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INVESTIGATION OF VIBRATION IN DIESEL-FUELED MOTOBLOCKS IN THE CASE OF SUPPLYING DIFFERENT TYPES OF FUEL MIXTURE

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Engine, Vibration, Biodiesel, High-risk Factor, Working Conditions.

ABSTRACT

At present, where most of the soils of Georgia have a small contour, the demand for small-capacity technical means, in particular motoblocks, has increased. Motoblocks perform agricultural work for various purposes, where the work process is performed by the operator, who experiences various magnitudes of vibration, impact, noise, and in general, as a result of long-term work production, causes body damage, dynamic load, and respiratory diseases in people. In the scientific paper, the dependence on the vibration of different types of diesel fuel is investigated in the case of five different revolutions in the internal combustion engine. Studies have shown that fuel and engine speed are the only risk factors that contradict the ISO 5349-2(2004) international standard. The experience of four years of work studies showed that 10% of operators received various types of injuries as a result of working with motoblocks. Experiments also showed that the amount of vibration decreases when the number of revolutions of the engine increases, and in the case of using biodiesel fuel, the damage risk factor is 5-10%, and in the case of using conventional diesel, this indicator has gone up to 20%.

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1. Introduction.

In motoblocks, vibration occurs from the start of the internal combustion engine to the completion of agricultural work, and all this causes noise, and petroleum products emit gases as a result of combustion, which cause over time the destruction of the ozone layer, pollution of the environment and various types of diseases in large industrial cities. To avoid this, in world practice, such fuels are being researched that will be alternative and reduce the risk factors of pollution, and one of them can be considered diesel fuel made from green vegetable and animal fats, the risk of atmospheric pollution as a result of combustion is very low. Such fuels are obtained as a result of the processing of sunflower oil, vegetable and animal fats. The main part of agricultural production works, both in tractors and in motoblocks, is performed by diesel-type internal combustion engines, on the correct operation of which the reduction of risk factors of human injury and pollution of the environment depends [1, 3]. Based on many studies, it has been established that noise and vibration are mainly caused by the use of conventional diesel fuel [2, 6], and the purpose of our current research is the impact of the fuel used as a result of mixing diesel fuel and biodiesel in relation to vibration in motoblocks.

2. Materials and Methods.

The vibration generated during engine operation is calculated by the mean square acceleration method using the following formula.

$$a_{rms} = \left[\frac{1}{T}\int_0^T a(t)^2 dt\right]^{\frac{1}{2}} \quad (1)$$

Where a_{rms}- root mean square (m/sec^2)
t- acceleration area,
T- acceleration period (m/sec^2)

Vibration can be evaluated according to the international standard ISO 5349-2 (2001) in the three-dimensional XYZ system and is defined according to the low or high frequency manifestation. [4,6], And the mean square value of the acceleration can be calculated as follows:

$$a_{hw} = \sqrt{\sum_{i=1}^{n}(k_i a_{hi})^2} \quad (2)$$

Where k_i - is the standard factor
a_{hi}- Addition of standard factor frequency
n-Frequency.

We selected the following technical parameters for testing and research:

Table 1. Motoblock engine basic data.

Engine	Internal combustion engine
Number of cylinders	One
Beat cycle	Four strokes
Cooling system	Air
Engine speed	1200-3200 rot/min

According to the international standard ISO 5349-2(2001), the vibration assessment in the XYZ system can be written as:

$$a_{hv} = \sqrt{a_{hwX}^2 + a_{hwY}^2 + a_{hwZ}^2} \quad (3)$$

Where a_{hv}- is the total root mean square acceleration (m/sec^2)
a_{hwX}- Vibration acceleration with respect to the X axis (m/sec^2)
a_{hwY} - Acceleration of vibration with respect to the YY axis (m/sec^2)
a_{hwZ} - Acceleration of vibration with respect to the Z axis (m/sec^2)

In accordance with ISO 5349-2 [7], 8 hours of operator working time is taken as the working norm for receiving vibration and is calculated by the equation:

$$A(8) = a_{hv}\sqrt{\frac{T}{T_0}} \quad (4)$$

სადაც $A(8)$ –Daily vibration magnitude.
a_{hv} –total root mean square acceleration (m/sec^2).
T – The period of total acceptance of vibration.
T_0 –8-hour vibration receiving period.
Daily vibration can be calculated by the formula:

$$D_y = 31{,}8\big(A(8)\big)^{-1.06}$$

3. Result and discussion.

The research was carried out in the case of different conditions of the operator holding the handle of the motoblock (Fig. 1).

