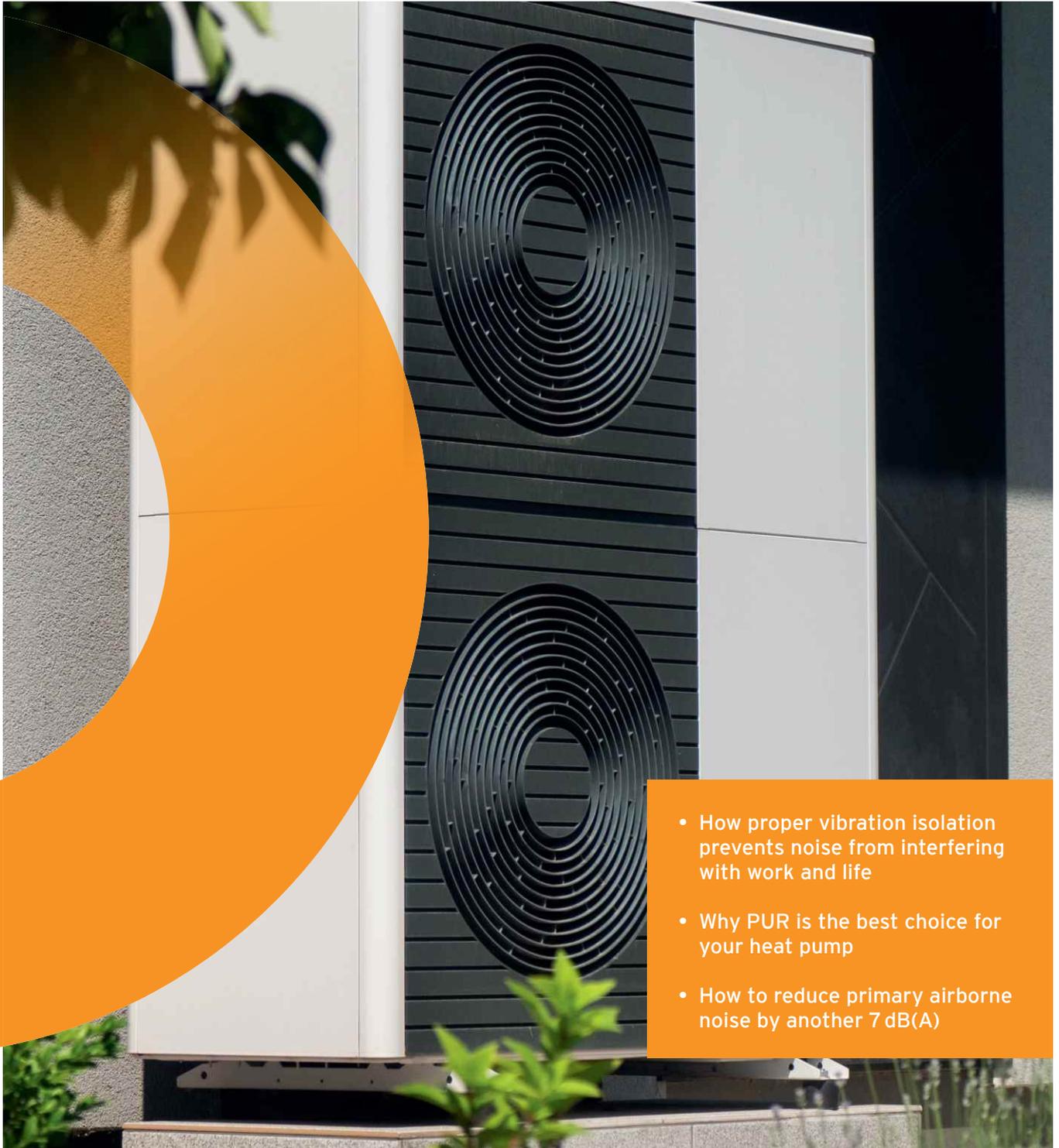


# MAKE YOUR HEAT PUMP QUIETER



- How proper vibration isolation prevents noise from interfering with work and life
- Why PUR is the best choice for your heat pump
- How to reduce primary airborne noise by another 7 dB(A)



## **Why it is important to focus more on the compressor vibrations and the transfer of structure-borne noise.**

“It’s loud. It’s humming. I cannot sleep.”. A situation probably all of us have been through - as a manufacturer, installer or end customer. This low frequency “rumbling” noise drives you crazy. And it’s no surprise as we are getting more and more aware of noise and the impact on our daily lives.

