Perforated Liner Tuned Acoustic Absorbers

In many noise control applications, the offending noise occurs only in a narrow range of frequencies or even at a single frequency. Noise generated by industrial machines/equipment mostly fall in this category. For such situations, it is possible to design a sound absorption system that is "tuned" to those target frequencies. One of the most commonly used tuned absorber is Helmholtz resonator (HR).

In most applications, the effective absorption of the noise requires the use of many small HRs, spread over a large area, rather than one large HR placed at one location. To avoid making and installing many individual HRs, one can use a perforated acoustic liner backed by a cavity; see Figure 1. Depending on the intended application, the cavity is either divided into smaller sub-cavities (cells) with each cell assigned to one or a small number of perforations or it is a large common cavity servicing all or a larger number of the perforations. As in HRs, the inertance of the gas oscillating in the perforations can be viewed as a mass and the compliance of the gas in the absorber cavity can be viewed as a spring, the combination of which realize the tuning frequency.

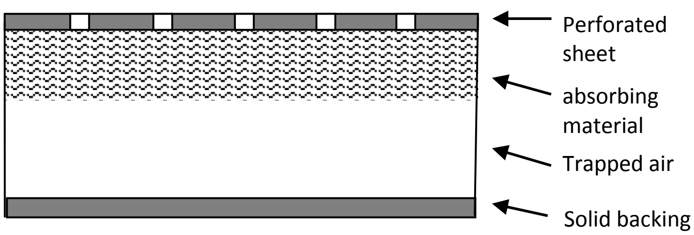


Figure 1 Make-up of perforated acoustic liner

The frequency response functions of Figure 2 depict the pressure measured inside an enclosure with no acoustic treatment (black/dotted line), treated with 2 inches of glass fiber sound absorbing material (blue/dashed line), and c) treated with perforated liners tuned to around 430 Hz (red/solid line).

Comparing black/dotted line with blue/dashed line traces in Figure 2 clearly indicates that the addition of 2 inches of plain sound absorbing material (glass fiber) does not dissipate low frequency sound, appreciably. Extending the comparison stated above to the red/solid line trace in Figure 2, shows the effectiveness of the perforated acoustic liner in terms of dissipation of acoustic energy in the narrow frequency range centered at the tuning frequency of 430 Hz.

High absorption efficiency of perforated acoustic liners at the vicinity of their tuned frequency make them highly attractive in acoustic treatment of machinery enclosures, fan generated noise, lining mufflers, and aerospace applications.

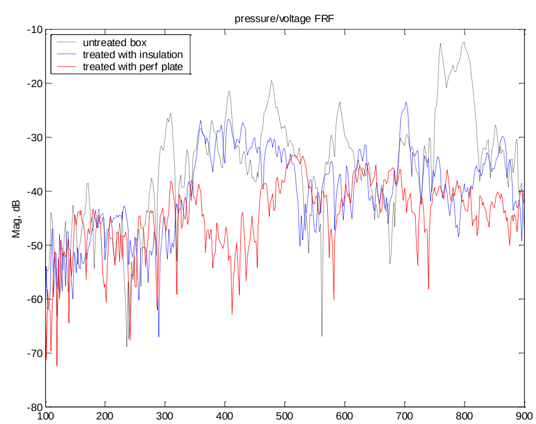
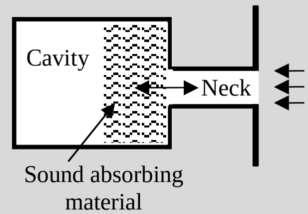


Figure 2 Frequency response functions indicating absorptions with different acoustic

Helmholtz resonator (HR) is comprised of a cavity (acting as a spring) and a neck through which the gas (acting as mass) travels back and forth between the cavity and the external medium; see the schematic figure.

Frequently a layer of sound absorbing material is also added in the cavity, next to the neck.



The cavity and neck combination, resemble a spring mass combination, and as such have a *natural frequency* determined by the inertance of the gas in the neck and the compliance of the gas enclosed in the cavity.

At natural and neighboring frequencies, the gas moves vigorously in and out of the cavity, through the sound absorbing material, causing the acoustic energy of the gas to be converted into heat (and dissipated).

Tuning a Helmholtz resonator to an offending narrow-band noise, dissipates the energy of that noise.