



Designing acoustics in industry

Industrial pipe systems



Ensure effective noise protection at the workplace

Whenever people are working alongside machines or motors, effective noise protection solutions are needed. Noise protection in industry requires noise protection concepts for the protection of the health of employees, to minimize absenteeism, to improve the working climate and to remain in compliance with the directives and regulations in force.

Not only do machines, powertrains or engines increase noise pollution in industrial halls, factories and workshops, but process pipes also amplify noise and degrade acoustics in industrial operations. In the long run, noise levels in the workplace can contribute to poor concentration, loss of performance and increased absenteeism.

On the contrary, targeted noise protection measures help improve the quality of people's work and the long-term working atmosphere by significantly lowering the noise level.

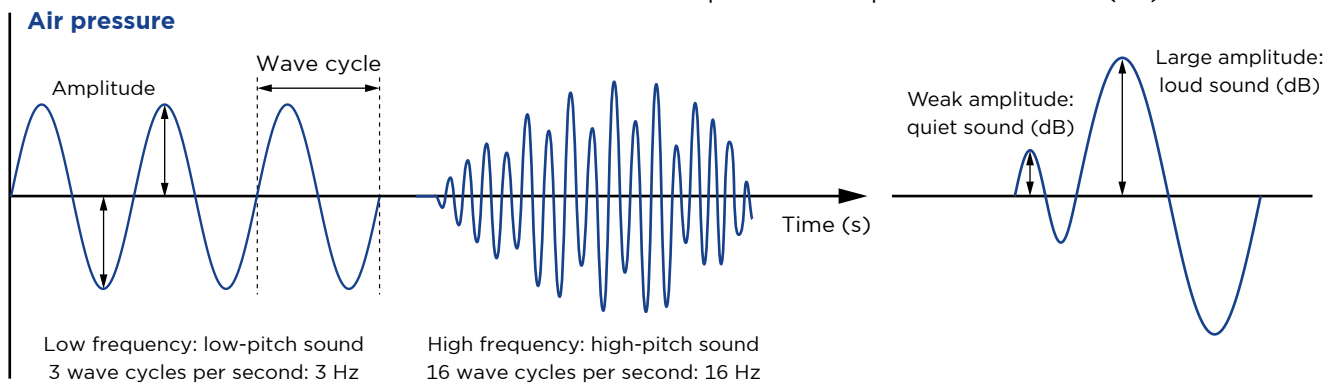
Insulation plays a key role in creating an optimal acoustic environment

In industrial acoustics, the noise source occupies a central place, and one must try to nip annoying noises in the bud.

A bit of acoustics theory

What is frequency?

The frequency of a sound is the number of pressure variations per second and is expressed in hertz (Hz). A frequency of 1 Hz refers to one wave cycle per second, while 20 Hz refers to 20 wave cycles per second. The number of pressure variations gives a sound its distinctive tone: a low frequency produces a low-pitch sound; a high frequency will give a high-pitch sound.

