1.7.16. AUTOMATED INTELLIGENT METHODS FOR ACOUSTIC EMISSION TESTING DATA PROCESSING

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Introduction. Acoustic emission testing is one of the most sensitive nondestructive testing methods. It allows detecting defects at their initiation and preventing development of such defects.

Thanks to high sensitivity acoustic emission method is used extensively for nondestructive testing and technical condition monitoring of complex industrial facilities, buildings and structures.

Acoustic emission testing is a passive NDT method, therefore its main stages are measurement and processing of AE data according to diagnostic model of the testing object. The reliability of detection and the accuracy of determination of AE source location depend on the correct interpretation of AE testing results.

During AE data analysis the following tasks are solved – recording of testing object surface oscillations generated by acoustical emission waves, noise filtering and interference elimination, detection and location of potential acoustic emission sources, evaluation of their hazard level.

Because of AE signals nonstationarity and non-availability of accurate diagnostic models, each of above mentioned tasks represents a serious scientific problem that requires a fundamental mathematical apparatus for solution. Up-to-date acoustic emission testing systems contain complex software, including various analysis utilities for filtering data and signals time-frequency analysis, classification and statistical processing.

As a rule, intelligent software for AE systems is not automatized and is designed only for off-line data analysis. Absence of automation at analysis of the data essentially reduces its importance, as along with extra options for diagnostic information processing, it imposes high requirements for user's qualification.

Besides, interactive software application is nearly not possible for field on-line data analysis, when reliability of testing results is of special importance.

One of our company's areas of activities is carrying out of scientific researches focused on practical application – increase of accuracy and reliability of AE testing results, and complex industrial facilities investigation.

Researches resulted in creation of computer-aided algorithms to provide intellectual support of AE testing procedure and data processing at all stages: from data measuring up to off-line processing.

Basic results. In the course of acoustic emission testing one may distinguish three main stages: preliminary stage, data collection and data analysis.

At preliminary stage calibration measurements are performed to determine acoustic properties of testing object and acoustic emission sensors sensitivity. To increase AE testing productivity preliminary calibration may be performed in automatic mode by means of acoustic emission wave simulators or sensors intrinsic emission instead of routine manual procedure with help of Hsu-Nielsen-Sourse.

Computer-aided calibration measurements allow to define more exactly AE sensors coordinates; estimate location speeds and determine quality of acoustic contacts between sensor and testing object surface.

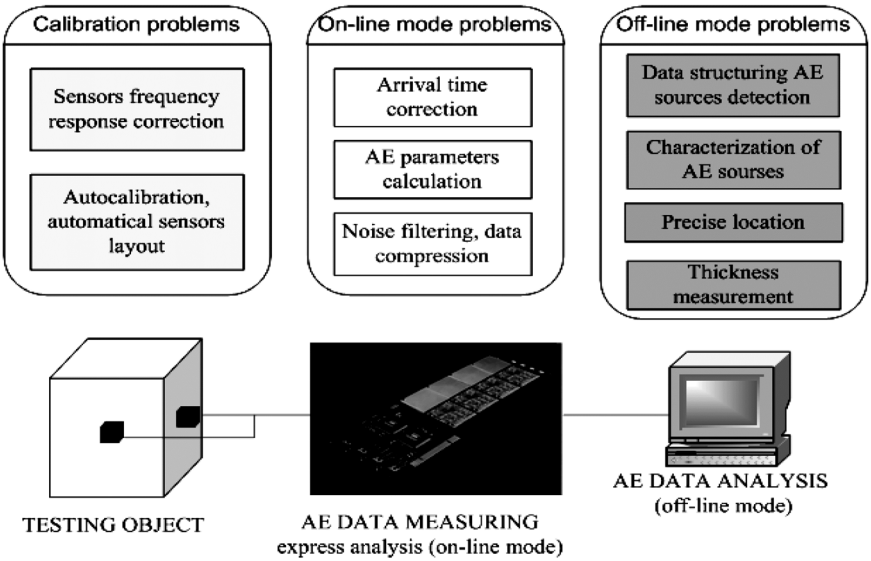

Fig. 1. Flowchart of computer-aided data processing at acoustic emission testing

Along with measurement chain calibration in on-line mode acoustic signal reconstruction is possible. That is provided by inverse filtering. With help of deconvolution it is possible to decrease influence of AE sensor impulse response and reconstruct acoustic signal waveform that increases analysis reliability.

To improve noise immunity of acoustic emission testing at data measuring stage various filtration algorithms are applied. The most effective one is using filtration schemes based on signal wavelet decomposition. Wavelet transformation allows estimating AE parameters with regard of multicomponent model of signals, specifying AE impulse arrival time and performing effective compression of AE signals.

In the course of delayed data analysis intellectual processing capabilities are not limited by high frequencies of data recording. In the post-processing mode automatic AE data structuring is possible. Via clustering analysis AE signals and impulses, relating to the same acoustic emission source, are grouped in clusters. Results of clustering are used in the following to clarify dangers level of potential defects.

During AE testing one of the most reliable defined parameters is coordinates of AE sources; to increase accuracy of results delayed analysis uses precision location schemes, considering dispersive character of acoustic emission waves propagation in thin-wall structures.

In the course of acoustic emission monitoring intellectual data processing allows to fulfill thickness measuring functions – evaluation of testing object wall thinning due to degradation. Measures the average wall thickness based on Lamb wave dispersion and resonances. Thickness determination accuracy in that case does not exceed units of percents.