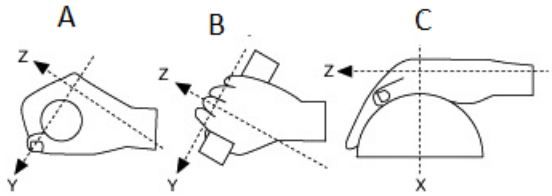

Fig. 1. Hand positions in positions A, B, and C.

For research, we used the following devices to measure vibration: notebook HP ProBook4540s; Tachometer, current controller and acoustic meter (Fig. 2).

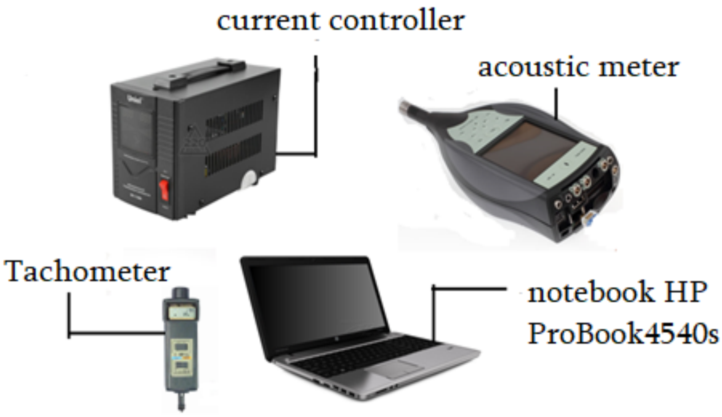

Fig. 2. Tools needed for vibration testing.

Six types of diesel and biodiesel fuel mixtures were used in the research. D; B5; B10; B15; B20 and B100 - engine 1400; 1600; 1800; In the case of 2000 and 2200 rpm. We measured the vibration in three phases, and software was used in the notebook. We chose the signal separately for different cases and for its mathematical programming we used Matlab 7 computer program and showed the received acceleration value schematically (Fig. 3).

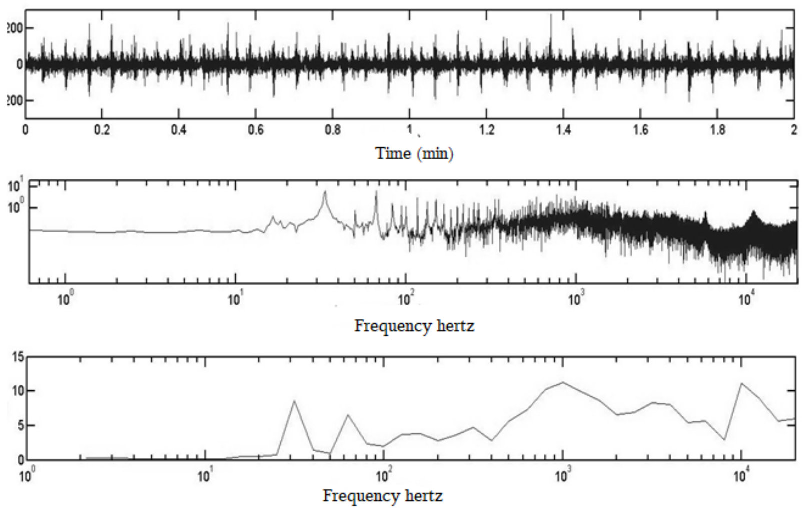

Fig. 3. Oscillogram of acceleration magnitude.

We presented the vibration value of the engine in the case of different rotations in the form of a table [8];

Table 2. Vibration values at different engine speeds.

Engine speed	Type of fuel					
	D	B15	B10	B15	B20	B100
1400	3,10	3,16	3,82	3,78	3,54	3,53
1800	1,28	1,22	1,19	2,02	1,75	1,77
2200	2,27	2,45	2,97	3.07	2,90	2,85

The dependence of the fuel consumption on the fuel mixture can be represented graphically in the following form (Fig. 3).