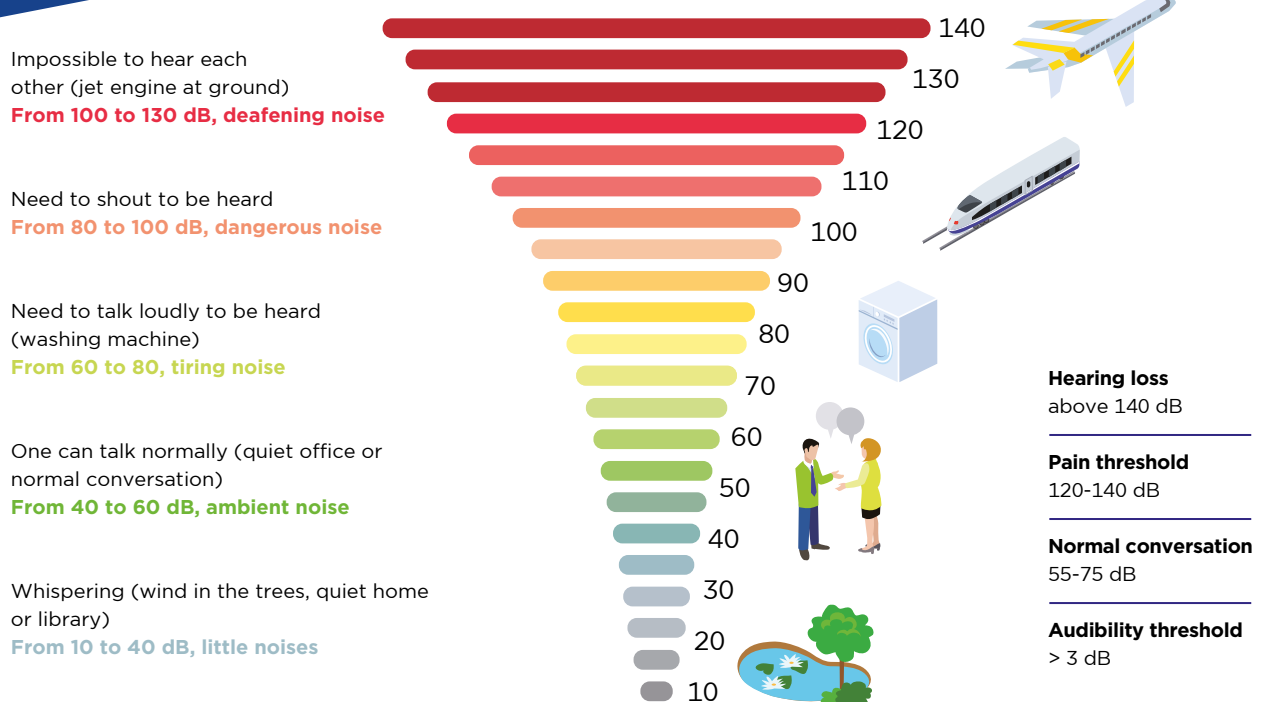


The audio spectrum is the frequency range that is audible to humans. This generally spans from 20 to 20,000 Hz.

What is sound pressure?

The sound pressure level terms the amplitude of a sound. A weak amplitude produces a quiet sound, a large amplitude a loud sound. The scale of sound pressure is expressed in decibels (dB).

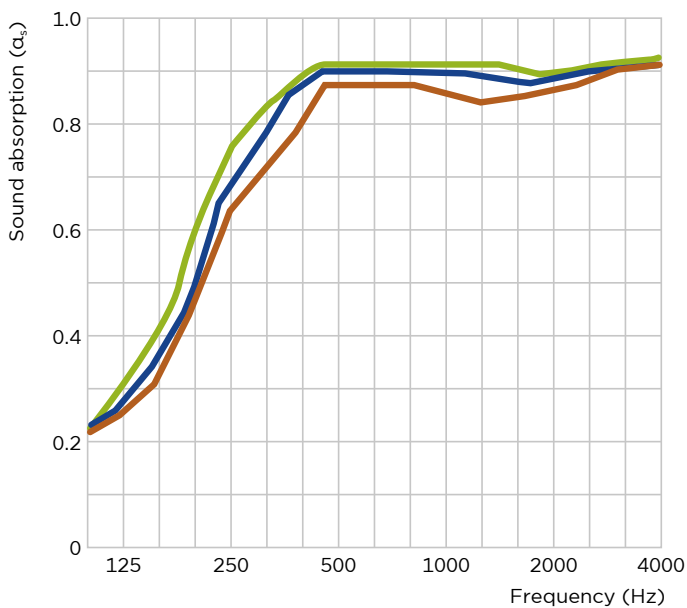
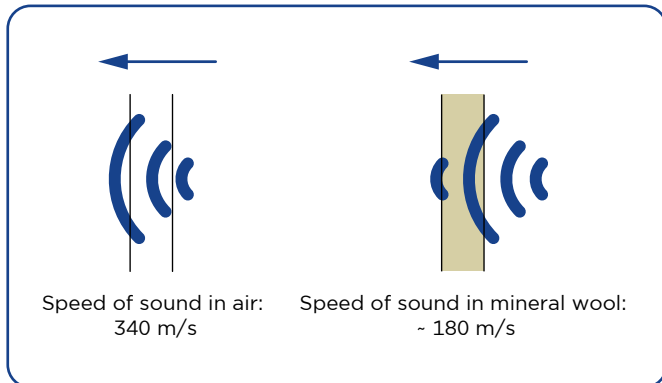
Noise level scale



