ENVIRONMENTAL NOISE CONTROL IN THE PULP AND PAPER INDUSTRY

43.50.Gf NOISE CONTROL AT SOURCE: REDESIGN, MUFFLERS, NOISE SILENCERS

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ABSTRACT

The number of external noise sources of a paper making line is typically around 80 pcs. The major ones are process and machine room ventilation and vacuum pump exhausts. The noise control targets will dictate the scope and costs of sound attenuation. Considerable cost reductions can be achieved if the noise control design starts at the early stage of a project. Additionally, depending on the noise level requirements, absorptive silencers, resonators or enclosures are used. Active Noise Control is yet another method of reducing noise, especially at the lower frequencies. The sensors and actuators are using ElectroMechanical Film (EMFi) technology.

GENERAL TRENDS IN EXTERNAL NOISE LEVEL REQUIREMENTS

The external noise level requirements in the paper industry have increased from the 80's till now. Already in the 80's some paper mills in the center of cities had very strict noise level requirements. The general overall trend, however, looks as shown in figure 1.

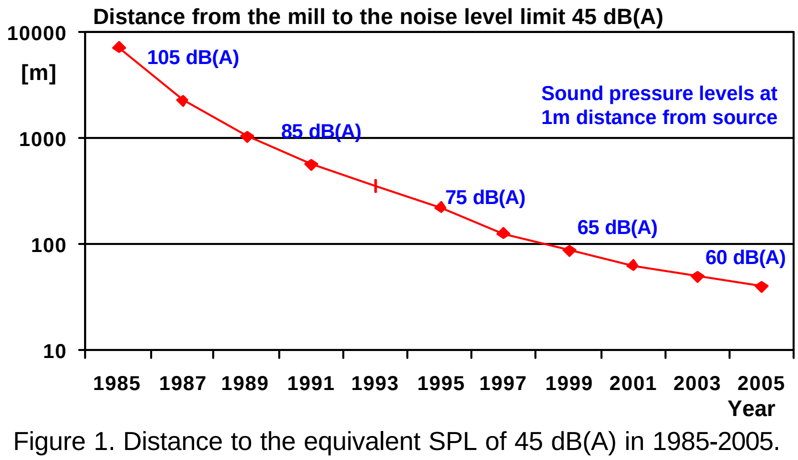

Figure 1. Distance to the equivalent SPL of 45 dB(A) in 1985-2005.

The average distance from the envisaged paper mill center to the immission point limit level, an equivalent sound pressure level of 45 dB(A), has decreased considerably. It has required a lot of efforts and investments from the paper mills to achieve these result.

LAYOUT ASPECTS AND PRELIMINARY DESIGN

Noise should be reduced as near its source as possible. Layout aspects in the early stages of a project and total process know-how are very important in the design of silent paper or board machines. An example of how right engineering reduces investment costs of sound attenuation is shown in the overpressure alternative of figure 2 where the exhaust air fan is located before the heat recovery stack.

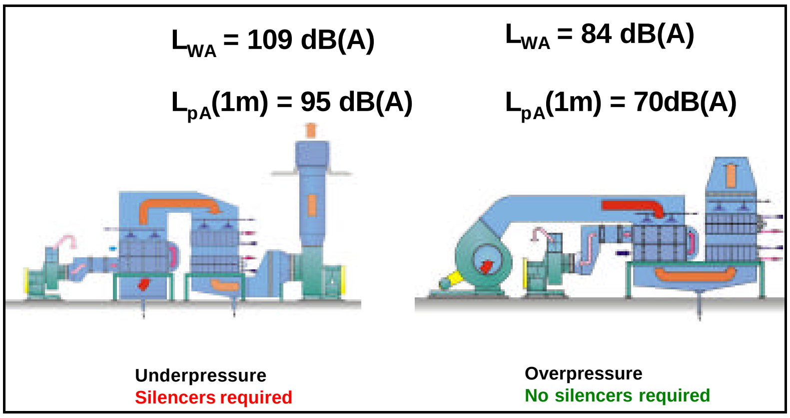

Figure 2. Heat recovery stacks, underpressure and overpressure.

The air/air and air/water heat exchangers and the stack parts with cross section changes and bends will drop the sound power level from 109 dB(A) to 84 dB(A). The sound power level before and after the stack is shown in octave bands in figure 3.

