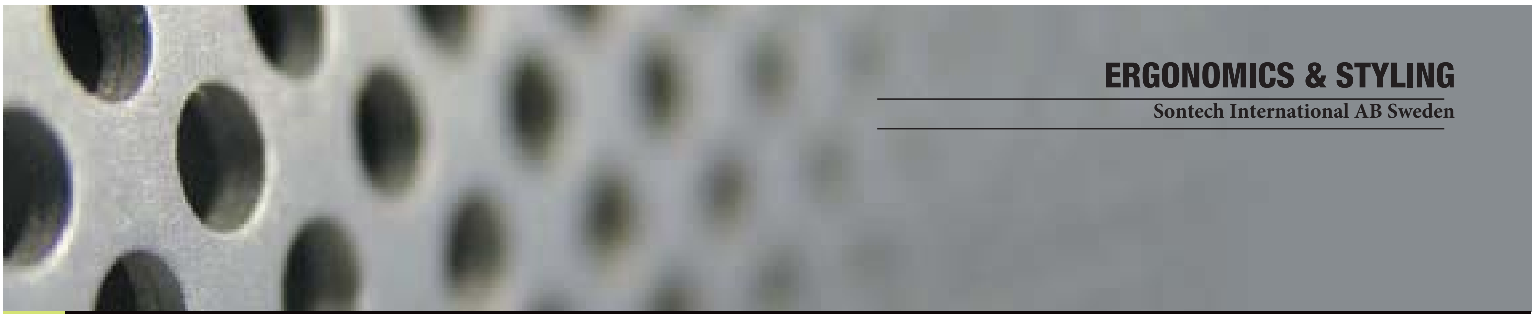


SOUND OF SILENCE

Microperforated panels are becoming a vital tool in the acoustician's battle to reduce noise emissions. The basic concept has now been expanded to cover more applications

The world of microperforated panels (MPP) for sound absorption has started to occupy the thoughts of acousticians over the past 10 years. For a while, perforated metal panels with holes in the 1-10mm range have been used as a cage for sound-absorbing glass-fiber bats where large holes let the soundwaves reach into the absorbant fiber. Another use has been the creation of narrowband Helmholtz absorbers which can be tuned by hole size and the dimensions of hole distance and air gap behind the panel.

However, when the hole dimensions are in the region of 0.05-0.5mm, it proves that narrow absorption peaks become much wider, making the additional fiber absorber more or less unnecessary, while still maintaining a very high absorption factor.

By varying geometrical and material parameters, the acoustical performance can be tailored to meet a multitude of specifications in various applications.

In general, the three acoustical/material interaction phenomenas of reflection, absorption and transmission can be optimized in relation to the acoustical field near the sound source and further away in the far field. Put simply, the holes in the walls are utilized to dissipate the vibration energy into friction heat.

Sheets of up to 1.5m wide and 2.5m long have been produced, with the most specified material being aluminium, followed by stainless and black steel. The material sheets are perforated in a cutting operation that results in a density of 50,000 to 500,000 slit-shaped holes per m^2. Precision of hole size is the most important issue and must be monitored continuously during the process.

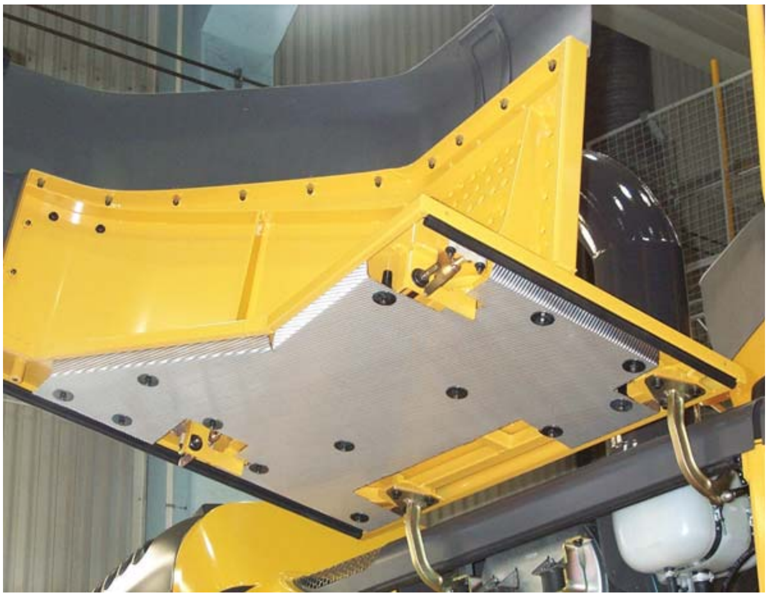
Sontech was one of the first to introduce a commercial product onto the OEM market and has further developed the basic concepts into a range of products for a variety of applications.

