General information on noise

Noise is generally accepted as unwanted sound. Noise in a ventilation system is a very complex and diverse phenomenon. There are often many noise sources occurring at the same time, which affects our perception of noise. It can be difficult to separate these noise sources from each other; however, it is very important to be able to separate them so that the appropriate sound attenuator can be installed.

Noise sources

In principle, the noise sources in a ventilation system can be roughly divided into the following main areas:

1. fan noise
2. duct noise
3. noise from dampers, leaks, etc.
4. building noise

1. Fan noise

   Noise from the fan can be divided into air flow noise and operating noise. Air flow noise is a function of the velocity and pressure. Operating noise comes from the fan motor, belt drives, bearings, etc. The air flow noise is usually the worst problem. The critical frequency is often the fan impeller frequency, fs.

   $f_s = n/60 \cdot s$ (Hz)

   n = number of revolutions (rpm)

   s = number of blades

2. Duct noise

   Duct noise is generated primarily when the air flow passes sharp edges, dampers, turning vanes in rectangular elbows and poorly installed saddle taps. Any obstruction to the air flow will cause turbulence and noise. Secondary duct noise may also originate from the transmission of noise through the duct from room to room.

3. Damper noise, valve noise, etc.

   Noise may also be caused near valves, dampers as the air flow passes through relatively small holes. Noise may also be caused by poor joints or leaks.

4. Building noise

   Building noise is the noise which is transmitted through parts of a building: walls, floors, ceilings and other components.

Noise or sound attenuation

It is desirable and often required that noise be attenuated or removed. Silencers are specially designed for attenuating noise originating from the sources specified in items 1 and 2 above. Before investing in sound attenuating products, it is very important to determine the origin of the noise.

What is sound?

Small changes in the normal atmospheric pressure which accompany a sound wave is called the sound pressure. When measuring the sound pressure, a total value for the strength of the sound can be obtained. As an example, the weakest sound the human ear can detect has a sound pressure of $20 \cdot 10^{-6}$ Pa at 1000 Hz. This is defined as the hearing threshold. A sound pressure around 100 Pa would be strong enough that it hurts the human ear. A sound pressure scale using measurements in Pa would become extremely long and cumbersome. For practical reasons the decibel system has been introduced.

Sound pressure level, L_p

The sound pressure level which is measured in dB is an expression of the perception of noise.

$$L_p = 20 \cdot \log\left(\frac{p}{p_o}\right) \quad \text{(dB)} \qquad (4.1)$$

Where:

p = the sound pressure in question (Pa)

p_o = reference pressure = $20 \cdot 10^{-6}$ (Pa)

Sound power level, L_w

The sound power level which is measured in dB is an expression of the sound power which the system gives off.

$$L_w = 10 \cdot \log\left(\frac{p}{p_o}\right) \quad \text{(dB)} \qquad (4.2)$$

Where:

p = sound power in question, W

p_o = reference power 10^{-12}, W

Calculation of sound power level, L_p

$$L_p = L_w + 10 \cdot \log\left(\frac{Q}{4pl^2} + \frac{4}{R}\right) \quad \text{(dB)} \qquad (4.3)$$

Where:

L_W = the sound power level of the sound source, dB

Q = direction factor

I = distance between sound source and measuring point, ft

$$R = \frac{S \cdot a}{(a-1)} = \text{room constant } (ft^2)$$

S = total absorption surface of the room (ft^2)

a = the room's mean absorption coefficient

Octave bands

As it is rarely possible to attenuate low frequencies and high frequencies with the same device, it is necessary to divide the noise into octave bands. This facilitates analysis of the area where the noise is prevalent. The octave bands used in this division are often designated as a given band's mean frequency, fm. In ventilation systems the bands used are usually those between 1 and 8.

Octave band	1	2	3	4	5	6	7	8
f_mHz	63	125	250	500	1000	2000	4000	8000

General information on sound attenuation

Sound attenuation is usually required in order to comply with project specifications or to fulfill a wish for a better environment. See Table 5.1. These acceptable noise levels are the result of all sound and noise sources (ventilation, electrical fittings, water pipes, fans in computer equipment, etc.).

