Abstract.*In Article rassmotrenы technology and tehnycheskye sredstva for Disclosure kornevoy system matochnыh plants klonovыh podvoev. Established something ratsyonalnым javljaetsja Option Using Device kombynyrovannoho with passyvnыmy razokuchyvatelyamy and aktyvnыmy tsylyndrycheskymy schetkamy with vertykalnыmy axes of rotation and bending of the working elements. Proanalyzyrovan Rabochy process one rod pile schetky and opredelenы sylы, kotoryya deystvuyut on him. Found terms, in Kotor smetayuschyy element schetky soil particles will be DELETE FROM substrate Or roll. C. Using Elliptic yntehralov Legendre opredeleno reaction rod on grounds of soil pile. On the grounds of the power analysis ravnodeystvuyuschey Resistance forces and soil reactions pochvennoy Fundamentals, naydenы graphic dependence ravnodeystvuyuschey from konstruktyvnыh and kinematically schetky parameters.*

Keywords: schetka, rod pile prohyb, deformation, kornevaya head, matochnoe plants, roll, soils, base reaction, Resistance

Annotation.*The paper considers technologies and technical means for the disclosure of the root system of the mother plant clonal rootstocks. Found that the rational option is the use of the combined device with passive disks and active cylindrical brushes with vertical axes of rotation and flexible working elements. Analyzed the workflow of one rod lint brush and determined forces that are not. Found the condition under which the element sweeping brush will remove the particles of soil or substrate from the roll. Using elliptic integrals, Legendre determined the reaction of the subgrade on the rod of the pile. On the basis of the power analysis of the resultant resistance force of soil reaction and soil bases, found graphic dependences of the resultant of the constructive and kinematic parameters of the brush.*

Key words: brush, rod pile, deflection, deformation, root head, mother plants, swath, soil, foundation, reaction resistance

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USING SPECTRAL ANALYSIS OF VIBRATION SIGNALS OF DIESEL ENGINES TO DETECT THE APPEARANCE OF DEFECTS

L. Titova, MA
O.V. Nadtochiy, Ph.D.

Abstract.*The use of spectral analysis of signal diesel engine SMD-31A, as part of the adaptive model of cultivation of vibration for the purpose of setting a clear diagnosis. Present theoretical diagram impacts of gas-distributing mechanism, fuel system, CHU of individual cylinders of the engine SMD-31A and its implementation phase For modeling used mathematical package MathCad MatLab.*

Keywords: vibrator, spectrum, spectral analysis, Fourier transform, amplitude fluctuations

Formulation of the problem. Vibroacoustic method for condition monitoring mechanisms for tractors and motor vehicles and their propulsion based on the analysis of elastic waves propagating through the shell and detail the interaction of the latter. In this regard, one of the main tasks of this method is to distribute the signals that detection of signal (EAC) caused spivudaramy details investigated the kinematic pair.

Analysis of recent research. Currently used a wide range of methods and means of diagnosing the technical condition of major components and mechanisms including tractors and internal combustion engines. Created entirely new system of maintenance, repair and diagnostics of technical units of machines. One of the machines in operation at the moment remains the task of improving the reliability of ICE, through a comprehensive assessment of the units based on the temporary collection of diagnostic parameters [1, 5].

The ability to detect faults in the early stages of their appearance with relatively low labor and material expenses determine the prospects for diagnosing DIC is vibration signals. Ensuring predictable reliability of conclusions regarding the state mechanisms and systems, this may be achieved using a statistical assessment of conformity temporal frequency of signal fragments and their compliance

speed of the crankshaft. Using modern compact measuring module with low energy consumption provides the ability to design and manufacture diagnosing devices in the mobile version, for installation directly on the vehicle during testing. So research aimed at developing methods of diagnosing mechanisms and systems, based on an assessment of signal generated in the case of ICE in the process as a method of control is very important for agriculture.

Results. Moving machine parts in locations with each other generate vibrations and sounds. The surface beloved parts can not be completely flat and smooth. Surface roughness is one of the causes of vibration in a narrow local contact of two rubbing surfaces mutually move. It can be dry or rolling friction and hydrodynamic friction when friction surfaces separated by a layer of oil or other lubricating fluids.

