2. Measurement of Noise

Object

1. To measure equivalent continuous sound level L_{eqA} (10 min.).
2. To draw the percent time occurrence of the particular sound levels in the laboratory.
3. To draw the graph of the statistical distribution of individual noise levels (compare it with the Gauss distribution).

Introduction

The Basic Sound Level Meter

A sound level meter is an instrument designed to respond to sound in approximately the same way as the human ear and to give objective, reproducible measurements of sound pressure level. There are many different sound measuring systems available. Although different in detail, each system consists of a microphone, a processing section, and a read-out unit. The microphone converts the sound signal to an equivalent electrical signal. The most suitable type of microphone for sound level meters is the condenser microphone, which combines precision with stability and reliability. The electrical signal produced by the microphone is quite small and so it is amplified by a preamplifier before being processed. Several different types of processing may be performed on the signal. The signal may pass through a weighting network. It is relatively simple to build an electronic circuit whose sensitivity varies with frequency in the same way as the human ear, thus simulating the equal loudness contours. This has resulted in three different internationally standardized characteristics termed the "A", "B" and "C" weightings. The last stage of a sound level meter is the read-out unit which displays the sound level in dB, or some other derived unit such as dB(A) (which means that the measured sound level has been A-weighted). The signal may also be available at output sockets, in either AC or DC form, for connection to external instruments such as level or tape recorders to provide a record and for further processing.

Calibration.

Sound level meters should be calibrated to provide precise and accurate results. The calibration is best done by placing a portable acoustic calibrator, such as a sound level calibrator or a pistonphone, directly over the microphone. These calibrators provide a precisely defined sound pressure level to which the sound level meter can be adjusted.

Detector Response.

Most sounds that need to be measured fluctuate in level. To measure the sound properly, we want to be able to measure these variations as accurately as possible. However, if the sound level fluctuates too rapidly, analog displays change so randomly that it is impossible to get a meaningful reading. For this reason, two detector response characteristics were standardized. These are known as "F" (for Fast) and "S" (for Slow). "F" has a time constant of 125 milliseconds and provides a fast-reacting display response enabling us to follow and measure not too rapidly fluctuating sound levels. "S" with a time constant of 1 second gives a slower response which helps average out the display fluctuations on an analog meter, which would otherwise be impossible to read using the "F" time constant. Many modern sound level meters have a digital display, which largely overcomes the problem of fluctuating displays, by indicating the maximum RMS value measured within the preceding second. Selection of the appropriate detector characteristic is then often dictated by the standard upon which the measurements are to be based.

The Impulse Sound Level Meter.

If the sound to be measured consists of isolated impulses or contains a high proportion of impact noise, then the normal "F" and "S" time responses of the simple sound level meter are not sufficiently short to give a measurement which is representative of the subjective human response. For such measurements, sound level meters having a standardized "I" (Impulse) characteristic are needed. The "I" characteristic has a time constant of 35 milliseconds, which is short enough to enable detection and display of transient noise, in a way which takes into account the human perception of impulsive sounds. Although the perceived loudness of short duration sound is lower than that of steady continuous sound, the risk of damage to hearing is not necessarily reduced. For this reason, some sound level meters include a circuit for measuring the peak value of the sound, independent of its duration. A Hold Circuit is also incorporated to store either the peak value or the maximum RMS value. Some standards require the peak value to be measured while others ask for a measurement using the "I" time constant. In either case, the Hold circuit makes reading the measurement easy.

Energy Parameters.

As sound is a form of energy the hearing damage potential of a given sound environment depends not only on its level, but also it's duration. So to assess the hearing damage potential of a sound environment, both the sound level and the duration of exposure must be measured and combined to provide a determination of the energy received. For constant sound levels, this is easy, but if the sound level varies, the level must repeatedly be sampled over a well-defined sampling period. Based on these samples, it is then possible to calculate a single value known as the Equivalent Continuous Sound Level or L_{eq} which has the same energy content and consequently the same hearing damage potential as the varying sound level. For an A-weighted L_{eq} the symbol L_{Aeq} is used. In addition to determining the hearing damage potential of a sound, L_{eq} measurements are also used for many other types of noise measurements, for example, community noise-annoyance assessments. The formulas for L_{eq} determination are

$$L_{ekv} = 10\log\frac{1}{T}\int_0^T 10^{0,1L(t)}dt \quad ,$$

$$L_{ekv} = 10\log\frac{1}{\Sigma t_i}\sum_{i=1}^{n} t_i\, 10^{0,1L_i} ,$$

where T is the duration of sound exposure time, and t_i is the time within which the L_i levels occur.

Quest 1800.

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Features:

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Procedure

Results

Conclusion

References