Decarbonization is a huge topic. It leads to governmental regulations like Domestic Renewable Heat Incentive in the UK. Governments encourage the installation of heat pumps to promote efficient methods of heating our homes. This will certainly increase the number of heat pumps around us and lead to problem areas. We are all moving closer together - not only in urban areas but also domestically i.e. multiple family homes. Several studies have shown that noise and noise reduction will become even more important in the future.

This means we should take a closer look at the source of noise originating from a heat pump. Not only focusing on primary but also bringing attention to structure-borne noise in our product design and installation considerations. Therefore, protection against the generation and transmission of structure-borne-noise plays an important role. In short, we need to talk about vibration isolation.

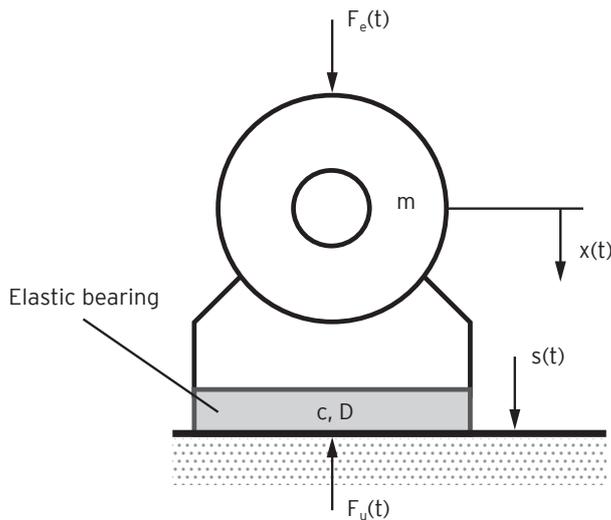
Compressors are the heart of every heat pump. Often “Silent Heat Pump Modes” are promoted and given sound values. The given sound

values typically refer to primary airborne noise. In many cases, this “whisper quiet” mode is achieved by using inverter compressor technology. This means motor speed of the compressor is regulated according to the actual need.

A wonderfully efficient way to make the most of your heat pump. Ironically, by reducing the motor speed you also change and reduce the excitation frequency of the compressor - creating even more of these unwanted, low frequency “rumbling” noises.

Therefore, focusing only on primary noise neglects the impact of structure-borne noise. As measurements show, a heat pump with efficient vibration isolation will have an even lower primary noise level. And best of all, common issues residents typically encounter with a heat pump attached to their home just don’t occur.

# CONCEPTS AND SOLUTIONS



$m$ [kg]	Machine Mass
$c$ [kN/mm]	Spring stiffness of the elastic bearing
$D$	Damping of the elastic bearing
$F_e(t)$ [N]	Exciting force
$x(t)$ [mm]	Movement of the machine
$s(t)$ [mm]	Movement of the floor
$F_u(t)$ [N]	Force transmitted into the foundation

**A heat pump creates, from a physical point of view, a single mass oscillatory system.**

The elastic installation elements and the mounted construction create, from a physical point of view, an oscillatory system. This is described using the single mass oscillator mode and possesses a resonance or natural frequency. The characteristic vibration frequency is derived from the mass  $m$  of the system and the dynamic stiffness  $c$  of the elastic bearing.