Vibration Corps ICE are complex in nature (Fig. 1) caused a lot of excitement and multi-pulse oscillation proliferation and uncontrolled presence of "noise". Therefore, vibroacoustic diagnosis ICE challenge is the separation of signals and signal selection of a compound that is diagnosed [4].

One of the main problems is the distribution method vibroacoustic signals, ie detection of signal (EAC) caused spivudaramy details investigated the kinematic pair.

The difficulty of this task is to increase the number of cylinders that leads to vibroimpulsiv Increase of density per unit phase space (ICE cycle of the angle of rotation of the crankshaft). Thus, the SMD-31A engine, the phase space only on the mechanism hazorozpodilchoho filled vibroimpulsamy so (Fig. 2), which uniquely identify the technical state of the i-th of the connection mechanism for one parameter possible. For the Increase of reliability of diahnostuvannya shall require the evaluation of several diahnostychnyh parameters.

The nature of the mechanisms of signal ICE has a complex structure, which depends on the dynamics of the mechanism and its component units set.

Analysis of the literature [5] allowed to determine the parameters of the vibration sensor installation (location and method of fixing). Chosen the following methods of attachment - the heels, and with a special clamping fixture. There have been attempts to fix the sensor using epoxy, but because of the long duration of installation, this method was adopted for not promising.

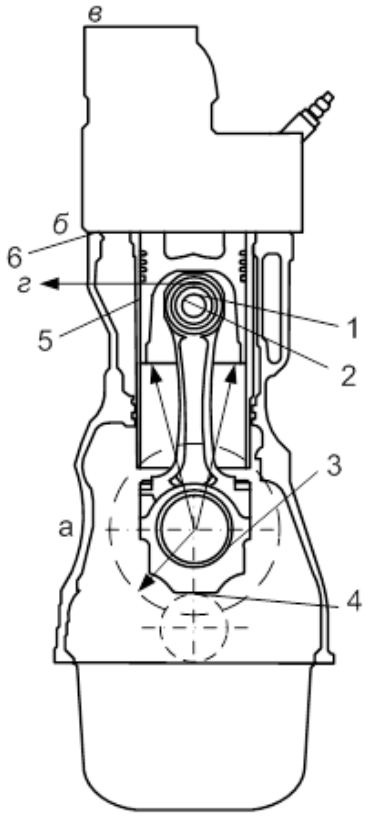

Fig. 1. The promotion of the collision parts in conjunction toe-end of the piston stroke of: 1 - the source of shock fluctuations; 2 - the first stage of propagation of oscillations (coupling finger - the upper connecting rod); 3 - the second stage of propagation of oscillations (combination of lower connecting rod - crankshaft connecting rod neck); 4 - the third stage of propagation of oscillations (combination of radical neck crankshaft - block); 5 - First stage of propagation of oscillations in the other direction (coupling piston - cylinder); 6 - resistance to the spread of vibrations (laying); a, b, c and d - efficient removal zone information.

Vibration signal emitted investigational combination of perceived vibration sensor (B & K Type 4333 №272437, D-14, IS-317). Before installing sensors kalibruvalys in accordance with GOST 25175-82.

To assess the state assemblies and mechanisms of internal combustion engines using vibrator sensor prytyskuvavsya to different areas of the motor unit (Fig. 3), choose the desired mode of operation of the engine and the recorded signals to a computer for further analysis and cultivation. Along with the removal of vibration parameters in the frequency range determined by the position of the piston relative to the first cylinder vmt, using inductive speed sensor.