Applications for engine compartments

Acustimet is an all-metal sound-absorbing panel for lining the interiors of engine enclosures and hoods in tractors, construction equipment, trucks, buses,, gen sets, boats and robot systems.

The level of absorption can be calculated using the theory for resistive sheet absorbers. Therefore, the most important parameters are:

- Flow resistance of the resistive sheet;
- Distance of resistive sheet from back wall, i.e. size of air-gap;
- Sound field and reaction characteristics;
- Mass of the resistive sheet.



Acustimet mounted on the hinged part of the engine hood

Volvo's wheeled loader suse Acustime tsound absorbents in the engin e hood

The Acustimet material is normally mounted at 30-50mm distance from the engine compartment walls, as can be seen in Figures 1 & 2. The absorption factor calculated for a 50mm air-gap application is shown in Figure 3(?)

The first step is to adjust and optimize the resistive sheet flow resistance for each application. The effect of too much flow resistance, which gives rather poor dissipative effects can be seen in the graph.

The next step is to optimize the distance – if the air gap between the resistive sheet and the wall is increased, then the curves are shifted towards lower frequencies and vice versa. The decrease of absorption factor for higher frequencies is an effect of the distance from the wall being similar to multiples of $\lambda/2$, giving air particle velocity equal to zero for the corresponding frequencies. Optimization of the air-gap is therefore required for each specific application or sound spectrum. The $\lambda/2$ problem can be eliminated by using two sheets of Acustimet.

The final step involves non-local reaction treatment. As can be seen, the low- and mid-frequency region is also affected by the type of reaction. Non-local reaction can be avoided by increasing the absorption inside the air cavity between the resistive sheet and the back wall as well as by forming the resistive sheet surface. The effect of increased absorption in the air-cavity is shown in DIAGRAM pic.

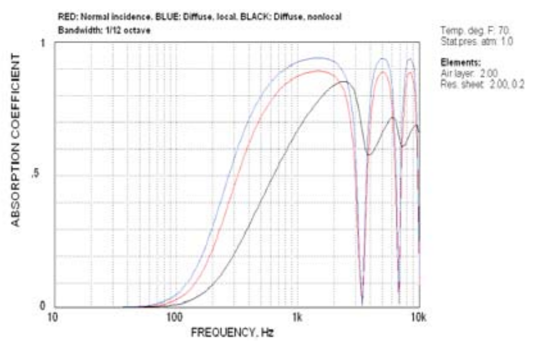
Since 1997, Volvo and Scania have been pioneers in using these panels for lining engine compartments. EU directives on the flammability of materials used near engines for many years demands that these materials do not act as wicks to absorb fuels and oils.

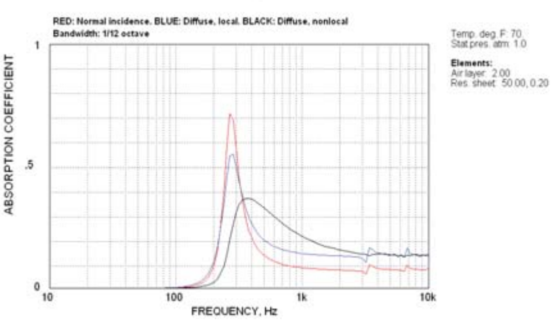
In the hot 'nasty' areas near the engine, catalytic converters and exhaust pipes, the usual metal shields can now be replaced by the value-added micro-perforated acoustical heatshields. The new invention has also spread to several automotive manufacturers who are currently evaluating various press-formed heatshield application areas .

In the most extreme environments, such as inside the exhaust gas channels and mufflers, some inventive manufacturers and users are performing design tests to utilize the outstanding properties, thereby eliminating the need for fibrous or ceramic absorbants which can be consumed or disintegrated during the first few years of operation. There is a special EU directive limiting the particle pollution from vehicles.

Some engine manufacturers have encountered the need to encapsulate the engine but find that solid steel sheet panels do not contribute to the necessary dissipation of sound. Replacing them with Acustimet has been shown to decrease the noise emitted in combination with an outer reflector panel.

In the lower regions of the engine bay, noise damping is rarely used, but new regulations have forced some OEMs – Kalmar, for instance – to install a bottom plate with acoustical reduction properties.





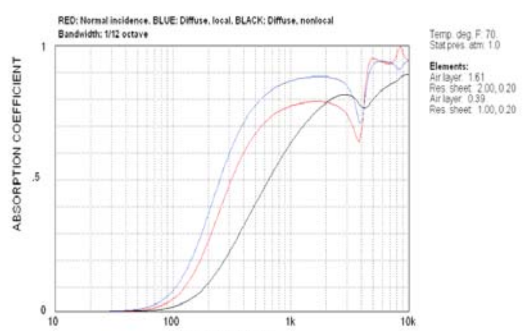


FIGURE 1: Absorption factor calculated for a 50mm air gap

Tackling other sources of noise

In the cabin, where more and more of the surfaces are designed with glass for maximum sightlines, one manufacturer has replaced a solid sheet cover with an MPP. To achieve extra comfort, it was laminated to a textile lining – without affecting the acoustical performance.