Acoustic properties of mineral wools

When choosing the best acoustic insulation solution for your projects, you should mainly consider the following parameters:

- Air flow resistivity, r (kPa.s/m²)
- Sound absorption, α_s (dimensionless)



- Air flow resistivity 6 (KPa.s/m²)
- Air flow resistivity 18 (KPa.s/m²)
- Air flow resistivity 47 (KPa.s/m²)

Air flow resistivity

The air flow resistivity is an intrinsic property of all absorbent materials. It determines their ability to reduce the transmitted acoustic energy, by reducing the speed of sound.

The air flow resistivity is the result of friction between the mineral wool fibres and the air particles they enclose. This property depends mainly on the length and diameter of the mineral wool fibres.

The air flow resistivity should ideally be between 5-50 kPa.s/m² (the acoustic behaviour at equal thickness is similar); below 5 kPa.s/m² the insulation will not provide sufficient sound absorption, and above 50 kPa.s/m² the transmission of noise will be predominantly structure-borne because it would be an excessively rigid material.

The air flow resistivity, r , is determined by the test carried out according to the EN 29053 standard, required for materials used in acoustic applications.

Sound absorption

Sound absorption means that part of the acoustic energy that hits a surface is absorbed and transformed into heat.

When a wave front reaches a vertical wall that separates two enclosures, part of the incident energy is reflected by the wall, another part of this energy is absorbed by it, and finally, the remaining energy passes through the wall.



The incident sound energy, E_i , is described by the following energy equation (principle of energy conservation):

$$E_i = E_a + E_r + E_t$$

Breaking this down, the above expression for E_i is as follows:

$$1 = \alpha + \rho + \tau$$

Where:

$\alpha = E_a/E_i$ is the **sound absorption coefficient** (dimensionless)

$\rho = E_r/E_i$ is the **acoustic reflection coefficient** (dimensional)

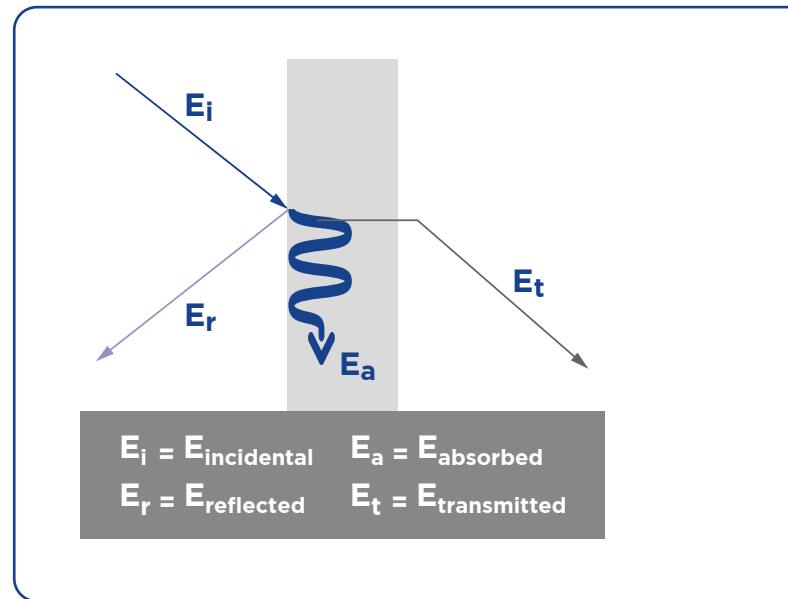
$\tau = E_t/E_i$ is the **coefficient of acoustic transmission or transmissibility** (non-dimensional)

The sound absorption coefficient α of a material is characterised by the amount of incident energy that the material is capable of absorbing; it varies according to several parameters:

- Air flow resistivity
- Sound frequency
- Porosity (air volume/total volume)
- Tortuosity (geometry of the material structure)
- Thickness

The sound absorption coefficient of an insulation material is typically measured in a reverberation chamber in accordance with the EN-ISO 354 standard for measurement and is called the "Sabine" absorption coefficient α_s .