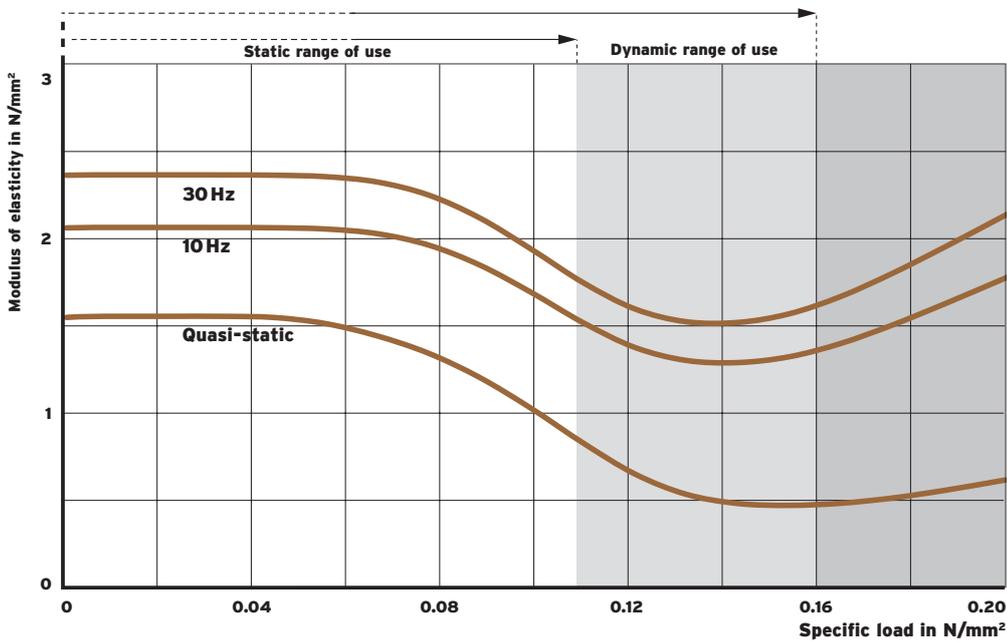
$$f_0 = \frac{1}{2\pi} \cdot \sqrt{\frac{c}{m}}$$

The oscillatory system is excited by an external stimulus and starts to vibrate. The model refers to this as the exciting force. When assessing the isolating effect of a single mass oscillator, the frequency ratio  $\eta$  between the excitation frequency of the external stimulus ( $f_e$ ) and the natural frequency of the vibrating system ( $f_0$ ) has to be considered.

$$\eta = \frac{f_e}{f_0}$$

An isolation effect only occurs in the frequency range  $f_e/f_0 > \sqrt{2}$ . So-called low frequency tuning occurs when the natural frequency  $f_0$  of the system is around a factor of 1.41 lower than the lowest frequency  $f_e$  of the mechanical vibrations.

In the resonance range  $f_e/f_0 < \sqrt{2}$  there is an amplification of the mechanical vibration in all cases, independent of the dampening.



Polyurethane (PUR) materials are the most suitable for elastic vibration isolation of components. Compared to conventional rubber, PUR contains no plasticisers, so their elastic properties remain constant for decades.

Even more important for the vibration isolation performance is the dynamic stiffness, that describes the material response under load. Machine bearings on a polyurethane basis show a significantly lower level of dynamic stiffness compared to conventional rubber. This softness results in lower natural frequencies and in an increased effectiveness of vibration isolation.

**Minimized vibrations.  
Reduced noise.  
Quieter heat pumps!**

## AT A GLANCE

- Knowing the natural frequency of your system is important to find the most suitable vibration isolation.
- Using materials with exactly defined characteristics (e.g. polyurethane PUR) makes calculation easy.
- PUR gets softer under dynamic use which results in a better vibration isolation.

# ISOLATION CONCEPTS FOR HEAT PUMPS

With polyurethane identified as the right material for constant and efficient vibration isolation, we can now talk about isolation design or application.



**Isolation of the entire heat pump reduces primarily structure-borne noise.**

**Isolation of the compressor reduces airborne and structure-borne noise.**

You can either decouple the entire heat pump, focus on the isolation of the compressor inside only or do both. While machine decoupling reduces structure-borne sound by preventing vibrations from being transmitted into the building structure, the decoupling of the compressor has an additional positive effect on primary airborne sound.

