignition temperature, °C | Self-ignition temperature, °C | Almost nonflammable according to GOST 12.1.044-89 | Nonflammable | It is possible to use without protection up to 100 °C, which corresponds to A-degree of combustibility - nonflammable | 290-300 | 390-400 | according to GOST 25076 (self-extinctive) | according to GOST 25076 (self-extinctive) |

| Sound absorption factors at frequency, 800 1000 Hz | Resistance to water, crude oil, oils, cleaners | Resistance to influence of chemically hostile environments, salt solutions | Chemical resistance to oils, acids, alkalis | Resistant | Having high chemical resistance | |
|---|---|---|---|---|---|---|
| 0,013 | 0,014 | 0,3-0,97 | 0,5-0,90 | 0,72 | 0,65 | 0,41 |
| 0,013 | 0,014 | 0,3-0,97 | 0,5-0,90 | 0,72 | 0,65 | 0,41 |
| 0,72 | 0,64 | |
| 0,65 | 0,75 | 0,55 |
| 0,56 | 0,74 | |

Extension of table 1
According to the data presented in table 1, it comes that applied materials do not correspond fully to a complex of the established standards and requirements, demanded to noise insulation materials applied on KAMAZ trucks (an interval of working temperatures from -70 °C to +1000 °C; heat conductivity factor - 0.37-0.41; sound absorption factor - 0.65-1.01) [12]. In this connection there is a severe need in working out of new composite materials which can be used as noise absorption materials for KAMAZ truck screens.

3. References

[1] Ilyashuk Y M 1958 Stiffening effect of walling on the noise-isolation /Sb. Noise control and noise effects on the body. MY 2 Lyoto, L P 57 -76
[2] Building Regulations . Protection against noise : SNIP II- 12 -77 : Utv.Gos.kom . USSR Council of Ministers 6/14/77 : Term introduced. effect 01.07.78/Gosstroy Rossi. - Izd.ofits. -M . SUE LAC , 1998
[3] Klyachko L N 1965 Questions of industrial noise reduction methods soundproofing. Author. dis. Candidate . tehn. Sciences: Chelyabinsk . Uralnistropro draft p 24
[4] Galyautdinov R T, Kashapov N F and Luchkin G S 2002 Avtomobil'naya Promyshlennost 3 21-23
[5] Galyautdinov R T, Kasparov N F, Luchkin G S 2003 Inzhenerno-Fizicheskii Zhurnal 75 (5) 170-173
[6] Noise Protection: snip 23 -03- 2003. - St. Petersburg: DEAN, 2004 457 p
[7] Kravchun bp 2002 Generation and methods to reduce noise and sound vibrations Moscow: Moscow State University, 182 p
[8] http://uralbask.ru/content/view/26/48
[9] http://kompozit-sib.ru/stsplast.html
[10] http://technicalconsulting.ru/Product.aspx?Action=Detail&GoodsID=21
[11] http://www.izolex-ba.sk/al-aralamino.php
[12] Contractual job number 10 from November 20, 2012 FBGEE HPE INECA with "NPO " ROSTAR " " Development of new noise insulation screens of "KAMAZ".

| Note                  | Metalwork finishing in a place at installation of screens is accompanied by emission of a glass dust | There are no glutinous and reflecting layers, necessity of a thickness set sewing together of several layers of a material | Cutout and assembly is accompanied by emission of a glass dust | Has low t ignition and self-ignition | Has low t ignition and self-ignition | Has low t ignition and self-ignition |