SLOVENSKI STANDARD
oSIST prEN 13554:2009

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Neporuġitveno preskuġanje - Akustiļ na emisija - Sploġna naļ ela

Non destructive testing - Acoustic emission - General principles

Zertörungsfreie Prüfung - Schallemission - Allgemeine Grundsätze

Essais non destructifs - Émission acoustique - Principes généraux

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19.100 Neporušitveno preskušanje Non-destructive testing

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Non destructive testing - Acoustic emission - General principles

Essais non destructifs - Émission acoustique - Principes généraux

Zertörungsfreie Prüfung - Schallemission - Allgemeine Grundsätze

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (prEN 13554:2009) has been prepared by Technical Committee CEN/TC 138 “Non-destructive testing”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 13554:2002.

1 Scope

This European Standard specifies the general principles required for the acoustic emission (AE) testing of industrial structures, components, and different materials under stress and for harsh environment, in order to provide a defined and repeatable performance. It includes guide lines for the preparation of application documents, which describe the specific requirements for the application of the AE method.

Unless otherwise specified in the referencing documents, the minimum requirements of this standard are applicable.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1330-1:1998, *Non destructive testing — Terminology — Part 1: List of general terms*

EN 1330-2:1998, *Non destructive testing — Terminology — Part 2: Terms common to the non-destructive testing methods*

EN 1330-9:2009, *Non-destructive testing — Terminology — Part 9: Terms used in acoustic emission testing*

EN 13477-2, *Non-destructive testing — Acoustic emission — Equipment characterisation — Part 2: Verification of operating characteristic*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1330-1:1998, EN 1330-2:1998 and EN 1330-9:2009 apply.

4 Personnel qualification

It is assumed that emission testing is performed by qualified and capable personnel. In order to prove this qualification, it is recommended to certify the personnel in accordance with EN 473 or equivalent.

NOTE For pressure equipment see directive 97/23/EC, annex I, 3.1.3: "For pressure equipment in categories III and IV, the personnel must be approved by a third-party organization recognized by a Member State."

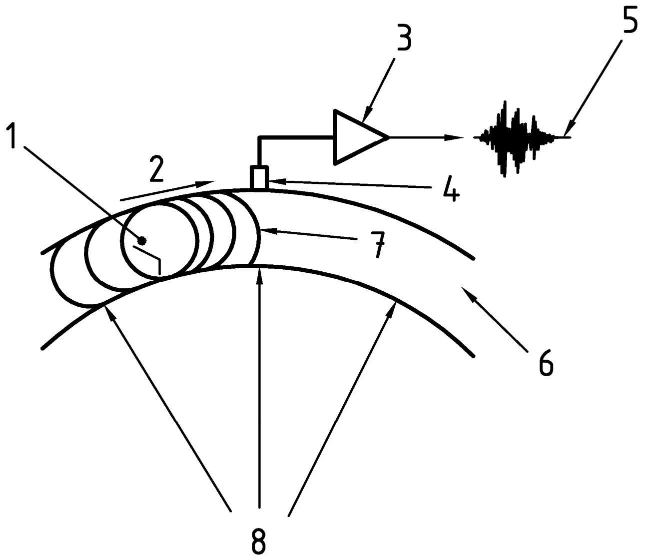
5 Principle of the acoustic emission method

5.1 The acoustic emission (AE) phenomenon

Acoustic emission is a physical phenomenon whereby transient elastic waves are generated within a material or by a process.

The application of load or harsh environment in a material produces internal structural modifications such as local plastic deformation, crack growth, corrosion, erosion and phase transformations. AE sources also arise from impact, leakage (turbulent flow), cavitation, electric discharge and friction. All these mechanisms and processes are generally accompanied by the generation of elastic waves that propagate in materials or into ambient liquids. The waves therefore contain information on the internal behaviour of the material and/or structure.

The waves are detected by the use of sensors that convert the particle motion at the surface of the material into electric signals. These signals can be of a burst or continuous nature and are processed by appropriate instrumentation to detect, characterize and locate the AE sources. Figure 1 shows the schematic principle of AE.



Key

1 Growing discontinuity
2 Surface waves
3 Preamplifier
4 AE sensor
5 Signal out
6 Section view of the component material
7 Wave packet
8 Applied load inducing stress

Figure 1 — Schematic principle of Acoustic Emission and its detection

5.2 Advantages and features of AE

The AE method has the following features:

— it is a passive detection method that monitors the *dynamic* response of the material to the applied load or environment;

— it allows detection of sources, depending of the materials properties, up to several meters distance;

— it allows a 100 % volumetric monitoring of the test object;

— it is sensitive to growth of discontinuities and changes in the material structure rather than to the presence of static discontinuities;

— it is non invasive;

— it offers a dynamic real time monitoring of any discontinuity that grows under the applied stress;

— it can be applied to monitor the structures during operating conditions;

— it can be used to detect the effects of the application of load in order to prevent catastrophic failure of structures;

— it is capable of locating a growing discontinuity in the structure under test by the use of a sufficient number of sensors;

— its measurement frequency range extends from about 20 kHz to 2 MHz depending on the application.

