International Standards: IEC TC87 WG3, High Power Ultrasonic Transducers

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Presentation Content

- Scope of Working Group activities
- Existing standards
- IEC 60886 – Investigation on Test Procedures for ultrasonic cleaners
- Future activities

R. Pohlmann and T.J.M. Herbertz: A new instrument for measuring the ultrasonic energy density in liquids. *Ultrasonics for Industry Conference papers 1970.*

WG3 Scope

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To prepare standard measurement procedures for ultrasonic high power transducers

WG3 make up

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- Francisco Chinchuretta (Sp)
- Mark Hodnett (GB)
- Tsuneo Kikuchi (Jp)
- Shuyu Lin (Ch)
- Noriyoshi Shibata (Jp)
- Friedrich Ueberle (De)
- Mark Schafer (US)
- Bajram Zeqiri (GB)

IEC 60782 – Technical Report

- Measurements of ultrasonic magnetostrictive transducers

Scope: applicable to magnetostrictive transducers, designed for different types of ultrasonic processing such as cutting, welding, chemical processing.

Lists essential characteristics (electroacoustical efficiency, vibration displacement amplitude, electrical input power) and measuring methods.

IEC 1088 – Technical Report

- Characteristics and measurements of ultrasonic piezoceramic transducers

Scope: specifies the essential electroacoustic characteristics of piezoceramic transducers for industrial applications. Applicable to piezoceramic longitudinally vibrating transducers operating at a single frequency up to 100 kHz.

Lists essential characteristics (output acoustical power of the transducer, vibration displacement amplitude, frequency response) and measuring methods.

IEC 60886

- Investigations on test procedures for ultrasonic cleaners.

The introduction of the standard refers to IEC Publication 653: *General considerations on ultrasonic cleaning*, in particular it referred to a test procedure to determine the stresses invoked during ultrasonic cleaning.

Appendix A of IEC 653 contained a test procedure but was incomplete as there was no reproducible method for measuring **sound pressure** in the bath. Also, an "*anomalous behaviour of sound pressure with temperature which was unresolved"* was reported.

IEC 653: Ultrasonic exposure test

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- Deterioration: surface finish and markings.
- Deterioration of material, leads and bondings.
- 40 kHz and 25 kHz considered. Damage assumed to be due to resonances, rather than cavitation.
- Peak acoustic pressure is the determining factor for component damage.
- Sound pressure has been shown to increase with temperature.

IEC 653: Clause 2
Further investigations to be made

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- To what extent is the sound pressure level significant when deterioration occurs?
- What level of cavitation is admissible (possibly specified by sound pressure) when deterioration occurs?
- Dependence of sound pressure on the bath temperature?
- Correlation between sound pressure and cavitation level?

IEC 653: Appendix

- Frequency (25 kHz; 40 kHz);
- Generator output power (10 W l^{-1}; 30 W l^{-1});
- Modulation (100 Hz or 120 Hz);
- Transducer type (PZT), distributed on bottom of tank.
- Preferred tank dimensions: 250 mm x 200 mm x 180 mm.
- Testing liquids specified (DI at 50 ± 5ºC), liquid height specified; degassing period.
- Duration: 5 minutes.
- Positioning of specimen in the tank.
- **A3.2**: Method of measurement of sound pressure or sound intensity. *Not defined yet.*
- **A4.2**: Sound pressure. *No values available yet.*

IEC 60886: Investigations on test procedures for ultrasonic cleaners

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Scope and Object

To provide a source of reference for work which has been carried out to evaluate the various test procedures for checking the ***effectiveness*** of ultrasonic cleaners. ***None of the test procedures was considered to be sufficiently reproducible to form the basis of an IEC standard.***

It is hoped that this report will stimulate further research into the ultrasonic cleaning process to provide a better understanding of the phenomena involved.

IEC 60886: Investigations on test procedures for ultrasonic cleaners

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- There is a need for a standardized test procedure to measure the *effectiveness* of an ultrasonic cleaner under closely defined conditions so that the performance of makes and models can be compared.

- A number of tests were reviewed, over four main categories.

IEC 60886: Investigations on test procedures for ultrasonic cleaners

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- *Quantitative* removal of a standard soil from a test piece. (***Preferred technique, as it relates directly to cleaning***).

- *Quantitative* measurement of a *parameter related to cavitation* in the cleaning liquid.

- *Quantitative* measurement of the *energy density* in the cleaning liquid.

- *Qualitative* tests for cleanliness of a test piece after cleaning.

To be acceptable the measurement parameter must bear a consistent, quantitative relationship to the cleaning effect.

IEC 60886: Investigations on test procedures for ultrasonic cleaners.

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Technique	Implementation	Findings
Quantitative removal of a standard soil	*Rings with standard soil, weighed.*	Reproducibility poor, even within the same laboratory. Inconsistent soil properties.
Quantitative measurement of cavitation parameter	*Strips of lead or aluminium sheet, area removed assessed*	Amount of erosion not always linked to cleaning effect. With temperature increase, cleaning increases, decreases in erosion observed.
Quantitative measurement of energy density 	*Integrating probe, energy density determined in volume*	Intra-lab – repeatable; but not inter-lab. Highly nonlinear. Cleaning increases with acoustic power not mirrored by probe output.
Qualitative tests for cleanliness of a test piece after cleaning	*Graphite on ceramic rings*	Qualitative nature; arbitrary scale of 0 to 12, not considered suitable as the basis of an IEC standard.

87/493/DC – Review of IEC/TR 60886; 1987

National Committee views were requested on whether IEC 60886:-

- is still employed industrially to test ultrasonic cleaners;
- should be confirmed with its existing Scope and object;
- should be revised with its existing Scope to reflect progress in the technical field since its publication, which is approaching 25 years;
- **should be revised with a revised Scope which includes standardised methods to determine key acoustic parameters *likely to be related* to cleaning, such as acoustic pressure and acoustic cavitation and their distribution, as a pre-cursor to developing standardised (direct) cleaning methods;**
- should be completely withdrawn.

Questionnaire responses

- The norm (standard) should clearly distinguish two aspects:-

- Methods to test the cleaning efficiency based on standardised levels of contamination.

- Methods to physically test the level of ultrasound power in the bath.

- Today, it seems possible to define measurement procedures e.g. for real-time *cavitation-induced noise*, as an electro-acoustically measurable parameter describing cleaning activity of ultrasonic baths in a comparable and reproducible way. **There are also the first commercially available measurement devices on the market.**

Summary

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- There is a need for greater input into WG3, with the objective of developing standardised methods for high power transducers and systems.
- There is a need to address the area of ultrasonic cleaners, over a wider range of frequencies – 20 kHz to 1 MHz (megasonic).
- A *Tier 1* standard would address key acoustic related parameters, such as acoustic pressure, acoustic power and cavitation activity.
- This would leverage the metrology developed within the IEC TC 87 for the medical ultrasound area.
- It might lay the foundation for future standards or IEC Reports addressing more direct cleaning assessment methods.