The sound absorption coefficient is between 0 and 1.



DID YOU KNOW

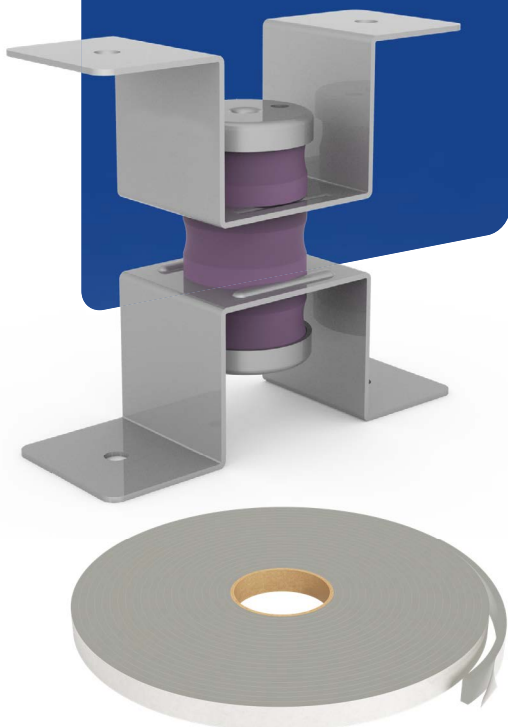
Mineral wools have very high absorption coefficients and are characterised by the way their surface allows sound energy to penetrate through the material's pores.



Solutions for all industrial acoustic applications

Fans, compressors, chimney exhaust systems and large motors are important causes of noise problems in industry. To treat them, there is a range of effective noise control solutions designed to work seamlessly with your process and equipment, including silencers, enclosures and cabins, barriers or insulation systems for pipework.

Discover our Isover TECH dB Spacers and Isover TECH dB Band, that not only minimise acoustic bridges, but even improve the acoustic performance of the overall solution (see table for Class 3 on page 9).



Pipework

Large industrial sites can be characterized by the presence of kilometres of pipelines which can represent a major source of noise. Noise can arise from the turbulent flow of compressible fluids, changes in pipe diameters, termination of piping at a header or vessel, and noise induced by equipment.

The noise radiated by the wall of a pipe is usually generated by equipment connected to the pipe and the flowing medium. These noise sources may cause long sections of pipes to radiate noise because noise will propagate in the pipe with little attenuation.

Acoustic insulation in pipes typically consists of a sound-absorbing and/or resilient material as mineral wool (“porous layer”) on the piping and an impermeable outer cover (“cladding”). An optional intermediate mass layer in direct contact with the cladding can also be added to improve the acoustic performance.

When spacers are needed to support the cladding, they shall be resilient instead of rigid as the ones used in support rings for thermal insulation (following the most common acoustics regulations).

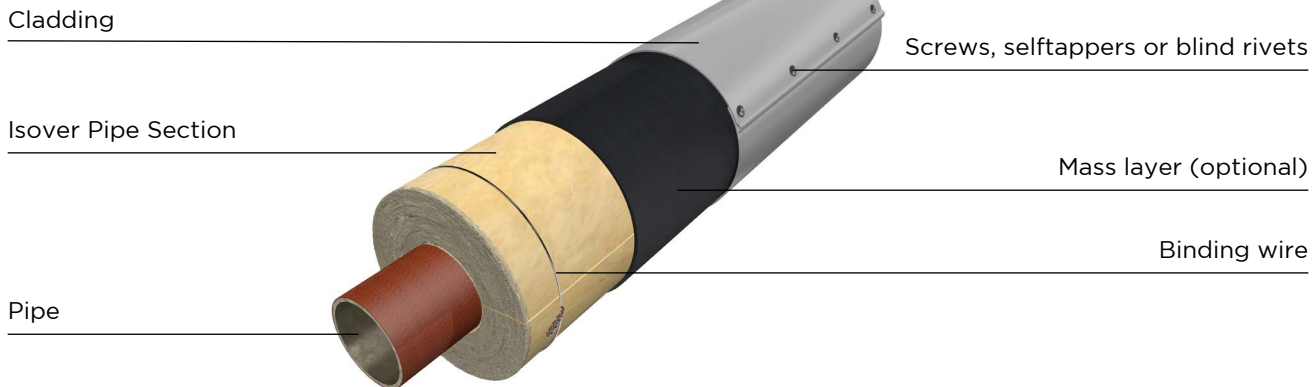
However, the spacers commonly used, although resilient, constitute acoustic bridges which reduce the performance of the sound insulation system.

