Suggestions for Receiving Reliable Results on Acoustic Emission Testing in Plants

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Abstract

During the past decade acoustic emission (AE) equipment developed a lot and single channel systems became quite affordable. In plant physiology, there is a trend to apply AE testing to quantify drought stress of trees by means of AE feature analysis. On contrary to other AE applications, such as pressure vessel testing, no standards or guidelines for handling of the equipment exist. Non-proper handling of the hardware and software can lead to wrong interpretations of the data received. Herein nine suggestions which might be helpful for receiving reliable results on AE testing in plants are presented:

(1) How to produce a smooth surface in plant stems?
(2) Contact pressure has a significant influence on the results.
(3) Mounting media and sealing wounds.
(4) How can be proper sensor coupling tested on a stem?
(5) Is attenuation associated with moisture content?
(6) Pre-testing for sensor coupling in leaves is necessary.
(7) Hardware setup: Detection threshold and waveform setup.
(8) Information on background noise is necessary.
(9) Data analysis: Getting rid of scrap.

The presentation should initiate a discussion including AE companies, AE experts in traditional applications as well as plant physiologists about the possibilities and limitations of the application of AE technology in plants. The outcome should result in some kind of manual for AE applications in plants.

Nine Suggestions for Receiving Reliable Results in Acoustic Emission Testing of Plants

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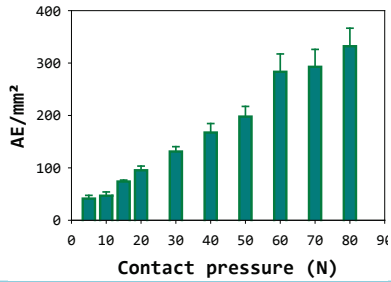
During the past decade acoustic emission (AE) equipment developed a lot and single channel systems became quite affordable. In plant physiological research, there is a trend to apply AE testing to quantify drought stress of trees by means of AE feature analysis. On contrary to other AE applications, such as pressure vessel testing, no standards or guidelines for handling of the equipment exist. Non-proper handling of the hardware and software can lead to wrong interpretations of the data received. Herein nine suggestions which might be helpful for receiving reliable results on AE testing in plants are presented. The presentation should initiate a discussion including AE companies, AE experts in traditional applications as well as plant physiologists about the possibilities and limitations of the application of AE technology in plants.

1. Producing a smooth surface

The flat sides of wood rasps and files with different coarseness (e.g. Dick, D) are well suited to produce smooth and parallel surfaces for perfect sensor coupling on plant round shoots or branches.

2. Contact pressure

The number of AE detected from dehydrating sapwood sections (0.2 mm thickness) increases with increasing contact pressure. It is suggested to use a contact pressure of 30 N between the AE sensor and the wood surface.



3. Couplant & wound sealing

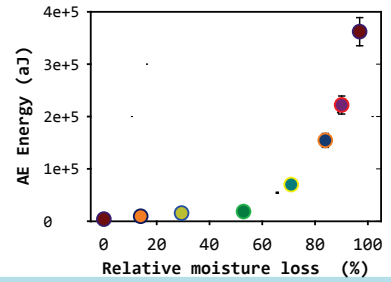
Silicone grease (e.g. Wacker, D) guarantees close contact between sensor (WD, Mistras Group, Inc., USA) and the wood surface. Open wounds near the sensor should be closed with Parafilm® (Pechiney Plastic Packaging, USA) in order to avoid water loss.

4. Sensor coupling test on stems

By means of the Hsu-Nielsen source (pencil lead break) the coupling between transducer and surface can be tested. The tip (3 mm ± 0.5 mm) of a lead (0.5 mm or 0.3mm) of a pencil equipped with a guide ring is broken at the wood surface. The AE should have amplitudes >80 dB (reference voltage 1 mV).

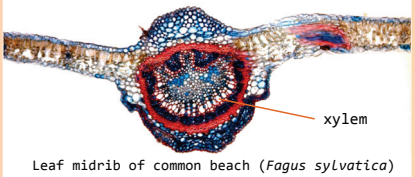
5. Attenuation and wood moisture

The energy of AE from lead break tests performed on wood surfaces (5 mm, 2H, 10 cm) increases with increasing moisture loss. Knowledge on attenuation changes with water loss is helpful for data interpretation.



6. Sensor coupling in leaves

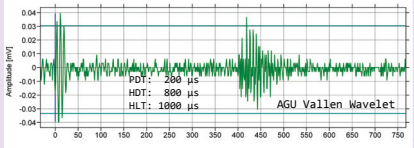
AE sensors can be mounted at the midrib on the lower or on the upper side of the leaves. In most cases, the upper side is the best choice because the xylem conduits (here is the source of AE when water columns break) are located closer to the upper surface of the leaf. However, in some species, such as common beech, the xylem of the main vein is closer located to the lower leaf surface.



Leaf midrib of common beach (*Fagus sylvatica*)

7. Acquisition setup

A detection threshold of 35 dB is sufficient to filter out background noise under laboratory conditions. Under field conditions, a threshold of 45 db is suggested. Inappropriate acquisition setups can result in wrong results (e.g. two signals counted as one).



Suggestion **PAC/Mistras**: 100 µs PDT (Peak Definition Time), 200 µs HDT (Hit Definition Time), 300 µs HLT (Hit Lockout Time)
Suggestion **AMSY/Vallen**: 200 µs DurDT (Duration Discrimination), 500 µs ReaT (Rearm Time)

8. Background noise

Operating an empty AE sensor during the measurements enables to pinpoint events that do not arise from the testing material. If the same events are detected by the sensors mounted on the plant material, those data must be excluded in further analyses.

9. Data analysis

It is suggested to exclude AE with less than three counts (threshold crossings) from further analyses.