

ME 820 WAVE DYNAMICS IN FLUIDS**Spring 2011****Experiment #2:****Acoustic Attenuation Performance of Silencers****Experiment Date: 5/9/2011; Report Due Date: 5/16/2011**

The acoustic attenuation performance of seven different silencers will be measured in a flow-impedance tube facility (Selamet *et al.*, 1994¹, 2011²) in terms of Transmission Loss (TL). The first six silencers are reactive, including (1) Helmholtz resonator (HR); (2) Quarter-wave resonator with closed end; (3) Quarter-wave resonator with open end; (4) expansion chamber; (5) short perforated resonator, and (6) long perforated resonator; and the seventh silencer is absorptive: (7) an outer cavity filled with continuous strand fiber material communicating with an inner duct through a perforated wall. The TL measurements will be conducted for all configurations in the absence of mean flow. In addition, one of them, HR, will then be subject to mean flow. The measurements will be made in the frequency domain³, and the results will be presented in the form of TL versus frequency. The measured transmission loss data will be provided to you following the experiment.

The report should include the objective and the description of the experiment, and answer the following questions:

1. The neck length of the Helmholtz resonator is $\ell_c=8.5$ cm and the neck diameter is $d_c=4.044$ cm. Using the classical lumped approach, estimate the volume of the cavity. How does this estimate compare to the actual cavity dimensions of length $\ell_v=24.42$ cm and diameter $d_v=15.32$ cm (Selamet *et al.*, 1997⁴)?

¹The Herschel-Quincke Tube: A Theoretical, Computational, and Experimental Investigation, *J. Acoustical Society of America* **96**(5), 3177–3185 [1994; J11].

²Effect of Flow on Helmholtz Resonator Acoustics: A Three-Dimensional Computational Study vs. Experiments, SAE Paper 2011-01-1521 [2011].

³Range for silencers 1-3: 0-1600 Hz; Range for silencers 4-7: 0-3200 Hz.

⁴Circular Concentric Helmholtz Resonators, *J. Acoustical Society of America* **101**(1), 41–51 [1997; J18].

2. Determine the branch length of the quarter-wave resonator based on transmission loss measurements, and compare this result with the actual geometric length of 0.854 m.
3. Using the measured transmission loss spectra, determine the inner diameter and the length of the expansion chamber. The main duct diameter is 4.859 cm.
4. For both perforated resonators, estimate the length-controlled resonance frequencies and compare with measurements. For the dimensions of the perforated resonators, use Table 2 in Dickey *et al.*, 1998⁵.
5. For both perforated resonators, estimate the first Helmholtz resonance frequencies. How does this compare, for the short resonator, to the first length-controlled resonance frequency?
6. Discuss the impact of filling material on the acoustic attenuation.
7. Discuss the impact of mean flow on the acoustic attenuation of Helmholtz resonator.

⁵Multi-pass Perforated Tube Silencers: A Computational Approach, *J. Sound Vibration* **211**(3), 435–448 [1998; J24].