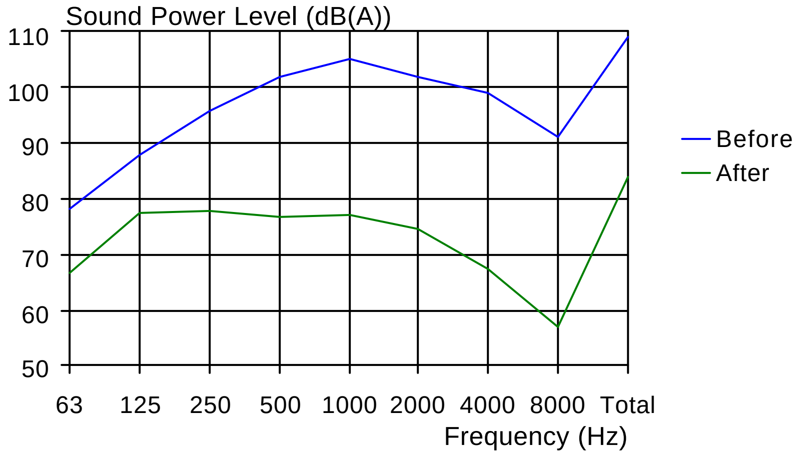

Figure 3. Sound power level before and after a heat recovery stack.

In rebuilds or noise abatement projects the relocation of fans inside saves sound attenuation costs and sometimes it is the only possibility to reach the desired sound level. Other important factors to be considered are directivity of the noise sources, screening effects, etc. An "immission corrected" sound power level must be determined.

At the design stage immission point calculation programs (standard ISO 9613-2) are used based on the machinery suppliers' sound power level data. When the paper machine once has started up, measurements in the predetermined immission points are often impossible to perform because of background noise, often from the traffic. Also then the above programs are used to calculate the immission point sound levels from the measured sound pressure levels at each noise source and their calculated sound power levels.

The sound pressure level measurements at the discharge are made e.g. according to the standard DIN 45 635-47-III or ISO 3746. The sound power levels can then be calculated according to the standards, an example is shown in figure 4.

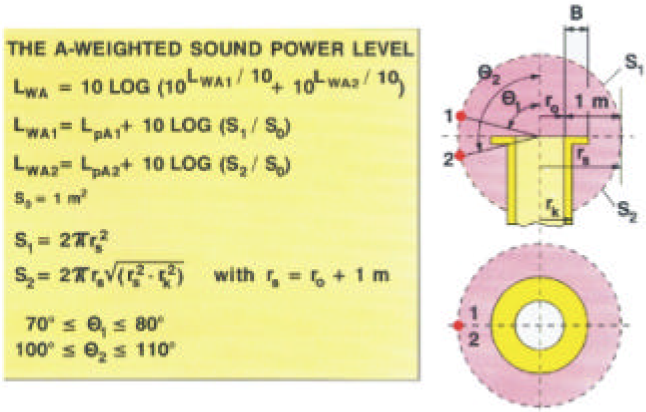

Figure 4. Sound level measurement DIN 45 635-47-KL3.

The harmonization of measurement methods of noise exposure is very important. The use of the same methods and standards in different countries is a prerequisite e.g. when comparing competing quotations.

ABSORPTIVE AND REACTIVE SILENCERS AND ENCLOSURES

Fans create broad band noise. The sound level spectra of the noise source must be known when silencers are dimensioned. Depending on the noise level requirements either absorptive or reactive silencers (resonators) are used, or a combination of them. Figure 5 shows the principle of exhaust air fan noise attenuation with absorptive and reactive silencers in series.

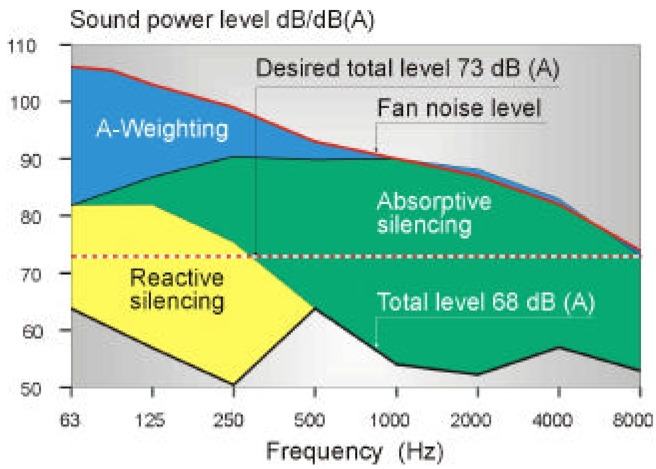

Figure 5. Fan noise attenuation (exhaust air).

