

Abstract

Topicality of research

Appearance of new materials, which main purpose is increment of strength and reliability of products without high material costs causes necessity of improvement of existing and development of new non-destructive testing (NDT) methods. Method TOFD is one of such methods. Signals, received in result of diffractions has low amplitude, and it requires using of special methods of signal detection and processing.

New materials, as example – composite, has specific characteristics, one of this characteristics is high attenuation of sound. Development of efficient methods of control for these materials also requires using of improved methods of detecting and processing of signals with low signal-to-noise ratio (SNR).

Purpose and tasks of research

Purpose of research – boost of probability of ultrasonic NDT methods by using methods of statistic phase measuring for processing of informative signals.

During research were solved following **tasks**:

1. To develop basis of information technology of processing signals of ultrasonic NDT, which include method, algorithm and program software of phase ultrasonic NDT.
2. To justify the use of circle statistics for detection and processing NDT signals with low SNR and absence of a priori signal frequency information.
3. To investigate impact of window function aperture on probability of signal detection.
4. To develop method of ultrasonic NDT signals with low SNR and absence of a priori signal frequency information.
5. To analyze probability of ultrasonic NDT signals detection by results of circle statistics analysis.

Object of research – process of ultrasonic non-destructive testing

Subject of research – method of ultrasonic NDT signals detection with low SNR and absence of a priori signal information.

Methods of research is based on using of theoretic basics of ultrasonic non-destructive testing; digital signal processing methods; modeling of generating, spreading, receiving and processing of ultrasonic NDT signals via MatLab environment.

Scientific novelty of research:

1. For the first time suggested phase ultrasonic NDT method, which is based on statistical analysis of signal phase characteristics and allow boost of probability of signal detection with low SNR and absence of a priori information about signal frequency.
2. Substantiated use of phase difference of signal and noise processing, which provides efficiency with lower SNR values.
3. For the first time suggested to chose defect level in result of analysis of circle dispersion, received from phase characteristics of signals, which allows to boost reliability of detecting of defect signals.

Practical value dissertation results:

1. Completed modeling of process of generating, processing and detecting signals of ultrasonic NDT via statistic phase measuring methods with limited signal information.
2. Suggested method of signal processing allow to boost reliability of ultrasonic NDT, what was confirmed with theoretical and model research.
3. Suggested calculation algorithm for adaptive defect level depending on evaluations of expected value and dispersion of true and false hypothesis with main purpose of maximizing of reliability of right hypothesis choosing.
4. Formed recommendations for signal processing process parameters, such as amplification coefficient and window function aperture, which allow

to maximize ultrasonic NDT signal detection with absence of a priori information about signal frequency.

Approbation of dissertation results

Main ideas and results of research were reported on following conferences: scientific and technical conference “Modern devices, materials and technologies for non-destructive testing and technical diagnostics in machine-building and oil and gas equipment” (Ivano-Frankivsk city, 2017); international scientific and technical conference “Instrument making-2017” (Minsk city, republic of Belarus, 2017);

Scientific and technical conference of students, aspirants and young scientists “Look into future of instrument making” (Kyiv city, 2018); international scientific conference “Measurements, control and diagnostics of technical systems” (Vinnitsia city, 2017).

Publications

On the topic of research were published 7 scientific works, of which: 3 in professional editions of Ukraine, 1 patent of Ukraine and 3 theses in collections of conferences materials.

Key words

Ultrasonic non-destructive testing, phase methods of signal processing, methods of statistic phase measurement, window signal processing.