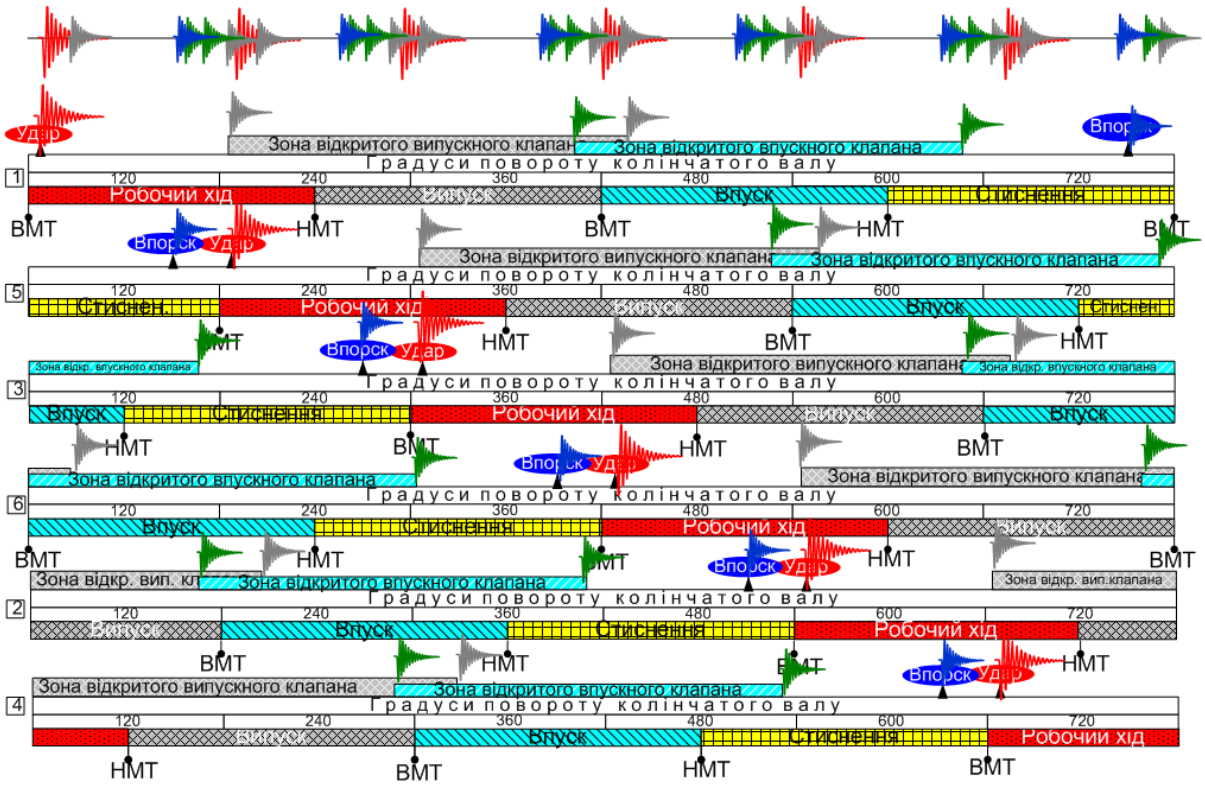

Fig. 2.Theoretical diagram impacts of gas-distributing mechanism, fuel system, CHU of individual cylinders of the engine SMD-31A and their implementation phase.