Some cabling and pipes are hidden from view behind the cover, which – because it was located near floor level – was constructed from a sturdy steel able to withstand boot kicks without permanent deformation.

In the roof area, the same technique using a textile lining on a form-pressed metal MPP is readily able to match colours and texture demands from the design department.

One exciting potential application that has not yet been exploited is the polymer-based MPP. This will enable even some of the transparent plastics to become noise absorbent, although this gain in acoustical properties is achieved at the expense of reducing transparency to 'light-transmissible'.

One final use that should not be ignored is the use of damping partition panels and ceiling modules to reduce noise in the workshop. Volvo now recommends its suppliers of automatic NC machines include Acustimet in the most challenging working areas in order to kill the noise as close to the source as possible.

Reducing noise is a must

EU directive 2000/14 stipulates that the noise emitted from outdoor machinery produced in, or imported into, the EU must be reduced to 60% of the current level as from 1 January 2006 – a challenging task for all producers of off-highway vehicles.

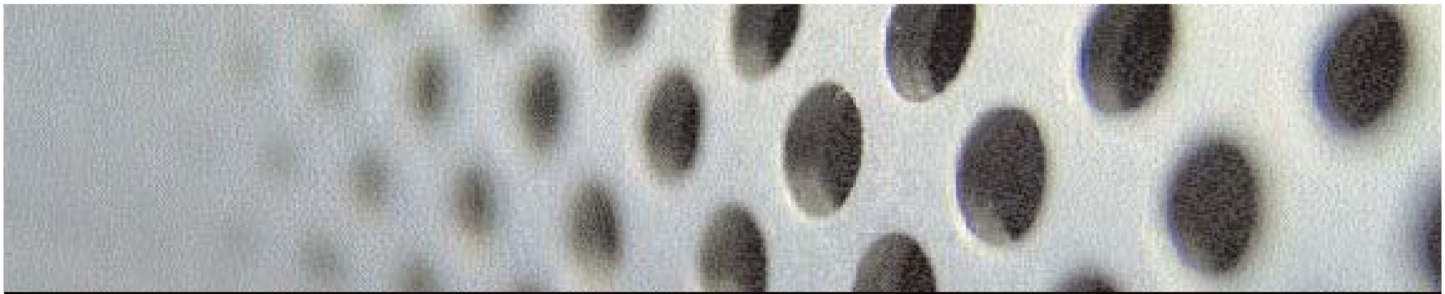
A 2-3dB(A) reduction certainly requires a profound redesign of engine encapsulation and exhaust systems as well as the transmission and hydraulic systems. In addition, Directive 2002/49 on general maximum noise levels in the work places directly limits the acceptable levels inside the cab. Levels higher than 87dB(A) are never allowed. How many of today's bigger machines meet this target?

Since its beginning in 1987, Sontech has been devoted to serving the needs of the OEM sector by assisting with the reduction of noise. As a supplier of both materials and acoustical solutions, the company has come into close contact with the real problems, such as:

Structural damping: The range includes vibration-damping add-on products and ready vibration-damped constructional steel laminates. Typical use: flat enclosure panels, thin sheets or pressed covers.

Noise absorption: Acustimet was developed during the early 1990s and a world-wide patent later approved. In this process, the need for metalworking expertise was accomplished with external help.

Acustimet mounted on the fixed part of the engine hood



Acoustical foams and fiber materials that may be formed by heat pressing or cutting are in continuous development in co-operation with customer demands. An acoustical laboratory with resources for further material development as well as consulting work for customers projects has been built up, where university graduate specialists pursue the development projects on a high technology level.

Optimisation of noise source enclosures

Every day, Sontech concentrates on reducing the amount of noise treatment materials required. By combining theoretical analyses, laboratory measurements of material parameters and practical/real noise sourcing, the total cost of noise treatment is often reduced when the job is complete.

The theoretical analysis performed is computer-based, with a continuous aim to develop prediction tools – work carried out in collaboration with many companies and independent experts.

Figure 1 shows the noise absorption coefficient prediction for an absorbing panel at 50mm air gap/distance from the engine hood. The result is dependent on the type of sound field as well as the type of reaction (local or non-local). A local reaction can be obtained by using foam material in the gap instead of air.

In the Sontech laboratory, small reverberation chamber and tube sound-absorption measurements and flow-resistance measurements are carried out, producing useful methods of choosing the most suitable noise absorbing solution for each customer application.

In an engine compartment, there are different frequencies dominating the total sound radiation depending on position. By varying the total flow resistance and the absorber thickness/distance from the engine hood, the absorbing effect can be tuned, giving maximum noise absorption in almost every part of the engine compartment. iVT

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