**Discover more**  
about different concepts of  
compressor bearing



[getzner.com/  
heatpump](https://getzner.com/heatpump)

# PRODUCT SOLUTIONS

Isotop by Getzner offers a wide range of machine bearings combining its polyurethane materials Sylomer®, Sylodyn® and Sylodamp® with metal parts for an easy, convenient and effective installation.

## Bearing of entire heat pump



**Isotop® DSD**



**Isotop® DMSN**



**Isotop® MSN-DAMP**



**Isotop® ENI**



**Isotop® SE pro**

## Bearing of compressor



**Isotop® MSN-DAMP**



**Isotop® Compact**



**Sylomer®/Sylodyn®  
Compressor Grommet (pro)**



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# REDUCING STRUCTURE-BORNE NOISE



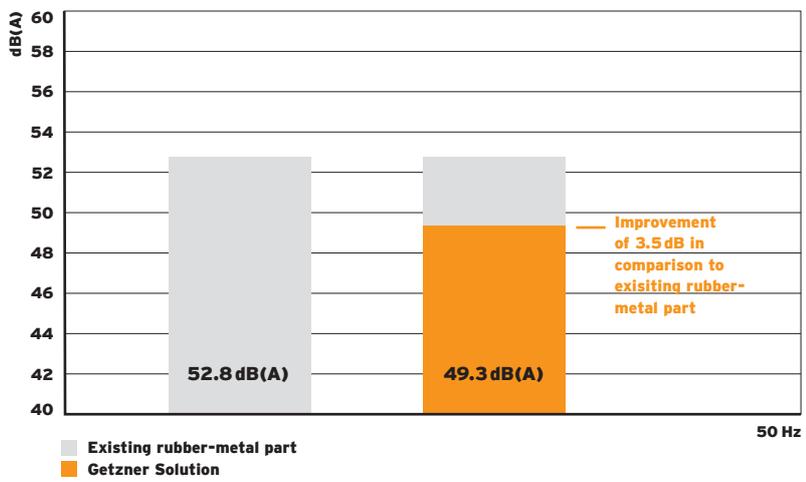
Effective bearing of refrigeration plant within the roof space

## Elastic bearing of an industrial compressor system

A client required three chillers for their manufacturing plant, which were installed one next to the other in the roof space above the office area. The structure-borne noise emitted by the two scroll compressors per unit disrupted the day-to-day work of the staff in the offices below.

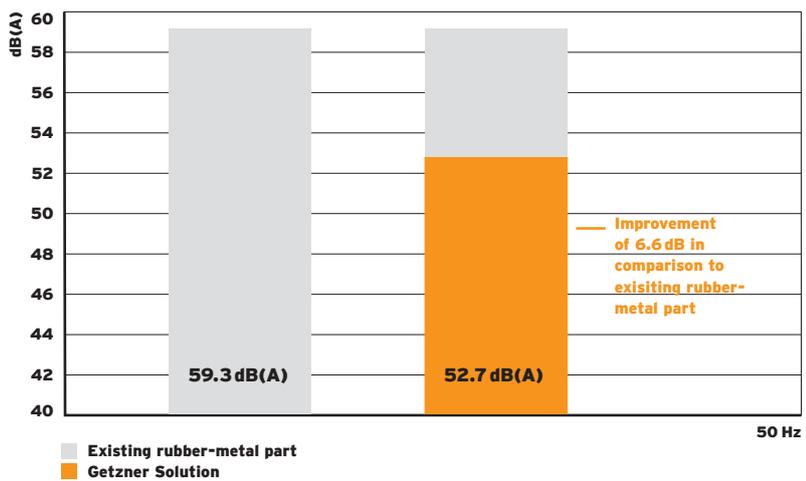
The existing machine bearings (rubber-metal) did not provide the desired results. The noise and vibration created by the compressors was measured by Getzner technicians before and after the installation of Sylodyn® point bearings. The structure-borne noise emitted was reduced by 4-6 dB(A) (Graph 1 and Graph 2). The vibration isolation effect was therefore improved by 10 dB (Graph 3). This meant that the Getzner solution significantly improved conditions for the employees.