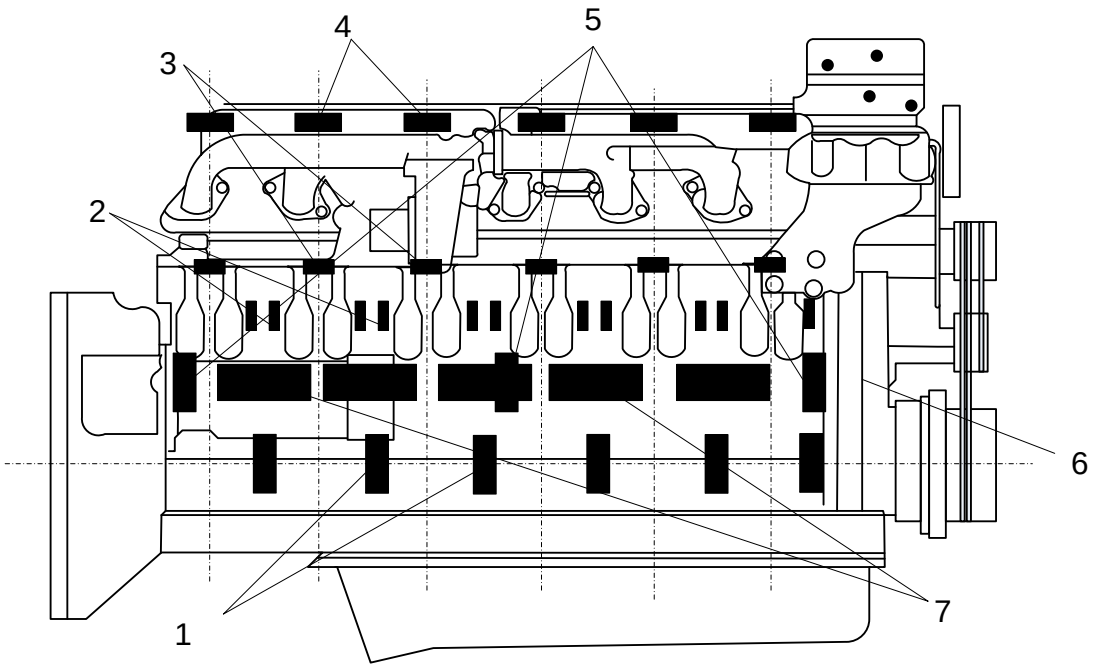

Fig. 3. listening signals in compounds of engine: 1 - crankshaft - main bearings; 2 - connecting rod - bush; 3 - valve - piston; 4 - peen rocker - shaft valve; 5 - camshaft - bearing; 6 - Distribution gear; 7 - cam camshaft - pusher.

Consider for example the nature of vibrations in the engine. Running the engine is characterized by the fact that workflows are different sections to their times, so the selection oscillatory process associated with the work of separate sections, or some one section, use the time selection. The nature of the excitation of vibrational processes ICE original. A characteristic feature of his character is pulsed excitation caused by high velocity pressure rise in the combustion chamber, relaying pistons process fuel injection and exhaust.

If you change the parameters of internal combustion engines, such as fuel injection time, violations in the gas-distributing mechanism of wear of piston rings, increase the clearance between the piston and sleeve associated with the work of these mechanisms pulses shifted in phase changes amplitude and duration, new impulses . This simultaneously operates a number of factors that cause complications of signal. For engines with more than 4 Cylinder coincidence in time (overlay) signals and unbalanced parts during the rotation leads to a range of signal frequencies are multiples of the frequency of rotation (Table. 1).

1. Definition of basic frequency exciting force in internal combustion engines.

The cause vibrations	Formula	Marking
1. Imbalance parts are rotating inertia forces and their first since the date	$f_{Д1} = \frac{kn_Д}{60}$	*k* = 1.2 - number of harmonics; $n_Д$ - Rotational speed of the crankshaft min-1.
2. The process of burning fuel	$f_{Д2} = \frac{c}{2D}$	*with* - Speed of sound combustion; D - diameter cylinder
3. Imbalance: - Parts that rotate the second order	$f_{Д3} = \frac{2kn_Д}{60}$	
- Parts distribution shaft	$f_{Д4} = \frac{kn_Д}{2 \cdot 60}$	
4. shifting piston CHU	$f_{Д5} = \frac{bzkn_Д}{60}$	*b* - Number perekladok pattern for normal forces; z - number of engine cylinders
5. Friction in the main bearing shaft	$f_{Д6} = \frac{z_T kn_Д}{60}$	z_T - The number of pairs of friction
6. Attempts valves	$f_{Д5} = \frac{z \cdot z_K kn_Д}{60m}$	z_K - The number one cylinder valves; m - taktnist

The example shows the complexity of oscillatory processes that occur in the engine. Therefore, the selection signal at diagnosing certain

node is associated with certain difficulties that larger while reducing the number of measuring channels. On the one hand there is a way out if - providing each with its own vibration sensor connections, which would dilute the signals over time due to significant attenuation with increasing distance from the source of vibrations. However, this approach results in considerable costs. A better approach is to use one or two sensors (up to 4) and ensure reliable algorithm cultivation signal to uniquely identify the source of vibrations. In this respect promising and effective method of technical diagnostics engine is considered to be the time implementation (Fig. 4) and frequency analysis.