This is why we have developed the Isover TECH dB Spacer, a specific acoustic spacer, and Isover TECH dB Band, an acoustic band, to maximize acoustic performance.

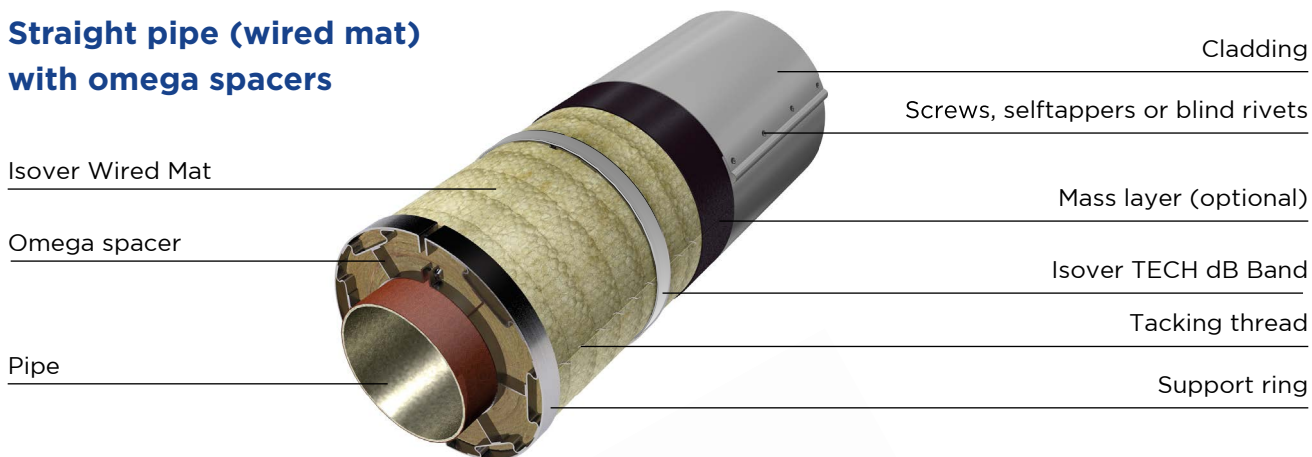
Insulation significantly reduces acoustic vibrations between the pipe and the cladding while absorbing noise.

The sound insulation performance requirements of systems for reducing noise produced by pipes, valves and flanges of an installation are defined in the standard document ISO 15665: 2023 “Acoustics. Acoustic insulation for pipes, valves, and flanges”.