The attenuation properties of silencers are measured in an acoustics laboratory (reverberation room) as Insertion Loss using the standard ISO 3741.

Different absorptive and reactive silencer types with their individual octave band attenuation spectra versus their costs are always cost-optimized for each case. When the requirements are strict, e.g. a sound pressure level of 65 dB(A) at 1m distance from the discharge, a combinaton of absorptive and reactive silencers must be used to cover the whole frequency range. In case of vacuum pump exhaust air attenuation, a combination is also often required.

Normally fans are located in a ventilation room ("noisy room") where higher noise levels are allowed, up to 95-105 dB(A). When fans are located outside, they must be sound insulated or equipped with sound insulation hoods.

EXAMPLES OF SOUND ATTENUATION DELIVERY SCOPES

The immission point targets, equivalent sound pressure levels L_{Aeq}, vary from country to country, but generally they can be expressed as:

- daytime	50-55 dB(A)
- evening	45-50 dB(A)
- night	40-45 dB(A)

These levels are low and the noise from traffic is normally higher. The noise from paper mills is continuous so the nighttime target must be fulfilled.

In a total paper machine delivery the number of silencers is very big. As an example, in an LWC-line (Light Weight Coated paper) the positions for external sound attenuation are typically the following:

- process ventilation	21 pcs
- vacuum pump exhaust	1-2 pcs
- machine room exhaust	27 pcs
- machine room supply air	27 pcs
- fan insulation hoods	3-5 pcs (generally not for new lines)

An example of a delivery of this size is Haindl Papier Augsburg PM3, the roof of which can be seen in figure 6.

Figure 6. Silencers on the building roof, Haindl Papier Augsburg PM3.

In order to optimize the sound attenuation costs, it is very important to consider the overall situation with all relevant noise sources, their location and directivity to the different immission points. As a result, a maximum allowable sound power level can be determined for each noise source. Normally the allowed realistic sound power levels will vary between L_W = 75-90 dB(A) for each noise source. When the number of noise sources is as mentioned above, the total sound power level of ventilation after attenuation is L_W = 98 - 102 dB(A). This is shown in octave bands in figure 7.

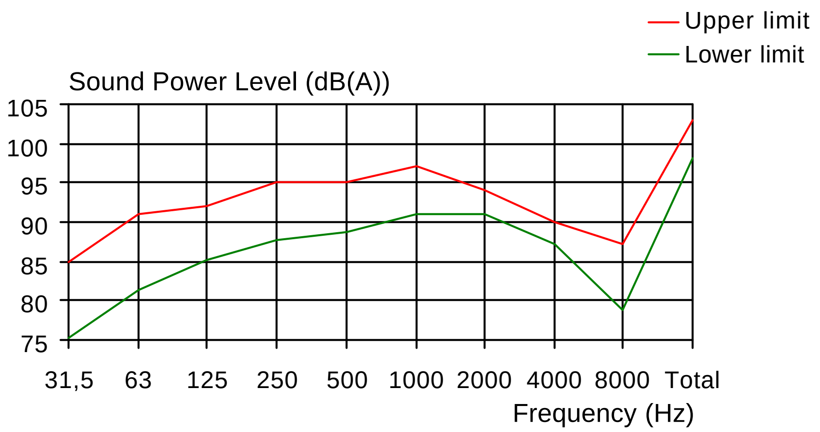

Figure 7. Total attenuated sound power level of PM ventilation.

Additionally to this, the building wall and door construction must be considered in order to insulate the noise from inside the machine room and production facilities.

For vacuum pumps a combination of absorptive and reactive silencers is often required. In the case of Stora Enso Hylte PM4 the guarantee value was a sound pressure level of 75 dB(A) at 1m distance from the discharge. But additionally, there was a guarantee at 100 Hz of 79 dB, without A-weighting. Based on field measurements a reactive silencer for the 100 Hz frequency and a baffle type silencer for the whole frequency range were dimensioned. Figure 8 shows the installation and figure 9 the measured sound levels before and after the installation.