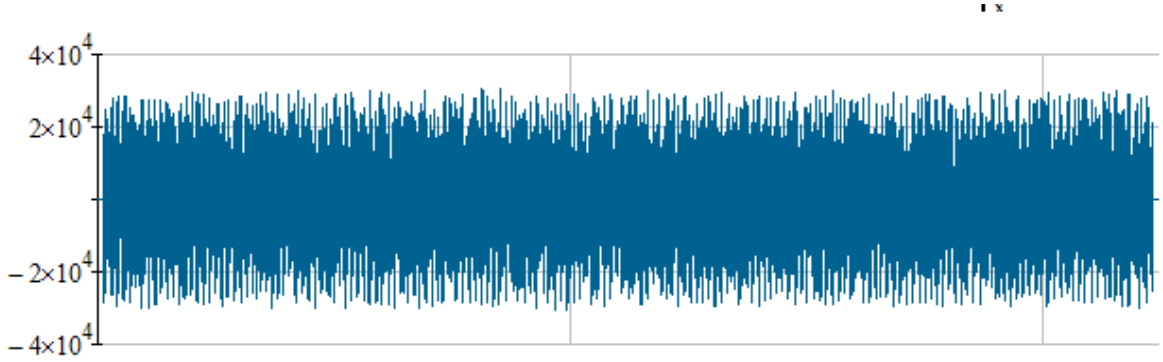

Fig. 4. Vibration acceleration engine SMD-31A. (Sensor in zone 2 in Fig. 3).

Indeed, the spectrum of the signal received from any point of the engine, contains information on all sources of vibration. However, the previously discussed characteristics of the engine signals complicates the analysis and interpretation of signals. Search for solutions in this area is associated with improved signal / noise ratio and improved algorithm interpretation of the signals based on their cultivation.

For spectrum of signal commonly used FFT. The Fourier transform is a change in function, which turns it into a set of frequency components. The basis of Fourier transform (PF) is a simple but extremely useful idea - beloved almost periodic function can be represented as the sum of individual harmonic components (sinusoids and kosynusoyid with different amplitudes A, period T and corresponding frequency ω). Mathematical content Fourier transform is the representation signal y (x) as an infinite sum of sinusoids type F (ω)·sin (ωx). Functions F (ω) called direct conversion (integral) Fourier.

$F := \mathrm{cfft}\left(M^{\langle 0 \rangle}\right)$

Мінімальна частота і крок по частоті $d\Omega := \frac{1}{xmax}$ $d\Omega = 6.104 \times 10^{-5}$

Кількість ординат по частотах $m := 1 + 2^{k-1}$ $m = 8.193 \times 10^{3}$

Поточна частота $\Omega_j := (j + 1) \cdot \frac{1}{xmax}$ Максимальна частота $\Omega max := m \cdot d\Omega$ $\Omega max = 0.5$

$\Omega_0 = 6.104 \times 10^{-5}$ $F_0 = -1.015 \times 10^{4}$ $\Omega_m = 0.5$ $F_{1024} = -5.363 \times 10^{3} + 1.025i \times 10^{4}$

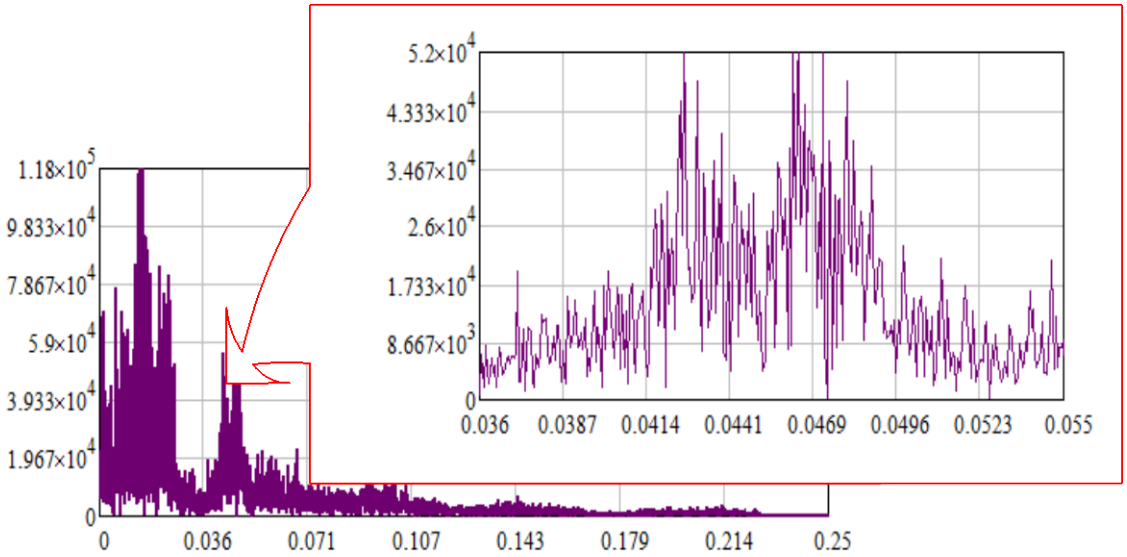

Fig. 5. Listing of signal reception range.

