About this document

Content

This document is the second part of a series of application notes on the sound energy quantities *sound power* and *sound intensity*. It contains information on why sound power and sound intensity are relevant quantities, as well as an overview of the various measurement methods.

Target group

This application note is suitable for acousticians who would like to learn more about the basic benefits of sound power or sound intensity measurements and the advantages and disadvantages of the various measurement methods.

Questions?

Do you have any questions? Your feedback is appreciated!
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For technical questions on our products: SVP-Support@head-acoustics.com

Sound Power and Sound Intensity – Part 2

1. Why are sound power or sound intensity of interest?

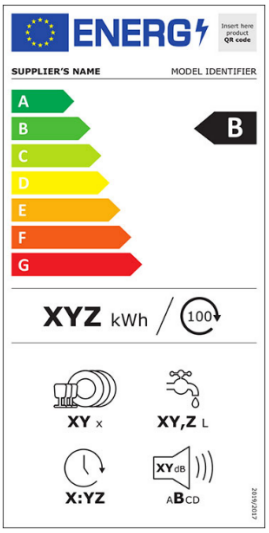
Significance of sound pressure

Sound pressure that exceeds a certain limit is harmful to human hearing. For this reason, it is useful to measure the sound pressure, e.g., at a person's working place. This measured value can be evaluated to determine the annoyance of sounds or the risk of hearing damage for the person.

Sound pressure, however, depends on the distance from the sound source and on the acoustic properties of the room (e.g., room size, and absorption behavior of the walls). Thus, sound pressure is not necessarily suitable for quantitatively assessing the sounds emitted by a machine or device. Sound power, on the other hand, is suitable for this purpose, as it can unambiguously describe the noise of a sound source, irrespective of the ambient conditions. For example, a room lined with sound-absorbing material reduces the sound pressure, while the sound power emitted by the sound source remains unchanged.

The sound power is the cause; the sound pressure generated at a location in the sound field is the effect.

Significance of sound power



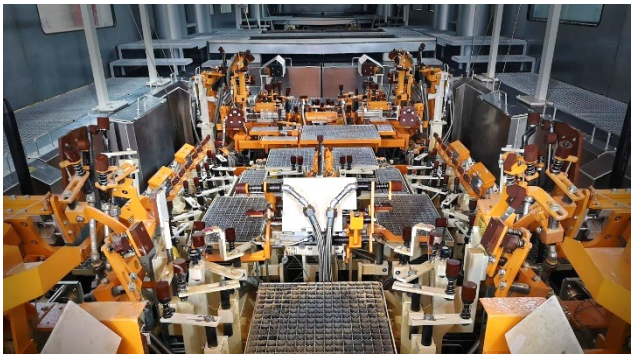
Sound power is thus a measure of the acoustic energy emitted by a sound source, irrespective of the acoustic environment. The specification of the sound power thus allows for a noise label that can be easily compared by the end user. Various voluntary or mandatory product labels, such as the European energy label, provide the end user with information on the noise emission of a product.

However, the comparability of the specification is only given if the different manufacturers use comparable measuring methods. To ensure this, standards have been adopted for certain types of equipment and machines which precisely describe the determination of sound power (see next chapter).

There are various methods to determine the sound power of a machine. The basis for the determination is either the measurement of sound pressures or the measurement of the sound intensity.

Use of sound intensity

Sound intensity being a vector quantity, the measurement of sound intensity is also suitable for determining the direction of the energy flow and sound source localization. This is very helpful, for example, in complex sound situations with several noise sources: In a factory hall with several machines, it can first be determined whether the sound pressure prevailing at a worker's position is in a range that is dangerous for the worker. If permitted limit values are exceeded, countermeasures must be taken and the worker's exposure to noise reduced.



