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EXTERNAL NOISE CONTROL IN THE PULP AND PAPER INDUSTRY

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Abstract

There can be up to 80 external noise sources in a paper making line. On the other hand, the limits on external noise levels in the pulp and paper industry have become increasingly strict over the last 20 years. Consequently, noise cancellation has become a major cost factor for pulp and paper mills. Layout aspects and the design of noise abatement measures are very important in the early stages of a project in order to save costs. The noise must always be reduced as near its source as possible. The most important primary noise sources are process and machine room ventilation fans, turbo blowers and vacuum pumps. The exhaust air from these is always blown to the outside and these outlets require silencers for both low and high frequency attenuation. New absorptive (resistive) and reactive silencers recently developed in the acoustics laboratory and their special properties are described. At the planning stage the predicted noise levels in the mill surroundings at predetermined immission points are calculated. These predictions are based on the sound power levels and the coordinates of the noise sources according to the ISO standard. The guarantee value for the supplier is the sound power or sound pressure level (at 1m distance) of each noise source. The verification procedure of attenuation is also discussed, i.e. post-start-up sound measurements from the discharge according to ISO or DIN standards. The measurements may also be performed at the immission points.

INTRODUCTION

Industrial noise can be divided into external and internal noise. The limits on external noise levels have become increasingly strict in the pulp and paper industry over the last 20 years. Whereas, in the 1980's, low noise emission limits tended to be applied only to mills in cities, today they are applied everywhere. As figure 1 shows, the average distance from the imagined paper mill center to the immission point limit level of L_{Aeq} = 45 dB has decreased considerably over the last two decades.

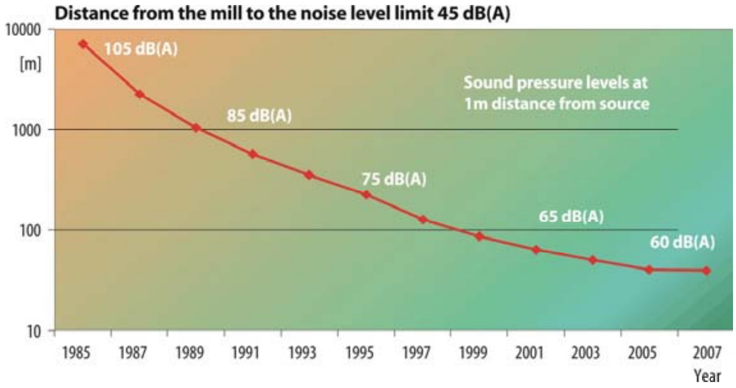

Figure 1 – Distance to the equivalent L_{Aeq} of 45 dB in 1985-2007

There are very many external noise sources in a total paper machine delivery. For example, the positions for external sound attenuation in an LWC (Light Weight Coated) paper line are as follows:

- process ventilation exhausts
- vacuum pump or turbo blower exhausts
- machine room exhausts
- machine room supply air units

An example of a delivery of this size with more than 80 external noise sources is Haindl Papier's Augsburg PM3 in Germany, the building roof of which can be seen in figure 2.

Figure 2 – Silencers on the building roof, Haindl Papier, Augsburg PM3

It is clear from the above facts that a lot of measures are required for sound attenuation in the pulp and paper industry. Implementation requires several areas of acoustics to be applied, e.g. sound propagation calculations, dimensioning of silencers, sound and vibration insulation and sound measurements [1]. Internal noise level targets have also become important – the objective being to create a better working environment for the papermakers themselves.

SOUND ATTENUATION OF EXTERNAL NOISE

In most cases, noise cancellation is relatively expensive. When noise sources have to be attenuated later on, the costs can become especially high. When designing a "silent" pulp, paper or board machine, it is vitally important to consider the whole process layout at an early stage. And the study of the entirety is the most important.

Noise should be reduced as near its source as possible. An example of how right engineering can reduce the investment costs of sound attenuation is shown in the overpressure alternative of figure 3, where the exhaust air fan is located before the heat recovery stack.