**Graph 1: Improvement in the level of airborne noise at 50 Hz (one system in operation)**

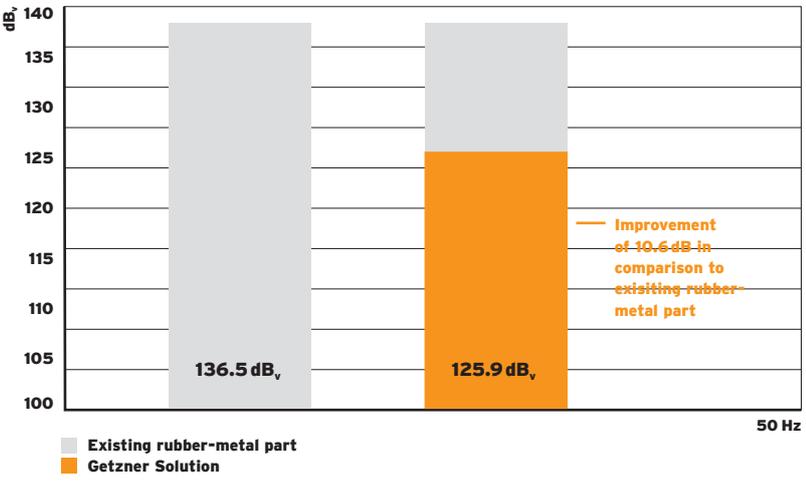


Scroll compressors installed in the system

**Graph 2: Improvement in the level of airborne noise at 50 Hz (all systems in operation)**



**Graph 3: Vibration accelerations at 50 Hz**



# REDUCING PRIMARY AIRBORNE NOISE



Setup of the measurement of airborne noise

## Elastic bearing of compressor

In order to compare the effect of different elastic bearings of a compressor on the primary airborne noise, measurements were carried out on a compact air conditioning unit.

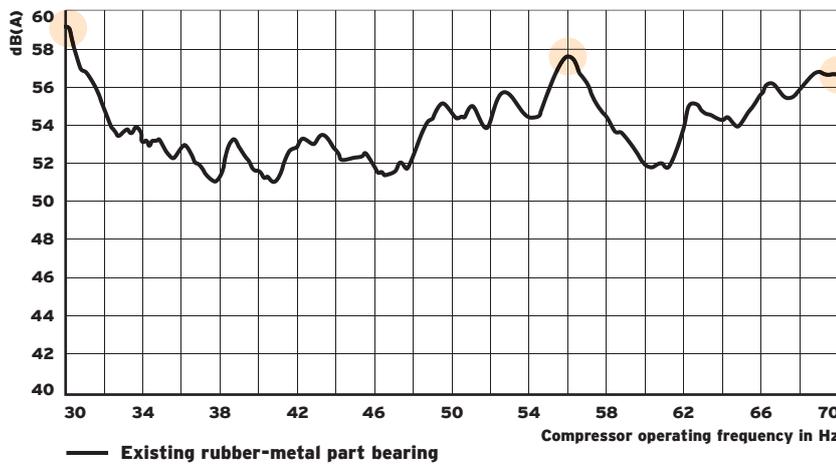
The main excitation came from a GEA Bock refrigerant compressor. A frequency converter allowed us to adjust the operating frequency between 30Hz and 70Hz. The fan was set to 30% of its nominal maximum performance. To measure the influence of the bearings on the primary airborne noise, four microphones were placed around the unit.

The compressor itself was installed on four bearing points. We compared the existing rubber-metal element to the Isotop® MSN-DAMP product.



