Abstract

The two-microphone impedance tube test method is a well-established and widely used technique for determining the acoustic absorption coefficient and impedance ratio of materials. This method uses two closely spaced microphones to simultaneously measure the incident and reflected sound waves. A two-microphone impedance tube measurement system made of 6061-T6 Aluminum with a diameter of 3 inches, a 0.5 inch wall thickness, and microphones spaced 2.7 inches apart has been constructed for undergraduate research at Texas Christian University (TCU). These geometrical values suggest a usable frequency range of 50 Hz to 2637.77 Hz as referenced in ASTM Standard E1050-19. Validation of the system was achieved by taking measurements on Owen Corning Type 705 pressed fiberglass board with a 1-inch thickness and comparing them to absorption data provided by the manufacturer. Additional validation measurements were taken without a test sample in place. All validation tests suggest that the TCU impedance tube is an accurate measurement system.

Key Design Parameters

As described in the ASTM E1050-19 Standard Test Method, the geometrical properties of the impedance tube determine its usable frequency range. To be more specific, the microphone spacing and the tube diameter limit the frequency. Since the tube diameter is 3 inches, a microphone spacing of 2.7 inches was chosen.

TCU Impedance Tube

- Tube Diameter = 3"
- High Frequency Limit = 2637.77 Hz
- 6061-T6 Aluminum Construction
- Wall thickness = 0.5"
- Microphone Spacing = 2.7"
- Low Frequency Limit = 50 Hz
- X2 = 9" - 3 diameters for Asymmetrical Surfaces
- 2.5" Doux Audio Speaker (LB020)
- 0.5" PCB Microphones (378B02 & Y378A13)

Testing and Validation

The validation of the TCU Impedance Tube began by calibrating the two PCB microphones. This process used a G.R.A.S Type 51AB acoustic calibrator to calibrate the phase of both microphones. Once the microphones were calibrated, the tube was set up to test. Once the microphones were calibrated, the impedance tube can be set up to test.

The validation test for the system was achieved by taking measurements on Owen Corning Type 705 pressed fiberglass board with a 1-inch thickness and comparing them to absorption data provided by the manufacturer as well as an impedance tube Dr. Hall created from 2016. The data was acquired using a LabView program that was then run through a Matlab program that extracted the necessary data and applied the proper transfer functions and equations. The output of the program is the absorption coefficient (a) for the Owen Corning at the frequency range tested.

References