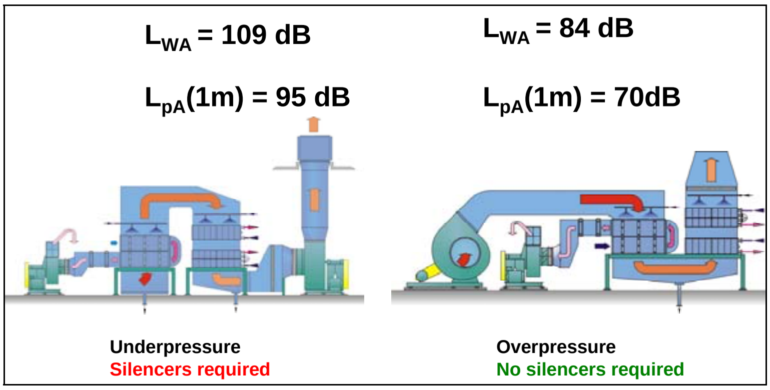

Figure 3 – Heat recovery stacks, underpressure and overpressure

The air/air and air/water heat exchangers and the stack parts with cross section changes and bends will cut the sound power level from L_{WA} = 109 dB to 84 dB.

It is not always possible to reduce the noise at its source, however. Hence, we need silencers, sound insulation hoods and screens, and the use of directivity.

FAN NOISE

The most important primary noise sources in ventilation are process and machine room ventilation fans, turbo blowers and vacuum pumps. The exhaust air is always blown to the outside.

Fans create noise that can be described as broad band noise. The sound level spectra of the noise sources must be known when the silencers are dimensioned. The sound power levels of fans are determined in an acoustics laboratory. Depending on the noise level requirements, either absorptive or reactive silencers (resonators) are used, or a combination of them. Figure 4 shows the principle of fan noise attenuation with absorptive and reactive silencers in series.

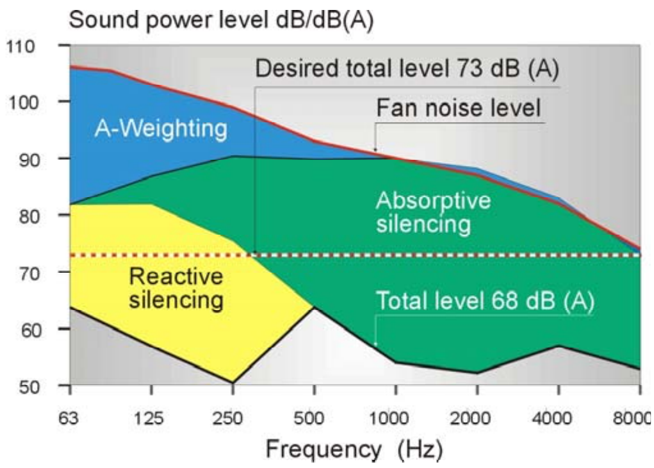

Figure 4 – Fan noise attenuation

Turbo blowers have the same kind of broad band noise spectra as fans, but their total sound pressure level is as high as L_{pA} = 130 dB. The exhaust air temperature is +150 °C which requires special fiber glass absorption material in the silencers. The vacuum pump (annular water pump) noise lies at lower frequencies, with a peak noise level often at 80 Hz and its multiple frequency 160 Hz.

SILENCERS

Metso Paper's silencer families represent both absorptive (resistive) and reactive silencers developed in the company's own acoustics laboratory in Turku. The laboratory comprises a 227 m^3 (8000 cu.ft.) reverberation room made of concrete. The latest development includes two new absorptive silencer families, BVN and LBV. The Insertion Loss (IL) and total pressure loss are measured according to the ISO 7235 standard [2].

Absorptive silencers

The absorptive silencer family includes conventional round silencers for positions where the maintenance need is minor. The next silencer has round duct connection and rectangular outer geometry with doors for maintenance (for cleaning and absorption material change on-site).

The most efficient absorptive silencers are the baffle-type ones. The new baffle type BVN silencer at the newly started-up SC paper machine of Stora Enso Kvarnsveden PM12, Sweden is shown in figure 5 (heat recovery stack application). The baffle thickness is 200 mm and spacing 100 mm. The total length is 4000 mm.