The inverse operation transforms the range F (ω) The output signal y (x). Listing MathCad (Fig. 5) is shown receiving vidbrosyhnalu spectrum (Fig. 4) using a Fourier transform.

The basic expressions for the Fourier transform of the input sequence {gn} n = 0, ..., N-1 are:

(Direct)

$$G(k) = \frac{1}{N} \cdot \sum_{n=0}^{N-1} g(n) \cdot e^{-j \cdot \frac{2\pi kn}{N}}, \quad (1)$$

(Inverse)

$$g(k) = \sum_{n=0}^{N-1} G(k) \cdot e^{-j \cdot \frac{2\pi kn}{N}}. \quad (2)$$

The procedure for calculating the discrete Fourier transform algorithm is fast Fourier transform (FFT).

Frame spectral analysis is the evaluation of the following characteristics:

– amplitude spectrum, power spectrum, power spectral density, integrated spectrum;

– coherence function, coherent output power ratio "signal interference".

Discrete Fourier transform (DFT) for the sampling process {Xk, k = 0, ..., N-1} is given by:

$$F(n, N) = \frac{1}{N} \cdot \sum_{k=0}^{N-1} X_k \cdot e^{j \cdot \frac{2\pi nk}{N}}, \quad (3)$$

Spectrum power density is defined as the average for N implementations and has the dimension (ED / Hz).

$$G_{спм}(n, T) = \frac{1}{\Delta f} \cdot G_{см}, \quad (4)$$

where: Δf -frequency of surveys (sampling).

The amplitude range is determined by the power spectrum and has the dimension (ED). This uses the relationship:

$$G_A(n,T) = \sqrt{G_{см}(n,T)}. \quad (5)$$

To further develop adaptive models cultivation and vibration analysis was used mathematical package MathCad 15 and MathLab R2007b.

This program contains a package of cultivation signals. For fast Fourier transform system implemented Mathcad several embedded features that differ regulation, namely fft (y) and FFT (y).

The calculation results are displayed in a module of the Fourier spectrum, because the spectrum is complex. An important parameter is the cutoff frequency $\Omega_0 = \frac{1}{xMAX}$ (Defines the lower limit of the spectrum) and the Nyquist frequency $\Omega_N = \frac{N}{2 \cdot xMAX}$ (Defines the upper limit of the range).

This sampling interval Fourier spectrum as equal Ω_0 And the total number of points of calculation is N / 2.

To calculate the inverse Fourier transform (recovery signal on actual spectrum) Use ifft (y) and IFFT (y).

In Listing (Fig. 6) using a packet MathLab calculated normalized range vidbrosyhnalu and found the maximum signal frequency.