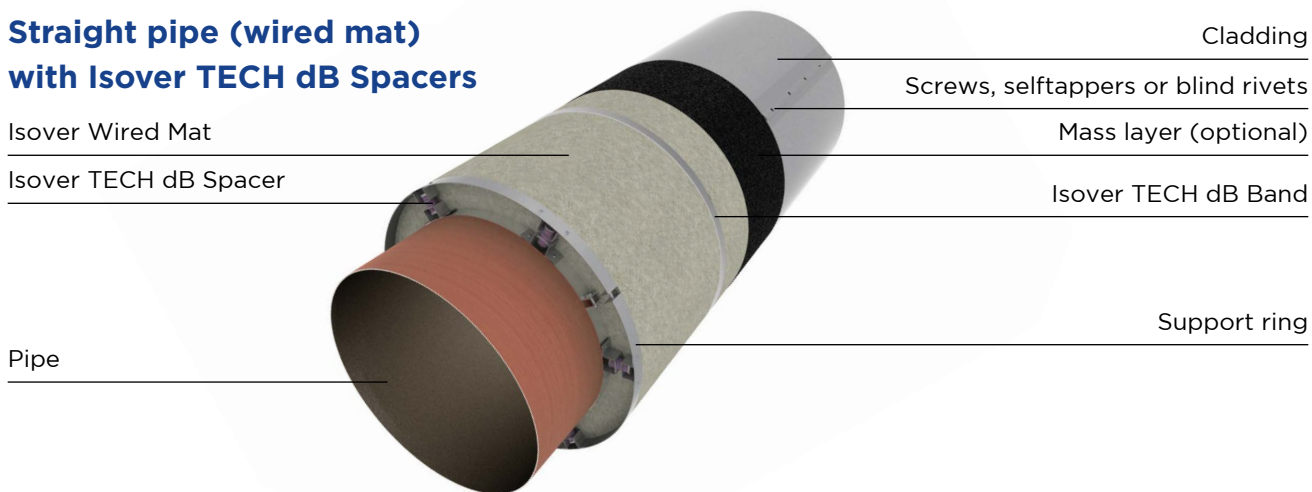
Straight pipe (pipe section), small diameter



Straight pipe (wired mat) with omega spacers



Straight pipe (wired mat) with Isover TECH dB Spacers



Insertion loss refers to the reduction of sound by adding insulation and cladding to a pipe to prevent sound from travelling outward. The difference in ambient (exterior) noise level between the bare pipe and the insulated pipe is the insertion loss.

Acoustic classes

Engineers and large operators in the field of industry use it to specify efficient soundproofing systems for specific noise reduction.

This International Standard defines the acoustic performance of three classes (Classes A, B and C) of pipe insulation in terms of minimum insertion loss requirements. The diameters of the pipes are divided into three groups of pipe sizes (1, 2 and 3) because the insertion loss of sound insulation is also related to the diameter of the pipe to which it is applied. In addition, a more demanding Class D has also been widely adopted in the industry sector.

Minimum insertion loss required for the above mentioned classes (A, B, C, D) according to ISO 15665

| Class | | Nominal diameter D (mm) | Octave band centre frequency (Hz) | | | | | | |
|-------|----|-----------------------------|-----------------------------------|-----|-----|-------|-------|-------|-------|
| | | | 125 | 250 | 500 | 1,000 | 2,000 | 4,000 | 8,000 |
| | | Minimum insertion loss (dB) | | | | | | | |
| A | A1 | D < 300 | -4 | -4 | 2 | 9 | 16 | 22 | 29 |
| | A2 | 300 ≤ D < 650 | -4 | -4 | 2 | 9 | 16 | 22 | 29 |
| | A3 | 650 ≤ D < 1,000 | -4 | -2 | 7 | 13 | 19 | 24 | 30 |
| B | B1 | D < 300 | -9 | -3 | 3 | 11 | 19 | 27 | 35 |
| | B2 | 300 ≤ D < 650 | -9 | -3 | 6 | 15 | 24 | 33 | 42 |
| | B3 | 650 ≤ D < 1,000 | -7 | 2 | 11 | 20 | 29 | 36 | 42 |
| C | C1 | D < 300 | -5 | -1 | 11 | 23 | 34 | 38 | 42 |
| | C2 | 300 ≤ D < 650 | -7 | 4 | 14 | 24 | 34 | 38 | 42 |
| | C3 | 650 ≤ D < 1,000 | 1 | 9 | 17 | 26 | 34 | 38 | 42 |
| D | D2 | 300 ≤ D < 650 | -3 | 4 | 15 | 36 | 45 | 45 | 45 |
| | D3 | 650 ≤ D < 1,000 | 3 | 9 | 26 | 36 | 45 | 40 | 40 |

The most suitable formats for pipe insulation are pipe sections or wired mats, depending on the diameter of the pipe and the thickness of the insulation. When choosing your acoustic insulation, you may also consider the thermal requirements.