Figure 5 – New baffle-type BVN silencers

The new developed features of this BVN silencer are:

- quick installation
- absorption material on walls, leading to better attenuation and insulation
- noise absorption surfaces without perforation, leading to cost savings
- better cleanliness and maintenance
- wall stiffener inside the casing, giving a better external appearance
- vibration-free outer surface
- tight construction (seals easy to change)
- better sound attenuation properties

The LBV silencer (labyrinth baffle) has been developed for cases where the noise level requirements are very strict. Its construction has been designed so that good attenuation is also obtained at lower frequencies. Otherwise the construction is similar to BVN, figure 6.

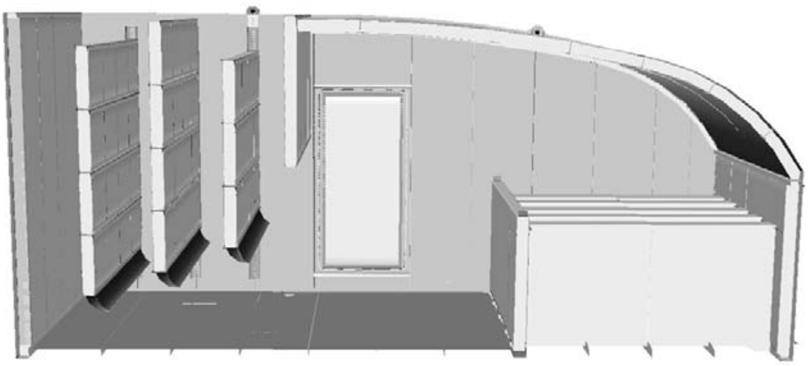

Figure 6 – Principle of the labyrinth-type LBV silencer

When the air flow and sound enter the silencer, they first pass through a normal baffle section. After that they enter the labyrinth zone and then pass through baffles arranged transversely at such a distance from each other that self noise generation is minimized.

When silencers are installed on the building roof they do not need any maintenance platforms for service. The maximum air flow through these silencers is 50 m^3/s. This means that the cross section is 3000 mm x 3000 mm. The maximum length of an LBV silencer is 8700 mm.

Reactive silencers

The reactive silencer family includes a PRV pipe resonator for fan noise attenuation. Resonators work at lower frequencies, below 500 Hz. As the performance of a pipe resonator is determined by its geometrical shape, no porous material is used. Resonators consist of two chambers. The chamber lengths determine the frequencies to be attenuated. Normally, resonators are used together with absorptive silencers.

For vacuum pumps and turbo blowers, an MPRV multi-pipe (multi-port) resonator has been developed because the total air flow is too big for a standard pipe resonator. Figure 7 shows the UPM Rauma PM3 case in Finland.

Figure 7 – Multi-pipe resonator and absorptive silencers for vacuum pumps

The sound pressure level guarantee was L_{pA} = 75 dB at 1m distance. Measurements of the outlet revealed sound pressure level peaks at frequencies of 80 Hz and 160 Hz with a magnitude of L_{pA} = 83 dB. A pipe resonator was tuned to these two frequencies. Seven exhaust pipes from the Nash pumps were led into the pipe resonator. After the pipe resonator, absorptive silencers were also used to attenuate the higher frequencies (broad band attenuation).

Figure 8 shows the A-weighted sound pressure levels at 1m distance before, and at two measurement points after, the silencer installation. The peak noise levels at the 80 Hz and 160 Hz frequencies have been reduced by 12 to 20 dB. The total sound pressure level guarantee at 1m distance of L_{pA} = 75 dB was reached.

