PORTABLE MULTI-CHANNEL DEVICE FOR ACOUSTIC EMISSION MONITORING OF STRUCTURES AND PRODUCTS

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Summary

In the paper eight channel acoustic emission (AE) device for selection, recording and processing signals of AE intended for use in the sphere of non-destructive testing of materials, products and structures of various forms and functional applications is described. The device is designed using a wide range of SMD elements and is adapted to work with Windows family operating systems. Specially developed software realizes functions of input data processing and its visualization, determination of defect position and storing the obtained results into computer memory.

The above-listed characteristics as well as high rate of data exchange between the device and PC (12 Mbit/s), enables to work in real-time mode, and efficient software allow to compete with developments of such world leading manufacturers as PAC, Vallen Systeme, Interunis etc.

Keywords: acoustic emission, destruction, non-destructive testing, technical diagnostics.

1. TOPICALITY OF PROBLEM

Presently in most production spheres new materials and technologies are launched, experience of using which under conditions of intensive strain and activity of aggressive working environment is insufficient. Therefore the objects using new materials or technologies need to be monitored to provide their reliable maintenance. With this purpose new progressive methods and means of diagnosing firmness and durability of the mentioned items, constructions and buildings are used.

Analysis of reasons for construction materials fail, which are widely used in mechanical and power engineering, pipeline transport, aircraft building, chemical and oil industry etc. showed that in the majority of cases it is the result of initiation and development of crack-like defects [1, 2]. Therefore the research of these processes has become a topical task.

Experience of the last decades proved great potential possibilities of the acoustic emission (AE) method. Its application is especially relevant under conditions when visual control is impossible or access to the object under control is complicated [3]. Distance control, high sensitivity, possibility of remote defect detection, which considerably exceed their sizes, possibility to obtain information regardless of form and sizes of the object under control, recording real time destruction development etc. are the advantages that have put the method of AE in a leading place among the known perspective methods of non-destructive testing (NT) [4].

For its successful implementation new effective portable devices based on modern achievements of electronics have to be developed.

2. STATE OF PROBLEM

If all the developments of AE devices known in literature are generalized, they can be classified into the following groups: for complex researches, specific purpose, for control over the state of large-sized objects and portable one- and multichannel ones.

Facilities for complex researches are intended for the reception of AE signals during defect development, which initiate in materials, wares and constructions. Equipped, as a rule, by devices are able to distinguish the signals from background noises and hindrances, they allow to estimate various parameters of AE signals and determine the state of the object under control.

Facilities for the specific purpose are developed mostly to solve particular NT tasks: to reject as defective wares during their mechanical testing; to record by AE signals the moment of initiation in construction machine-building materials the tensions which correspond to the physical limit of fluidity; to estimate plastic volume of material; to research the phenomenon of corrosion under tension; to record and analyze AE signals during the friction of solids etc.

Facilities of large-sized objects AE control allow determining the location of developing defects. Knowledge of coordinates of AE sources allows estimating distribution of defects within control area and taking into account power parameters of the radiation to estimate the level of damage risk. Such AE systems serve to reveal danger of initiation and accumulation of defects, location of AE sources and as preventive control systems for emergency situations of responsible buildings.

When testing the state of overall objects of complicated configuration, the determination of

coordinates or areas of emission sources location is performed using various methods. The most widespread is the method of calculating coordinates by means of triangulate calculations and area method of locating AE sources. Both are based on registering the difference in arrival times of AE signals perceived by the group of primary transformers.

Purpose of work – to develop and do experimental approbation of the portable eight-channel acoustic emission device.

3. DESCRIPTIONS AND BASIC ADVANTAGES

Eight channel acoustic emission (AE) device for selection, recording and processing signals of AE is intended for use in the sphere of non-destructive testing of materials, products and structures of various forms and functional applications. The device is designed using a wide range of SMD elements and is adapted to work with Windows family operating systems. Specially developed software realizes functions of input data processing and its visualization, defect location and storing the obtained results into computer memory.