Class 1

| Insulation | Thickness [mm] | Cladding | Mass layer | Classes |
|--------------------------------------|----------------|----------------|---------------------|----------|
| U TECH Pipe Section MT 4.0 | 50 | 1 mm aluminium | 5 kg/m ² | A1/B1/C1 |
| U TECH Pipe Section MT 4.0 | 50 | 1 mm steel | - | A1/B1/C1 |
| U Protect Pipe Section Alu2 | 50 | 1 mm aluminium | 5 kg/m ² | A1/B1 |
| U Protect Pipe Section Alu2 | 50 | 1 mm steel | - | A1/B1 |
| U Protect Pipe Section Alu2 | 50 | 1 mm aluminium | 8 kg/m ² | A1/B1/C1 |
| TECH CLIMCOVER Crimped Roll 2.0 Alu2 | 50 | 1 mm aluminium | 8 kg/m ² | A1/B1/C1 |

Other configurations available upon demand.

Class 2

| Insulation | Thickness [mm] | Spacers | Cladding | Mass layer | Classes |
|--------------------------------------|----------------|---------|----------------|---------------------|-------------|
| TECH Lamella Mat 2.0 | 100 | - | 1 mm aluminium | 5 kg/m ² | A2 |
| TECH CLIMCOVER Crimped Roll 2.0 Alu2 | 100 | - | 1 mm aluminium | - | A2/B2 |
| TECH CLIMCOVER Crimped Roll 2.0 Alu2 | 100 | - | 1 mm aluminium | 8 kg/m ² | A2/B2/C2 |
| TECH CLIMCOVER Crimped Roll 2.0 Alu2 | 100 | omega | 1 mm aluminium | 8 kg/m ² | A2/B2/C2 |
| U TECH Wired Mat MT 4.0 | 100 | omega | 1 mm aluminium | 8 kg/m ² | A2/B2/C2 |
| U TECH Wired Mat MT 4.0 | 80 | TECH dB | 1 mm aluminium | 8 kg/m ² | A2/B2/C2/D2 |
| U TECH Wired Mat MT 4.0 | 100 | TECH dB | 1 mm aluminium | 8 kg/m ² | A2/B2/C2/D2 |

Isover TECH dB Band is applied on all support rings. Other configurations available upon demand.

Class 3

| Insulation | Thickness [mm] | Spacers | Cladding | Mass layer | Classes |
|--------------------------------------|----------------|---------|----------------|---------------------|-------------|
| TECH CLIMCOVER Crimped Roll 2.0 Alu2 | 100 | - | 1 mm aluminium | 8 kg/m ² | A3/B3/C3 |
| U TECH Wired Mat MT 4.0 | 50 | omega | 1 mm aluminium | 8 kg/m ² | A3/B3/C3 |
| U TECH Wired Mat MT 4.0 | 100 | omega | 1 mm aluminium | 3 kg/m ² | A3/B3 |
| U TECH Wired Mat MT 4.0 | 100 | omega | 1 mm aluminium | 8 kg/m ² | A3/B3/C3 |
| U TECH Wired Mat MT 4.0 | 100 | TECH dB | 1 mm aluminium | 8 kg/m ² | A3/B3/C3/D3 |

Isover TECH dB Band is applied on all support rings. Other configurations available upon demand.

The acoustic class assigned to each system is based on values obtained from third party laboratory tests under certain conditions. Real life conditions may differ due to various environmental and operational factors. Third party test reports for each system are available upon request.

In many cases the Isover solutions outperform the requirements by ISO 15665.

Other unpublished configurations are available that may meet specific needs.

Also we can test or model custom systems at your request (e.g. systems for pipe diameters > 1,000 mm).



ULTIMATE™ insulation materials for industrial acoustics

Choose the right solution for your application

Regardless of how your acoustic requirements are defined or which industrial systems and components you want to insulate against noise, Isover offers you a wide range of suitable sound insulation solutions.

Our products for sound insulation are tested for the relevant acoustic properties, such as air flow resistivity,

sound absorption values and dynamic stiffness, and are verified by a third party.