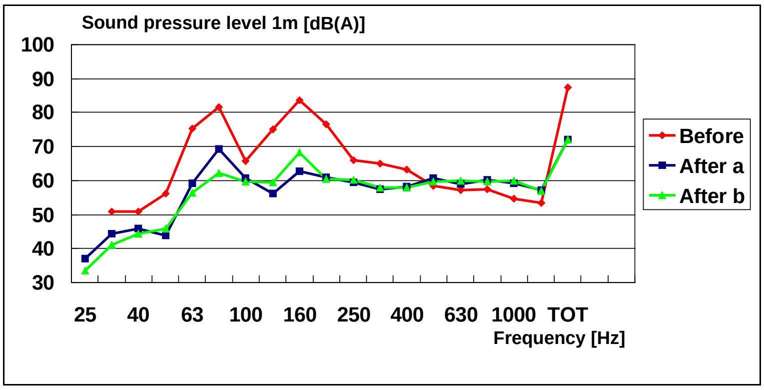

Figure 8 – Sound attenuation of MPRV and absorptive silencers

An example of a comparison of the typical Insertion Loss values of absorptive and reactive silencers is shown in figure 9.

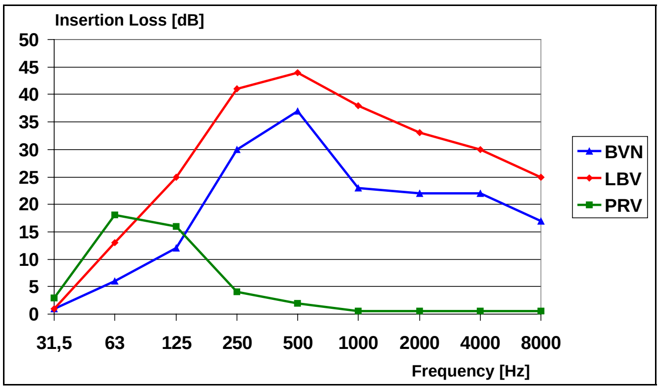

Figure 9 – Insertion Loss of different silencers

The latest MPRV silencer delivery was for turbo blower exhausts at Stora Enso Kvarnsveden PM12, started-up in December 2005. Here also absorptive BVN silencers were installed after the reactive ones.

In case of new paper machines, fans are always installed inside. If fans are installed outside on the building roof, they are provided with sound insulation hoods according to the noise level requirements.

PREDICTION AND VERIFICATION

At the planning stage the predicted noise levels in the mill surroundings at predetermined immission points are calculated. These predictions are based on the attenuated sound power levels and the coordinates of each external noise source according to the ISO 9613-2 standard [3]. When the number of noise sources is as mentioned above, the total attenuated sound power level from ventilation is L_{WA} = 98-102 dB.

After start-up the noise levels of all noise sources are measured, normally at 1 m distance from the noise sources and also at the immission points. The measurements and given guarantee values are based on ISO 3744 or DIN 45 635-47-KL 3 standards [4], [5]. The guarantee values may be expressed as sound power level or sound pressure level (at 1 m distance). However, long experience shows that the difference between the sound power level and the sound pressure level at 1 m distance is normally only about 8 dB rather than 10logS (S = measurement area). Therefore, measurements should be made at 3 m distance, for example. But this is often impossible because the background noise becomes too dominant.

CONCLUSIONS

Efficient noise control requires the consideration of several steps in order to reach as economical a result as possible. The first step is early acoustics design. Directivity and screening should also be considered, if possible. After that, the silencers for the noise sources must be dimensioned.

Metso Paper Air Systems was one of the first to recognize the importance of noise emission control for customers. Noise abatement is very important, leading to good and quiet working conditions for papermakers and a quiet mill neighborhood. Metso's Air Technology Center and Acoustics Laboratory have played, and will continue to play, a vital role in developing systems for noise emission control.

REFERENCES

[1] Ver I.L., Beranek Leo L. (Editor), *Noise And Vibration Engineering: Principles And Applications* (John Wiley & Sons Inc., 1992 and 2005)
[2] Standard ISO 7235 Acoustics. Laboratory measurement procedures for ducted silencers and air-terminal units. Insertion loss, flow noise and total pressure loss (2004)
[3] Standard ISO 9613-2 Acoustics. Attenuation of sound during propagation outdoors.
Part 2: General method of calculation (1996)
[4] Standard ISO 3744 Acoustics. Determination of sound power levels of noise sources using sound pressure. Engineering method in an essentially free field over a reflecting plane (1994)
[5] Standard DIN 45 635-47-KL3 Measurement of airborne noise emitted by machines, enveloping surface method, chimneys (1985)