Acoustic Actuators (Loudspeakers) for Industrial Active Acoustic Damping Applications

A loudspeaker (acoustic actuator) designed for high-temperature, low-frequency active acoustic damping application is shown in Figure 1. The cabinet is all metal (made of aluminum) making the speaker suitable for outdoor applications. The 4 ports on the cabinet extend the performance of loudspeaker to lower frequencies. The ports also allow for equalizing the static pressure on both sides of the driver cone as well as air cooling of the voice coil.

Figure 1 High temperature, low-frequency loudspeaker

Frequently, active tuned acoustic absorption solutions are used for abating low frequency tones in a duct carrying gas at elevated temperatures. In such applications the actuator (speaker) requires to a) have the static pressure on both sides of the cone equalized, b) extend their capability to lower and lower frequencies, and c) allow for a temperature management scheme of both their surround and their voice coil. These requirements can be satisfied by placing the speaker driver in a Helmholtz resonator (HR) and blowing a small amount of cooling air at the voice coil and the surround. The ports of the HR allows for equalization of the static pressure on both sides of the driver cone. Tuning the resonator to frequency lower than the target frequency of the active absorber, extends the effectiveness of the speaker to lower frequencies. Moreover, the ports allow for the air used to cool the voice coil of the speaker to convect out of the cavity of the HR.

The gray/dashed line trace in Figure 2 depicts the frequency response function of speaker without the ports (a sealed box). As indicated by the green and red traces, the addition of 4 properly sized ports to the box, the frequency response function extends further into low frequencies. In addition, the ports allow for equalization of static pressure at both sides of the cone. It also allows the cooling air used to cool the voice coil, to flow out of the cabinet.

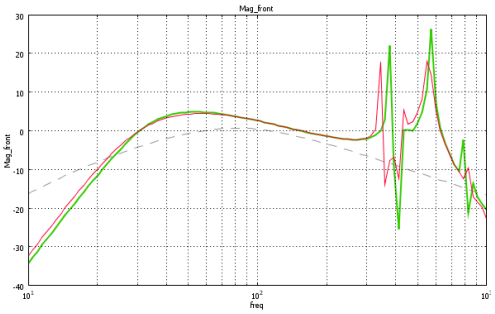
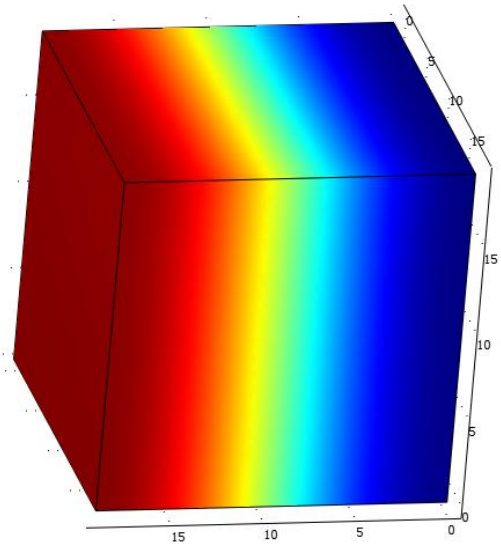
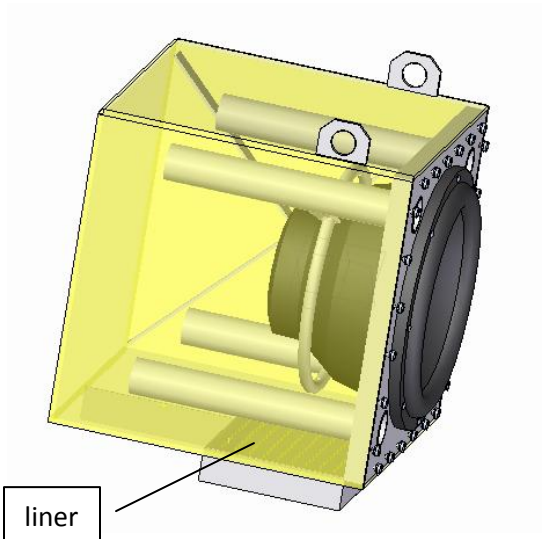


Figure 2 Frequency response function

Acoustic resonance of the speaker cabinet: By incorporating a perforated liner, tuned to the resonant frequency of the first acoustic mode of the cabinet, into one of the walls of the speaker, acoustic damping (absorption) is introduced into that standing wave; see Figure 3.



(a)



(b)

Figure 3 First axial standing wave of the cabinet (a) and an acoustic liner (b) for dampening it

Structural resonance: By bracing the side panels of the speaker cabinet (from inside) the low frequency structural resonance of the panels are increased by almost two folds.

Cooling: Provision for air cooling of the motor and the surround are designed and built into the makeup of the speaker. A thermocouple is attached to the motor magnet and one is placed close to the surround, allowing for the monitoring of the temperature at these locations. An aluminum heat sink is epoxied to the bottom of the magnet helping with the dissipation of heat. The flow of air thru the perforated liner further enhances the removal of heat from the motor. Figure 4 shows the port and driver assembly highlighting the cooling provisions of the motor.

Figure 5 depicts the speaker installed on an air duct carrying heated air, in a process industry.

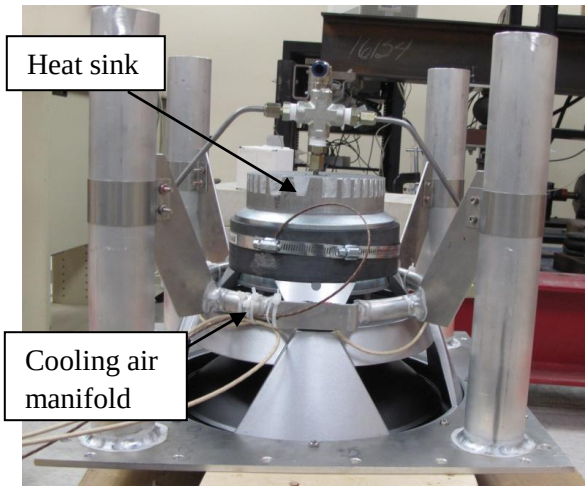


Figure 4 Port and driver assembly

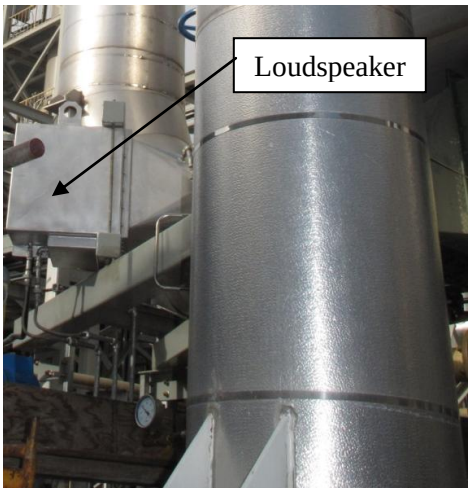


Figure 5 The loudspeaker installed