The AE method can be applied only if the materials in the structures or components are adequately stressed.

The difference between AE and most NDT methods stems from the above features. It is the *material itself* that releases the energy in consequence of structural degradation due to different source mechanisms. This is different to detecting existing geometrical discontinuities in a static condition.

AE is a method which points out the presence and location of an evolving degradation process under a given stimulus.

5.3 Limitations of AE

Limitations of the AE method are:

— non growing discontinuities may not generate AE;

— subsequent application of load to the previously applied maximum stress level will only identify discontinuities which are still active;

— it is sensitive to in-service or other extraneous noise.

Prior to performing an AE test, it is very important to check for the presence of potential noise sources. Noise sources should be removed or action taken to insure they do not reduce the effectiveness of the AE examination.

6 Applications of the acoustic emission method

AE is applied at the different phases of product life:

— materials and design optimisation;

— manufacturing (quality assurance);

— acceptance test;

— initial proof test;

— requalification tests;

— in-service condition / health monitoring;

— leak detection.

Furthermore, it is applicable to detection of:

— cavitation erosion;

— electric discharge;

— crack activity of rocks and concrete;

etc.

It is applied to:

— pressure equipment;

— pipe systems;

— atmospheric storage tanks;

- machinery;
- civil constructions (e.g. bridges, dams);
- power transformer;
- mines (e.g. rock salt mines for hazardous waste disposal);

etc.

These examples concern metallic materials, polymer composites, ceramics, concrete, rock, etc.

7 Instrumentation

7.1 General

The AE instrumentation shall fulfil the requirements of EN 13477-2 and the performance shall be checked periodically in accordance with this standard.

7.2 AE sensors

7.2.1 General

Detection is the most important part of an AE chain because any problem here (poor acoustical coupling, bad installation, incorrect frequency selection, cable mismatching, etc.) affects the rest of the measurements and hence the results.

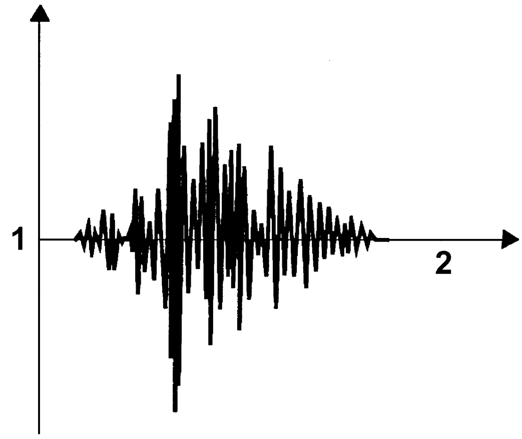
7.2.2 AE sensor selection

The sensors are normally of the resonant type, i.e. one frequency dominates the response; sensors with different resonant frequencies are available.

The choice of the sensor and the operating frequency depends upon:

- the purpose of examination;
- the requirements of the referencing standard or specification;
- type and shape of structure or component;
- operating temperature and surface condition of the structure or component (insulation, painting, coating, surface corrosion, etc.);
- environment;
- material properties;
- background noise;
- attenuation;
- material thickness.

The signal waveform from the sensor is affected by multiple path propagation and multiple waves modes that are generated in the material. An example of a typical AE burst signal is shown in Figure 2.



Key

1 Amplitude

2 Time

Figure 2 — Example of AE burst signal from a sensor

7.2.3 Sensor installation

The sensor shall be fixed to the test object using an acoustic couplant, a clamping device or an adhesive bond. In special applications, the AE sensor is installed on a waveguide. The surface at sensor positions shall be cleaned and sufficiently flat to ensure adequate and reproducible transmission of AE waves.

Verification of installation with Hsu-Nielsen source and/or other method shall be performed.

7.2.4 Coupling media

Different coupling media can be used, but their type shall be compatible with the materials to be examined. Examples are:

— water soluble paste;

— reagent soluble paste;

— oil;

— grease;

— wax;

— adhesive bond, etc.

7.3 Signal conditioning and processing

This includes signal transmission, amplification, filtering and extraction of the AE signal features. The frequency filtering shall be appropriate for the sensor response.

The preamplifier converts the signal from the sensor into a suitable low impedance signal for transmission over long distances, using suitable cables, up to the signal processing and analysis system.

The AE signal processor provides frequency band filtering for the rejection of noise, analog to digital conversion, threshold controlled feature extraction, e.g. peak amplitude, rise time, duration, energy, counts and time driven measurements, e.g. RMS, in real time. The AE signal processor may perform waveform capture. The AE signal