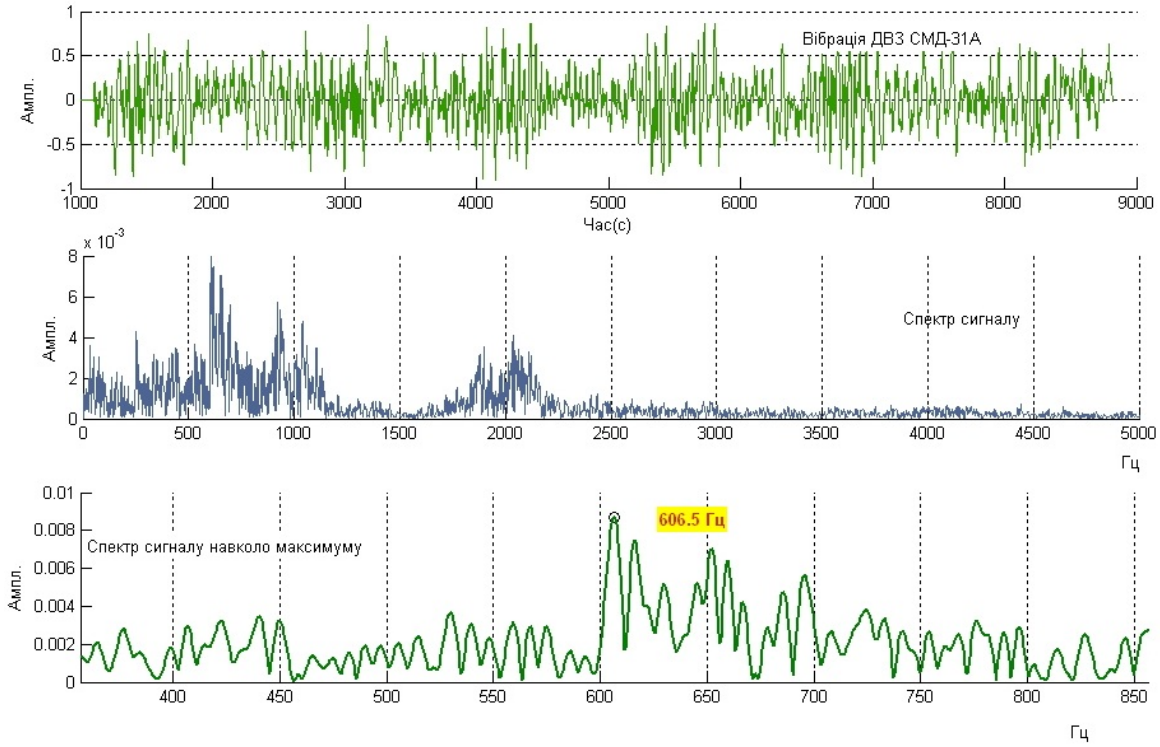

Fig. 8. vidbrosyhnalu calculated normalized spectrum and its maximum.

From the standpoint of signal analysis in the frequency domain and the subsequent recovery after a precise conversion can note a number of shortcomings expansion in Fourier series, which led to general and window Fourier transform and stimulated the development of wavelet transform, which go beyond the scope of this article and will considered in the future. These deficiencies include:

– Limited informative analysis of unsteady syhnalivi virtually no possibility of analyzing their characteristics (singularities), as in the frequency domain is "smearing" features signals throughout the frequency range.

– Harmonic basis functions may not reflect variations in signals with infinite slope type rectangular pulses need for infinitely large number of members of the series.

– Fourier transform displays global information about the frequency of vibration and does not give a complete picture of the local properties of the signal in a rapidly changing their spectral composition. The Fourier transform is unable to analyze the frequency response of the signal at arbitrary points in time.

Conclusion. Simulations cultivation diesel engine vibration signals using spectral analysis showed that the use of FFT and get the whole range of possible signal for use in conditions as close to the source of the sensor oscillation. Use of the method of direct and inverse Fourier

transform to be used to enhance the signal / noise ratio for further development of adaptive model of cultivation of vibration for the purpose of setting a clear diagnosis.

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Abstract.*Using spectral analysis Rassmotreno signal vybroakustycheskoho diesel engine SMD-31A, How adaptyvnoy element model obrabotku vybrosyhnala with a view of setting a clear diagnosis. Present Theoretical Chart udarov from hazoraspredelytelnoho mechanism, toplyvnoy apparatury, CHU on otdelnыm cylinder engine SMD-31A and s fazovaya Implementation for modeling yspolzovalys matematycheskye paketы MathCad, MatLab.*

Keywords: vybrosyhnal spectrum, Spectral analysis, Fourier transformation, amplitudes, fluctuations

Annotation.*The paper considers the use of spectral analysis of vibro-acoustic signal for diesel engine SMD-31A, as an element of the adaptive processing model of the vibration signal for the purpose of setting unambiguous diagnosis. Theoretical chart of strikes from timing, fuel injection equipment, CPG for individual engine cylinders SMD -31A and implementation phase was used For simulation the mathematical package MathCad, MatLab.*

Key words: vibrating signal spectrum, spectral analysis, Fourier transformation, amplitudes, fluctuations
UDC 631.53.01

STUDY OF FORCE PRYSMOKTUYUCHOYI THE EFFECTIVENESS OF CERTAIN delighted seed