1.7.13. ACOUSTIC EMISSION SIGNALS PARAMETERS USE EFFICIENCY CONSIDERATIONS

Ovcharuk V.N., Pacific National University, Far East Regional Center on NDT and environmental monitoring, Khabarovsk, Russia

Material acoustic emission is the process of producing elastic waves, provoked by local dynamic reconstruction of its structure [1]. Acoustic emission method allows detecting and registering of only developing defects, prompting to classify them not by the size but by the danger level. Besides, it is the most sensible method of NDT. All above mentioned gives acoustic emission method undeniable advantage which unfortunately is hard to always realize.

In early 60s, when the opposition of two great powers inspired the studies of acoustic emission phenomenon, there was no special equipment for that. The peculiarities of acoustic emission signals forming and propagation (complex spectrum, low energy level, wide frequency and dynamic range, etc.) raise the demands to measuring equipment [2]. Acoustic emission equipment should have high sensibility, high amplification coefficient, minimal noise level and introduce minimal distortions. Ionizing emission detecting equipment met all these requirements that time. Besides, the majority of new phenomenon researchers were nuclear physicists. It is reasonable that receiving and measuring devices designed to amplify and measure electrical signals at ionizing signals detector output were used to detect weak elastic vibrations of acoustic emission signals by simple replacement of detector by piezoelectric converter. Geiger-Muller-based devices with their scale marked in impulses per time unit were widely used to measure ionizing emissions. These devices were called intensimeters and the value measured using them – intensity. This was very convenient for detecting the particles with foregone energy characteristics. At that it was meant that to get the actual values of ionizing emissions intensity it is necessary to multiply the result by the correction factor depending on the converter type, as well as registered ionizing emission type and energy. In the process of using this type of electronic equipment to detect acoustic emission such sharpness was lost. As a result, the most common acoustic emission signals parameter is the intensity or the counting rate became deficient of physical content. Contrary to ionizing emissions the number of impulses per time unit here is by no means connected to the intensity of ultrasonic wave propagated on the deformable body.

It cannot be stated that nobody was aware of the situation. As early as in 80s NPO “Dalstandart” in Khabarovsk carried out experiments which have demonstrated that applying acoustic emission parameters based on impulses reading (total acoustic emission, number of AE impulses, AE count rate, and AE activity) for quantitative acoustic emission description principles invariably results in low researches results precision. Such situation in measurements may occur in the presence of not excluded systematic inaccuracies and bear the evidence of incorrectness of such measurements due to improper choice of physical units characterizing acoustic emission properties. If to compare main acoustic emission measurement units with the International System of units [3], it can be seen that generally accepted acoustic units are almost never used for acoustic emission description. The same situation was observed before 70s in the sphere of ionizing radiation measurement just due to wide use of measurement units based on impulses counting. Upon switching to International System of units there was some regulation in values and units usage characterizing ionizing radiation and its field, and that increased measurement re-

sults reliability. Unfortunately, that did not happen in the sphere of acoustic emission. All existing normative documents starting from GOST 2763–83 and ending with rather up-to-date RD 03-131–97 and RD 03-299–99 recommend using parameters based on impulses counting.

Experimental studies results inconsistence and huge measuring inaccuracies apply not only to parameters based on impulses counting. Such parameters as AE signal maximum value (amplitude), AE signal average power, AE signal energy, the physical sense of which is beyond exception, are measured by modern acoustic emission systems with abnormally large error. Just receiving converter calibration error is 30%, adding thereto converter unit error and physical quantity measuring error. In the process of metering parameters registration these errors at least double. But this is still not the determining factor. The main error and variability source is the unwillingness of the researches to work in broad band. And we can understand them – in the process of receiving converter pass band spread its sensibility decreases. Up to this day they failed to create broad pass band converter with suitable characteristics. This forces the users to work in narrow band, having measuring error in the above mentioned parameters exceed 100%, thus loosing the meaning of the measurements. Researchers try to solve this problem demonstrating miracles of ingenuity. This results in the variety of parameters, the physical sense of which can be hardly explained.

The author as early as in 1982 during the X International Conference on nondestructive testing in Moscow, based on spectral analysis of the research studies of acoustic emission features of different materials demonstrated the inconsistency of using traditional parameters when analyzing narrow band acoustic emission signals [4], and several times proved that in his further research works. The situation is paradoxical. It turns out that it is simply impossible to measure the majority of acoustic emission parameters. We talk only about detecting an event, the validity of which should be first proved. All that is not beneficial to the method and thwarts its wide application. The situation makes the usual NDT specialist at best having passed the course in the process of qualification, become the experimentalist. Such transformation is hard for some people, and that is the main reason of the non-usage of acoustic emission method. It still used by small number of people and wide sphere for scientific researches. The existent expert NDT reference aids recommend to use twenty six parameters, eighteen of which are primary. The number of secondary parameters used by researchers in their work is kiting with each new thesis and has long ago exceeded reasonable limit.

Taking into consideration all above mentioned I think that:

1. It is necessary to separate the detectors which are the majority of modern means of acoustic emission control from the measuring equipment and in new researches make special reference to measuring the limited amount of parameters having physical sense.
2. It is required to bring into sync the acoustic emission measurement units and International system of units, abandon the parameters based on impulses counting, or use correction factor when detecting each separate impulse.
3. When registering signal amplitude it is required to consider its frequency distribution connecting each amplitude rate with the corresponding vibration rate.
4. It is strictly contraindicated to measure signal energy in narrow band, naming such measures as “energetic parameters”. Energetic parameters as the acoustic emission energy itself may be obtained only based on the whole spectrum analysis.

5. With the purpose to reduce the measurement error it is required to perform receiving piezoconverters calibration right on the tested unit and in the process of test analysis consider “unit-converter” transfer characteristic.

6. It is required to create the commission with the purpose to draw out general provisions of the normative document that would determine the rules of acoustic emission control organization and performance rules as well as specify main requirements to acoustic emission equipment.

References:

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