Compressor placed on four Isotop MSN-DAMP products

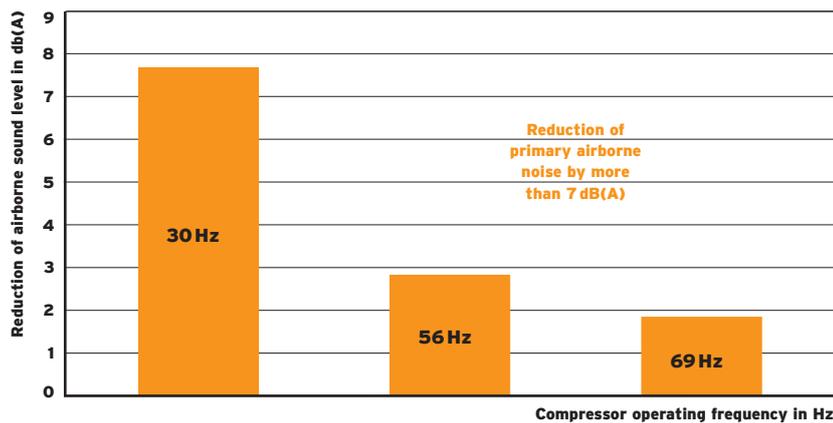
**Absolute sound level db(A) existing rubber-metal bearing (mean values over 4 measurements)**



During the first measurement with the existing rubber-metal bearing, the compressor operating frequency was increased slowly and continuously. The signal of the microphone was recorded and the A-weighted airborne sound level was determined (average of four measurements). The maximum of the sound emissions at 30 Hz, 56 Hz and 69 Hz inverter frequency are clearly visible.

After this first measurement, we changed the set-up to the Isotop MSN-DAMP product. The graph on the right shows the measured reduction in airborne sound radiation compared to the rubber-metal element. Differences of up to 7.7 dB(A) were measured, especially in partial load operation with low compressor speed (30 Hz inverter frequency).

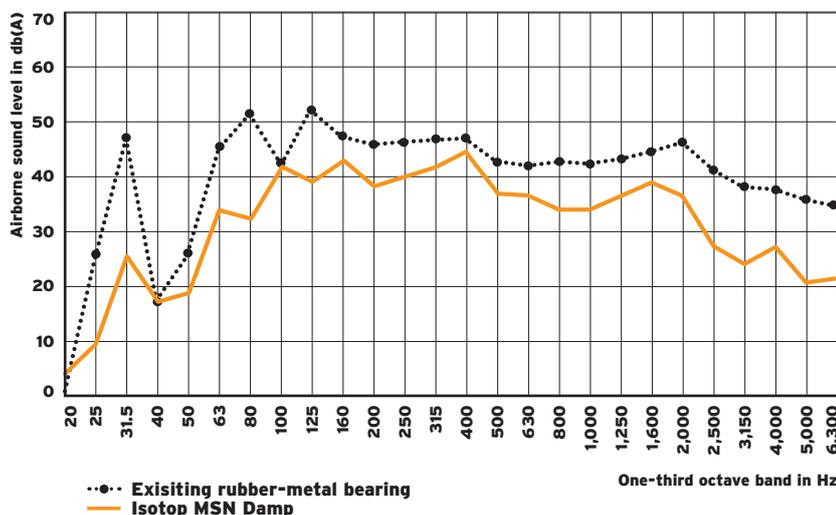
**Reduction of airborne sound level with Isotop MSN-DAMP compared to existing rubber-metal bearing**



Heat pumps with inverter compressor technology with its very positive effects on efficiency have become the state-of-the-art in this industry. Therefore, we were very much interested in the effects of changing operating compressor frequencies (i.e. partial load areas) on the primary airborne noise when using a well designed vibration isolation.

If we look at an operating frequency of 30 Hz and examine the frequency domain (one-third octave spectrum), we see a clear improvement. It is remarkable that the improvement occurs almost evenly over the entire audible frequency range.

**Airborne sound third-octave spectrum of compressor operating frequency 30 Hz**





# THAT IS HOW TO MAKE YOUR HEAT PUMP QUIETER

- Get engineering support and input as early as possible in the product development cycle.
- Try to get as close as possible to the main source of vibration (i.e. compressor isolation).
- Select a vibration isolator that gets softer under dynamic use - not stiffer.
- Choose a vibration isolator with a low natural frequency in order to efficiently decouple compressors under partial load.
- Choose vibration isolators with consistent long-term performance. In other words, try to avoid materials with softeners.

## **Selecting the most suitable product for your heat pump is quite easy.**

Our online product selector EquipCalc is fast, intuitive and always up-to-date. Register now!



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equipcalc](https://getzner.com/equipcalc)

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