

Active Tuned Damping of an Acoustic Enclosure

A tuned damper, i.e., a quarter wave tube (QWT) was used to damp the acoustic resonance in an industrial enclosure. Due to space limitations, the 2 inch diameter quarter wave tube could not be placed optimally on the enclosure. Note that to couple effectively with the acoustic mode targeted for damping, the acoustic treatment should be placed where it can effectively couple with the target resonant mode. As expected the passive tuned damper exhibited some, but not enough, damping performance; mainly due to unfortunate placement constraints.

The QWT was tuned to 320 Hz (the target) mode, adding a moderate amount of damping to it (the target mode). Figure 1 shows the magnitude of the frequency response functions, with and without the passive acoustic damper, mapping perturbation at the disturbance location to the pressure measure somewhere inside the enclosure.

The QWT provided the less than satisfactory effectiveness shown in Figure 1, with *having no sound absorbing material in the tube*; placing any energy dissipative material such as mineral wool or glass fiber in the tube, made the damper ineffective. As stated above, this was to be expected, considering the dramatic difference (almost a 20 fold) in dynamic pressure between the damper location and at anti-node corresponding to the 320 Hz mode. Not having enough energy dissipation in the tuned damper resulted in a very narrowband effectiveness. Beside a degree of mode splitting did occur; see Figure 1.

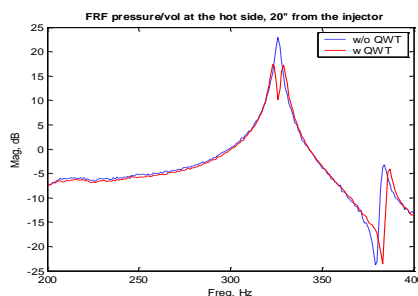


Figure 1 Frequency response functions without (blue/dashed line) and with (red/solid line) QWT damper

Considering that the low controllability associated with the location of the passive damping device, i.e., the QWT, the use of active acoustic damping was attempted. Note that both passive (QW tube) and active control elements were installed at the same location, to the rig.

Although subject to the same placement constraint as the passive treatment, the active tuned damper proved far more effective. Figure 2 depicts the magnitude of the frequency response functions, with and without active control, mapping perturbation at the flame speaker to the pressure measured at the same location where the measurements of Figure 1 were made. Figures 3 (a) and (b) show the time responses of the pressure with the controller off (a) and on (b). Clear from Figures 2 and 3, the active acoustic tuned damping scheme effectively abated the 320 Hz pressure pulsation by more than 25 dBs.

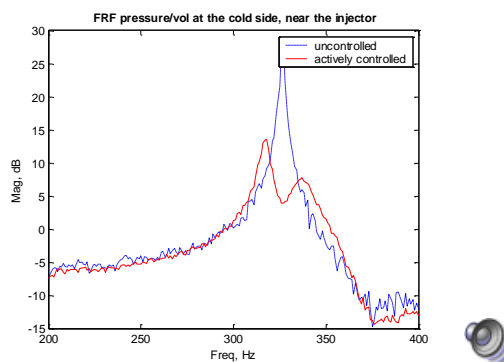


Figure 2 Frequency response functions without (blue/dashed line) and with (red/solid line) active tuned acoustic damping



(a) (b)

Figure 3 Time traces of pressure without (a) and with (b) active tuned acoustic damping