To help you quickly find the best sound insulation solution for your needs, we have summarized the sound absorption values for common products used in industry in the table below.

| Isover® product | AFr (σ) kPa.s/m ² | Sound absorption coefficient (α) | | | | | | | | | | | | | |
|--------------------------------|--|---|--------|-------------------|--------|-------------------|--------|-------------------|--------|---------------------|--------|---------------------|--------|---------------------|--------|
| | | α_w medium | | α_p 125 Hz | | α_p 250 Hz | | α_p 500 Hz | | α_p 1.000 Hz | | α_p 2.000 Hz | | α_p 4.000 Hz | |
| | | 50 mm | 100 mm | 50 mm | 100 mm | 50 mm | 100 mm | 50 mm | 100 mm | 50 mm | 100 mm | 50 mm | 100 mm | 50 mm | 100 mm |
| U TECH Slab 2.0 | AFr > 10 | 1 | 1 | 0.17 | 0.57 | 0.80 | 1.19 | 1.03 | 1.13 | 1.08 | 1.07 | 1.08 | 1.06 | 1.10 | 1.11 |
| U TECH Slab MT 3.1 | AFr > 20 | 1 | 1 | 0.18 | 0.70 | 0.82 | 1.15 | 1.09 | 1.09 | 1.07 | 1.09 | 1.02 | 1.05 | 1.09 | 1.11 |
| U TECH Wired Mat MT 4.0 | AFr > 30 | 1 | 1 | 0.24 | 0.86 | 0.94 | 1.05 | 1.15 | 1.01 | 1.08 | 1.03 | 1.04 | 1.07 | 1.09 | 1.10 |
| U TECH Wired Mat MT 6.0 | AFr > 50 | 1 | 1 | 0.44 | 0.87 | 1.11 | 0.91 | 1.01 | 0.99 | 1.01 | 1.03 | 1.05 | 1.02 | 1.09 | 1.08 |

Note

These values were determined in laboratory tests under defined boundary conditions. However, in real-world conditions, values may vary due to environmental and operational factors. Therefore, these values are to be understood as guideline values and serve primarily to estimate the planned noise protection measure.

The specific determination of the damping required in the application is an engineering service on the part of the customer and cannot be replaced by the orientation values in the tables. Isover assumes no liability in the event that the insulation used does not meet the individual requirements.



ULTIMATE™ - High Performance Solution for Industrial Equipment

Lightweight and flexible for easy installation

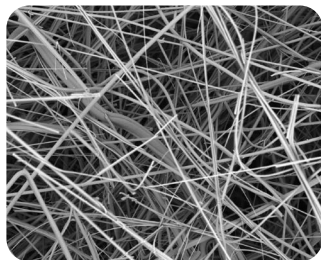
ULTIMATE™ is a high-performance lightweight mineral stonewool. It is produced in a manufacturing process patented by Isover, similar to glass wool, without slugs.

At the same time, ULTIMATE™ offers equal or even better performance in terms of sound, fire and thermal insulation than conventional stone wool, even with a significantly lower density.

This means that ULTIMATE™ can easily replace traditional stone wool in all applications and also offers the unique combination of excellent soundproofing properties, low thermal conductivity, optimal fire protection properties, low weight and easy processing.

A look through the electron microscope shows the advantages of ULTIMATE™ compared to traditional stone wool

ULTIMATE™ under the electron microscope



100 µm enlarged 100 x

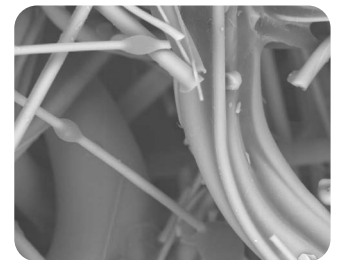


10 µm enlarged 750 x

Traditional stone wool under the electron microscope



100 µm enlarged 100 x



10 µm enlarged 750 x

Advantages ULTIMATE™

- Excellent acoustic properties
- Up to 20% better thermal insulation
- High compressibility: up to 60% less storage space required
- Long fibres with high resilience
- No slugs due to 100% fiberization

Project Advice

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