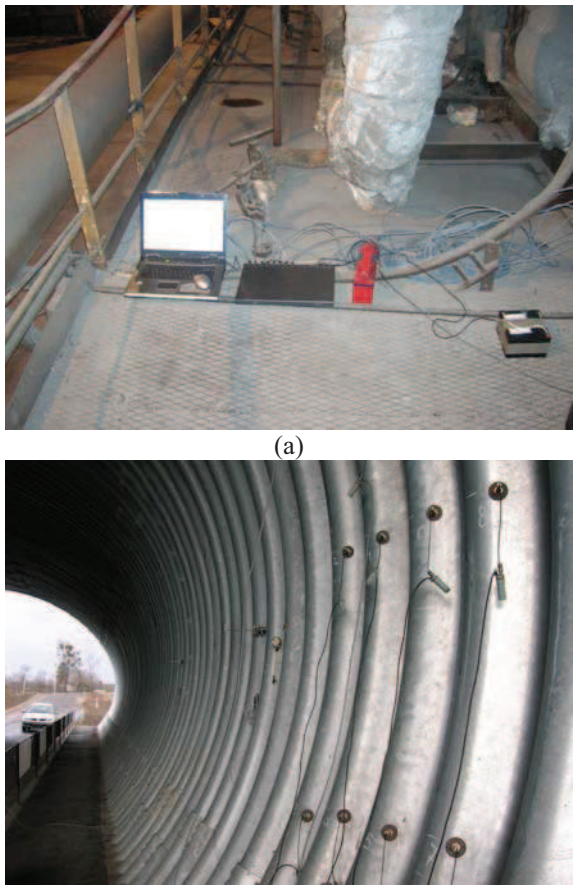
The above-listed characteristics as well as high rate of data exchange between the device and PC (12 Mbit/s), enabling to work in real-time mode, and efficient software allow to compete with developments of such world leading manufacturers as PAC, Vallen Systeme, Interunis etc.

In comparison with developments of world-famous manufacturers the designed device has a number of advantages:

- portability allows the device to be used not only in field conditions of inspected objects diagnosing but also in hard-to-reach, high-altitude and other difficult conditions;
- self-contained power supply enables to use the device under conditions of limited or unavailable network power supply;
- supply current 120 mA;
- sensitivity to tested surface displacement $10^{-14}...10^{-12}$ m;
- USB interface connection provides high rate of data exchange between the device and a PC;
- programmed control capabilities: choice of number of working channels, variability of sampling duration etc.
- inaccuracy in determination of AE source location depending on inspected object testing conditions does not exceed 10 %;
- user-friendly software interface together with convenient help system allow users to quickly acquire skills of working with the device;
- overall dimensions: 370×256×30 mm, weight – 2,1 kg;
- compactness and good constructional solution of the device conduce to easy and convenient transportation;
- the price of the device is significantly lower in comparison with similar AE equipment of this class of other well-known manufacturers.

4. CONDUCTING EXPERIMENTAL RESEARCHES

An approbation of the device when monitoring the state of several bridges, overpasses, tunnel transitions etc. was conducted, that is represented in proper publications and acts of NT applied methods implementation (fig. 1).



(a) (b)

Fig. 1. Application of the developed AE system when diagnosing heat-and-power engineering equipment (a) and bridge transition (b)

5. AREA OF APPLICATION

The device can be used for monitoring and technical diagnostics of long-term operation objects:

- bridges;
- tanks, pressure vessels;
- pipelines;
- elements of bridge, frame and tower cranes;
- port lift-and-carry mechanisms;
- other components and mechanisms,

as well as in laboratories for fundamental and applied researches of structural materials:

- static and cyclic crack growth resistance;
- creeping, plastic deformation;

- nucleation and propagation of cold - and autocracks while welding;
- threshold value of stress intensity factor for hydrogen-induced and stress corrosion cracking of materials;
- composites research etc.

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