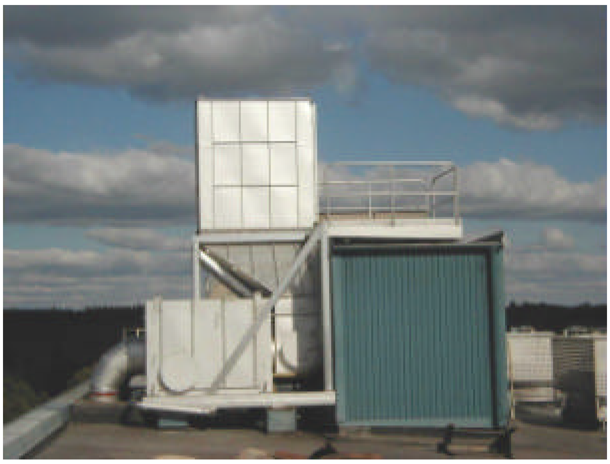

Figure 8. Vacuum pump silencers.

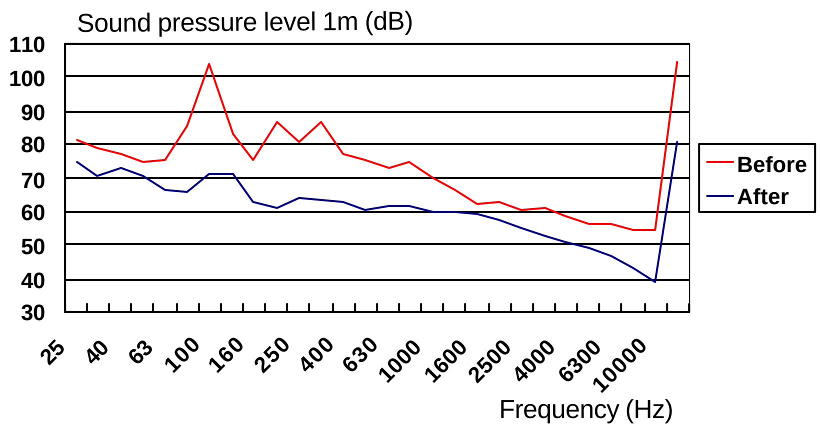

Figure 9. Sound pressure level before and after silencer installation.

The sound pressure levels were measured at the discharge at 1m distance according to DIN 45 635-47-III. We can obtain a significant reduction at 100 Hz.

NEW SOLUTIONS FOR SILENT VENTILATION SYSTEMS AND FUTURE TRENDS

Metso Paper Air Systems' product development is performed in an acoustics laboratory equipped with a reverberation room. The standard ISO 3741 is applied. The product develoment approach is focusing on integrated systems where silencers are a property or charactersitic of the equipment itself, aiming at source-specific attenuation. This will guarantee low noise levels together with cost effective and compact design. One example is the new silent roof exhaust unit called SPY, figure 10.

The unit is compact and modulated and the installation time is very short, the whole unit can be assembled with a single lift. For easy maintenance the unit can be delivered as a falling unit. Service can then be done without a crane and the attenuator elements are easy to replace.

Figure 10. Silent roof exhaust air units SPY.

The noise level in the machine room must also be considered. During a shut-down the machine room ventilation noise must not often exceed 70 dB(A), measured 1,55 m above the floor level.

Active Noise Control (ANC) is a potential technology for reducing noise especially at the lower frequencies, where it is difficult to reduce noise with passive means. In ANC original noise and anti-noise cancel each other and the net result is greatly diminished sound. The sensors and actuators are using ElectroMechanical Film (EMFi) technology. The results are promising and the technology seems to be at a point of actual exploitation.

CONCLUSION

Efficient noise control requires several steps to be considered in order to reach as economic results as possible. The first steps are early acoustic design and consideration of layout aspects. The directivity and screening are also important to consider. This means that it is very important to master the overall situation. As there are numerous external noise sources of a paper machine, acoustic optimization with respect to efficiency and economy is a necessity. To improve the economy of noise control still requires further product development.