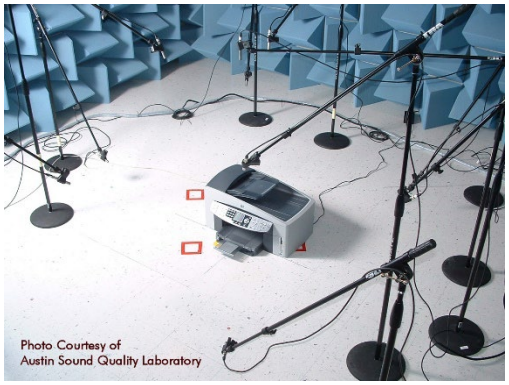
Sound intensity measurements can help determine on site which machine is emitting most of the sound energy and thus needs to be optimized. Furthermore, the contribution of the individual machine components to the total energy can be determined. Modifying this very component can then be particularly effective in reducing both the emitted sound energy and the worker's exposure to noise.

2. Measurement Methods for the Determination of the Sound Power

Enveloping surface method

Sound power is the energy that is emitted by a sound source per unit time. It is not measurable directly but can only be determined by using specific measurement methods. In practice, the enveloping surface method is the most widely used among the various methods for determining sound power. In this method, the sound power emitted by a sound source is recorded by measuring at numerous measuring points on a measuring surface enclosing the source.

Standards for sound power measurement



Sound pressure measurements according to ISO 3744 to 3746 or sound intensity measurements according to ISO 9614-1, -2 and -3 can be carried out to determine the sound energy penetrating this surface. Other methods available are the method for reverberation test rooms (according to ISO 3741) and the reference sound source method (according to ISO 3743-1, ISO 3743-2 and ISO 3747). When using the method for reverberation test rooms, the test object is operated in a reverberation test room and the sound power is calculated from the sound pressures recorded in this room. With the reference sound source method, the sound power is determined by comparing the sound source under test with a reference sound source that emits a precisely known sound power.

Sound power determination by means of sound pressure measurements

The measurement of the sound power based on sound pressure measurements can only achieve a certain accuracy if controlled experimental conditions are observed during the measurement. These conditions include requirements for the test room and for the environmental acoustic conditions (each described in the relevant standards). So-called noise test codes further specify the operating conditions under which certain products are to be tested.

Sound power determination by means of sound intensity measurements

When noise emission measurements are carried out in practice, the environment often does not allow for controlled experimental conditions to be maintained, and significant noise interference often cannot be avoided either. Therefore, possibilities had to be created to enable sound power measurements even under less ideal conditions. Sound intensity measurements allow the sound power to be measured in-situ. The sound intensity can be measured on site during regular operation. If several noise sources are present, this is not a problem when measuring the sound intensity, as stationary background noise is factored out by integration over the enveloping surface. Determining the sound power from the sound intensity also allows measurements in the near field[1]. Near field measurements of the sound intensity improve the signal-to-noise ratio of the measurement.

Sound intensity continues to be a very useful quantity in sound source localization. For this purpose, the emission patterns of complex machines are measured in-situ. Using

[1] In the near field, the sound energy circulates and does not propagate.

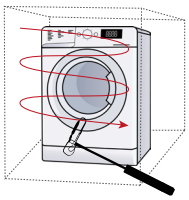
a sound intensity probe enables the direction of the energy flow to be determined and thus a sound source to be localized.

Summary

Depending on the test object, the issue, and the equipment available already, one or the other measurement method is more suitable for determining the sound power:

Sound power from sound pressure level measurements

- This method is often used for product certification and when high quantities are to be measured.
- Once the measurement setup is in place, the measurement can be performed very quickly. This allows for a very high level of repeatability and comparability of the measurements.



Sound power from sound intensity measurements

- This method is particularly suitable for stationary measurement objects that can only be measured on site.
- Background noise is tolerable.
- The minimum measurement setup allows the measurement to be performed quickly and cost-effectively. For this reason, this method is used, for example, for troubleshooting in product development.

Proceed to the third application note on sound power providing information on the determination of sound power on the basis of sound pressure measurements.

Proceed to the fourth application note on sound power providing information on the determination of sound power on the basis of sound intensity measurements.