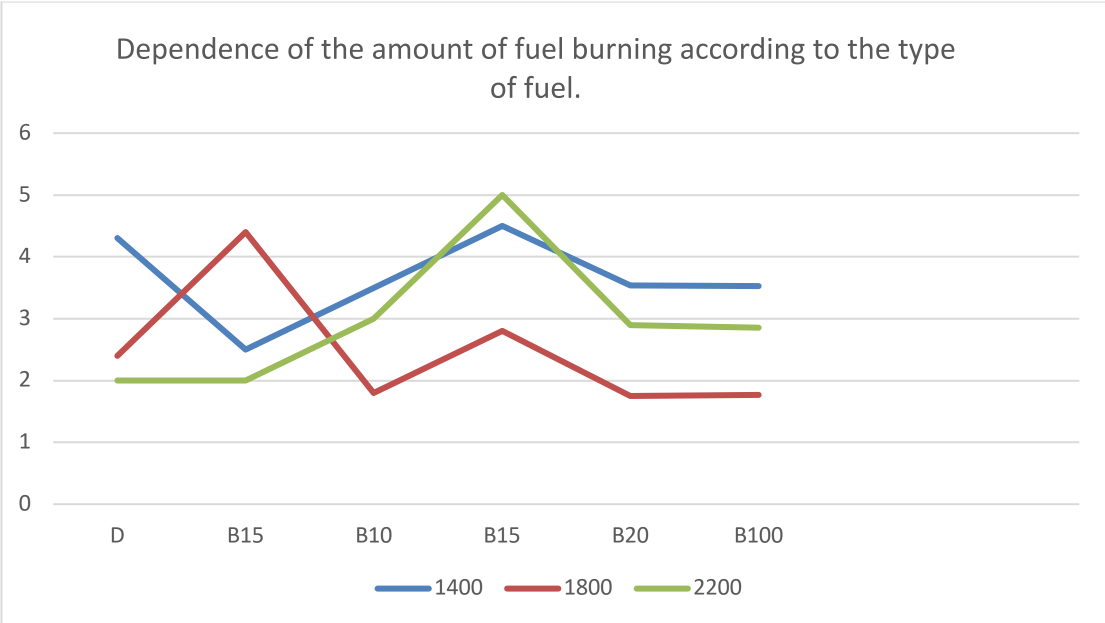

Fig. 4. Dependence of the amount of fuel burning according to the type of fuel.

We have presented the vibration in the case of different fuels according to the Dun Kahn method in the form of the following table;

Table 2. Presented the vibration in the case of different fuels according to the Dun Kahn method.

Type of fuel	The mean square acceleration value	The magnitude of Dun Kahn's analysis significance assessment
B10	3,078	A
B15	3,031	B
B20	2,93	C
B100	2,92	D
D	2,92	E
B5	2,57	F

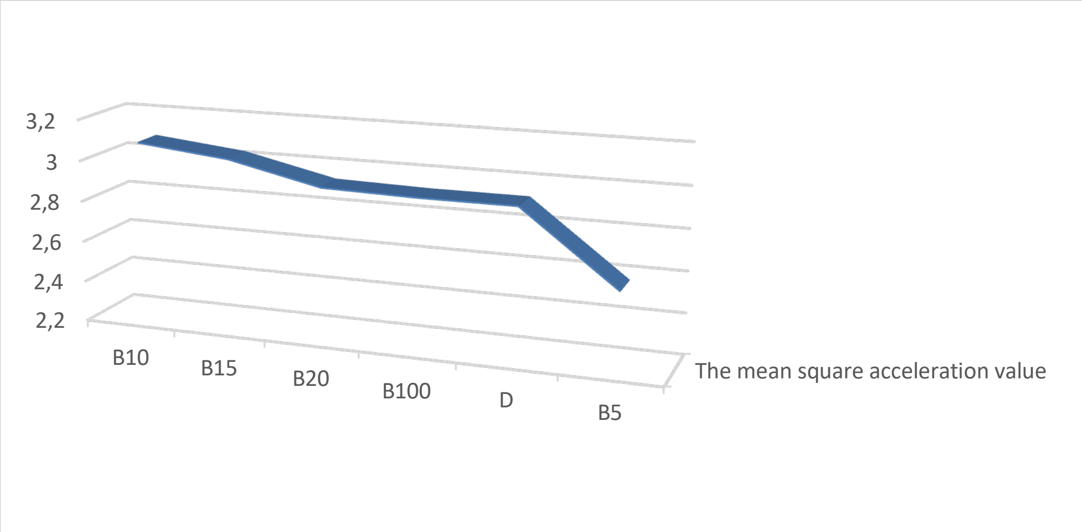

Fig. 5. Dependence of mean square acceleration according to fuels.

4. Summary:

The following conclusions can be drawn from the research:

- During four years of using conventional diesel, it is possible for the working conditions of the operator to deteriorate and the conditions of the ISO 5349-2 standard to be violated, and according to statistics, this may cause 10% of operator injuries.

- Experimental research showed that increasing the speed of the engine near the operator's body has a certain effect on vibration compliance, in particular, the greatest vibration and noise was detected at a speed of 1800-2200 rpm.

- In the case of 1800 rpm, the operator received the most vibration impact, therefore, in such a case, the production of work is not allowed.

- The risk of vibration in biodiesel is 10%, and in conventional diesel fuels it is 15-20%, and it can be said that in the case of small mechanized work, diesel fuel should be replaced with biodiesel.

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