Calculation of sound in ventilation systems

A precondition for sizing sound attenuators is to obtain an accurate sound calculation of the system. The sound calculation is based on the sound power level, which is then converted to the sound pressure level. (See Formula 4.3, page 3). In general, the sound power level of the fan must be known. The following must also be available before the sound attenuation calculation can be made:

Octave band analysis (frequency analysis)
Definition of desired end result

The A-weighted sound level

It has been found that humans do not perceive two sound pressures of the same magnitude but with different frequencies identically. However, it is possible to make the individual frequencies comparable through appropriate correction (A-filter) of the linear sound pressure level. The value achieved is called the A-weighted sound pressure level, L_{pA}, which is the sum of the corrected sound pressure levels in the individual octave bands. Instruments are available in which the A-filter can be inserted when measuring the individual octave bands. The measurement results are designated: Whole octave A-weighted values, measured in dB.

Specification of requirements

There are 2 methods for specifying the noise requirement:

1. by means of NC
2. by means of L_{pA}

Recommended maximum values for sound pressure levels

Below is a table which indicates the recommended maximum values for sound pressure levels in N-value and L_{pA}. There is no fixed ratio between the various sound specifications, but as long as the noise in question is ventilation noise without pure tones, the following rule of thumb applies:

$$L_{pA} = NC + 5$$

Building type	Room type	NC	L_{pA}
Dwellings	Kitchens	30	35
	Living rooms	25	30
Child-care	Kindergartens	30	35
Institutions	Day nurseries	30	35
Meeting facilities	Lecture halls	25	30
	Libraries	30	35
	Cinemas	30	35
	Concert halls	20	25
	Courtrooms	25	30
	Theaters	25	30
Shops	Retail	35	40
	Department stores	35-45	40-50
	Supermarkets	35-45	40-50
Hospitals	Corridors	30	35
	Operating rooms	25	30
	Patient rooms	20	25
Hotels	Lobbies	35	40
	Function rooms	30	35
Churches	All rooms	25	30
Offices	Conference rooms	30	35
	Large offices	30	35
	Computer rooms, large	40	45
	Computer rooms, small	40	45
Restaurants	Cafeterias	40	45
	Dining rooms	40	45
Schools	Lecture halls	25	30
	Corridors	30	35
	Gymnasiums	30	35
	Staff rooms	30	35
Sports	Gymnasiums	35	40
	Swimming pools	35	40

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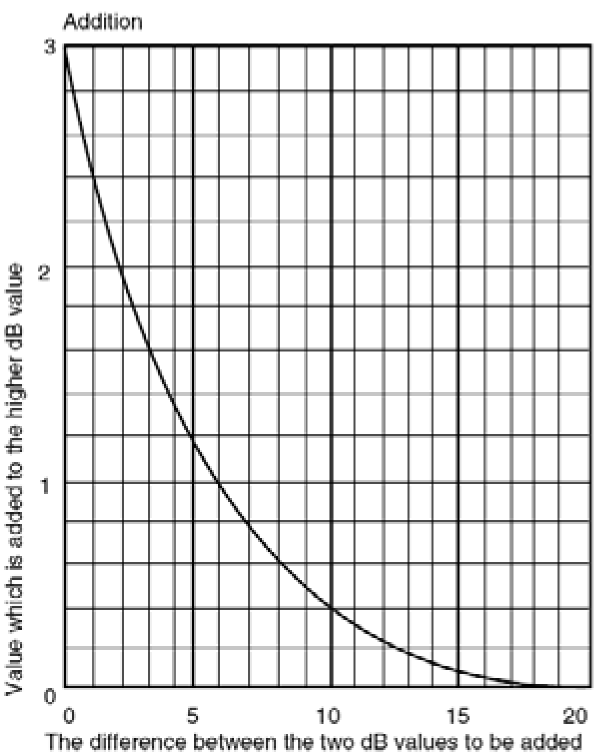
General information on sound attenuation

The L_{pA} value can be determined as follows:

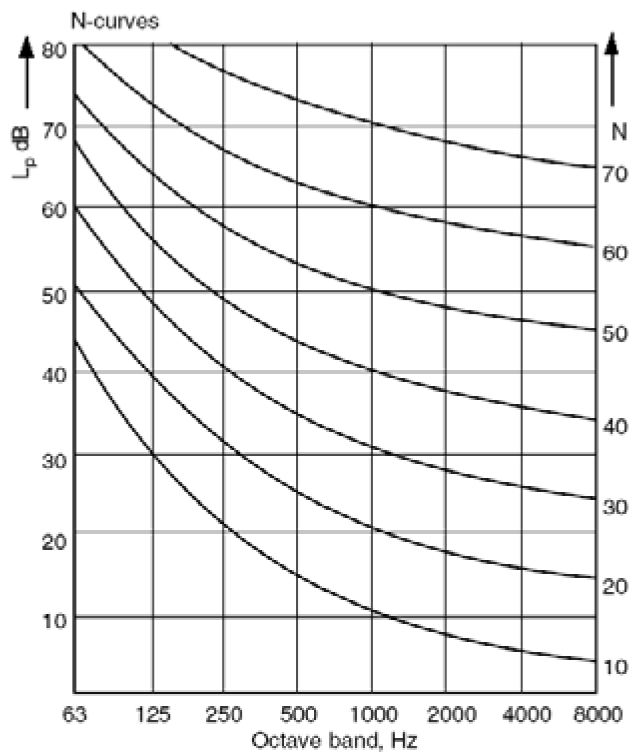
1. two random A-weighted octave values (usually the two highest) are added logarithmically by means of the curve.
2. the result is added logarithmically to a random third A-weighted octave value.
3. the addition continues and the L_{pA}-value is obtained when the addition includes all A-weighted octave values.

Example: 53 dB + 53 dB + 54 dB:
53 dB + 53 dB = 53 dB + 3 = 56 dB
56 dB + 54 dB = 56 dB + 2 = 58 dB



When determining the N-value, the sound levels in question are plotted and the points connected.

NC is determined as the N-curve which touches the spectrogram for the noise entered.



Technical description

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Design
The straight silencers in the EHG Silencer range are designed with a spiral seam outer shell and an inner perforated shell. The space between is filled with inorganic glass fiber sound absorption material. There is a fiber retention system between the perforated inner shell and the glass fiber material in order to prevent the erosion of fiberglass into the airstream.

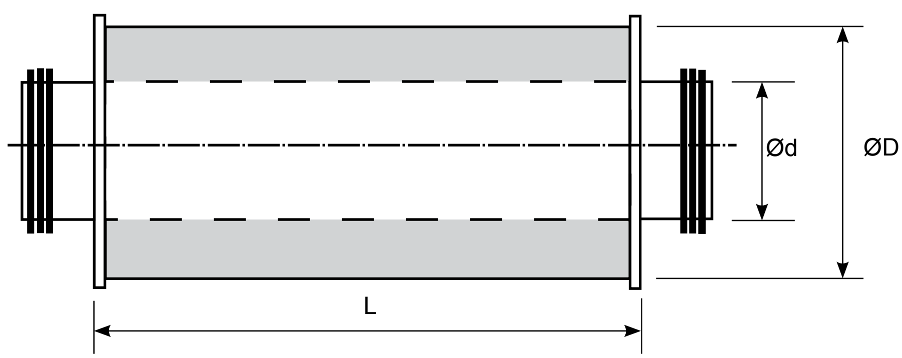
Connection
All silencers are supplied with EHG's G-3® end treatment as standard.

Size Range
All straight silencers are available from 3" to 50" diameter and in standard lengths of 12", 24", 36", 48", 60", 72", 84" and 96", depending on the connection diameter. Please contact the manufacturer for larger diameters.

Elbow silencers are available from 4" to 12" diameter in 2" thickness and from 4" to 24" diameter in 4" thickness.

Technical data
For information on dimensions, weight, insertion loss, self noise and pressure drop refer to the appropriate section for each individual silencer type.

Dimensional sketch for SLGG



Dimensional sketch for SLBGG