The Effect of Neck Geometry on Aeroacoustic Excitation of a Helmholtz Resonator

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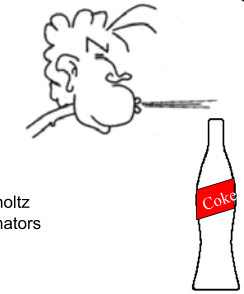
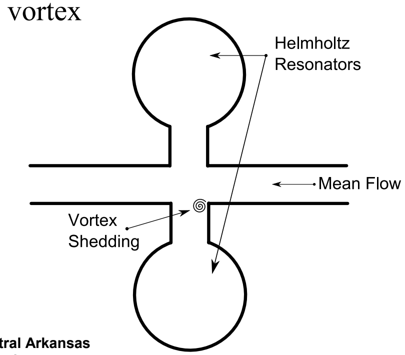
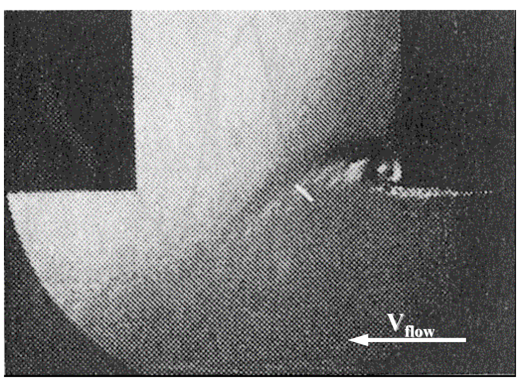
Project Overview:

- Aeroacoustic excitation of a Helmholtz flask
- Created by vortex shedding

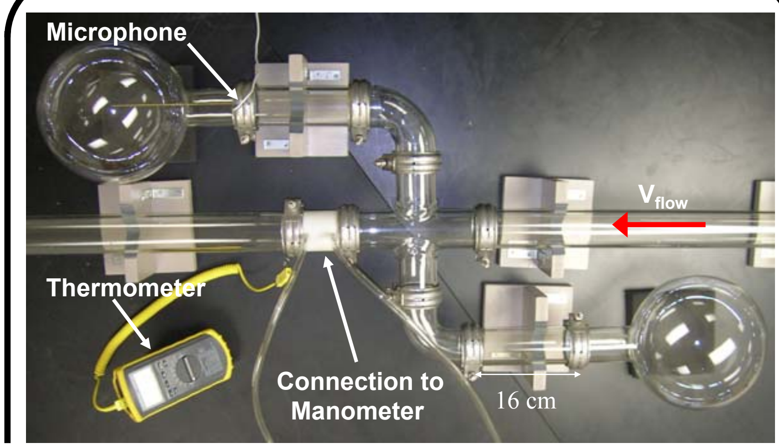


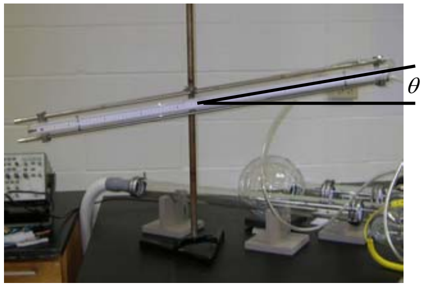


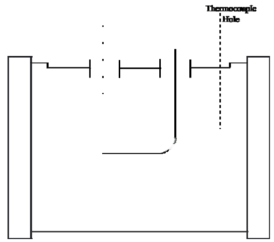
Vortices



M.C.A.M. Peters. Aeroacoustic Sources in Internal Flows.
PhD thesis, Technische Universiteit Eindhoven, 1993.





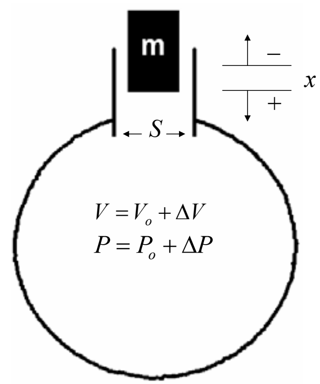


$$\Delta h_{tilt} = \Delta h_{measured} - \Delta h_{reference}$$

$$\Delta h_{no\ tilt} = \Delta h_{tilt} \sin\theta$$

$$v_{flow} = \sqrt{\frac{2\rho_{H_2O} g \Delta h_{no\ tilt}}{\rho_{air}}}$$

Sound is Adiabatic…



$$\frac{P}{P_o} = \left(\frac{V_o}{V}\right)^{\gamma}$$ **Taking the differential** $$\frac{\Delta P}{P_o} \approx -\gamma \frac{\Delta V}{V_o}$$

Given: $\Delta V = -Sx$

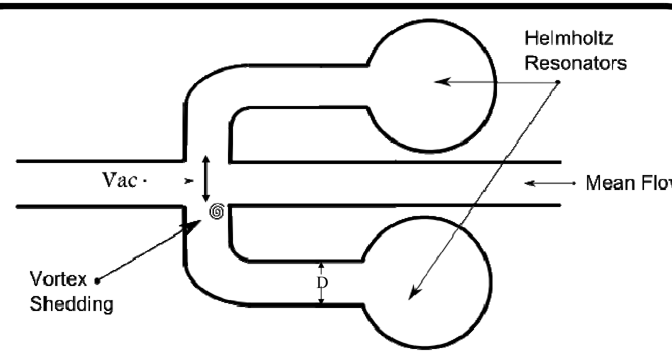
$$c_o^2 = \frac{\gamma P_o}{\rho_o}$$

Then: $$P_{ac} = \frac{\rho_o c_o^2 S}{V_o} x$$

Acoustic velocity: $\upsilon_{ac} = \frac{dx}{dt}$ **With solution:** $x = x_o e^{j\omega t}$

$$\frac{dx}{dt} = j\omega x_o e^{j\omega t} \xrightarrow{\text{taking the magnitude}} \frac{dx}{dt} = \omega x = \upsilon_{ac}$$

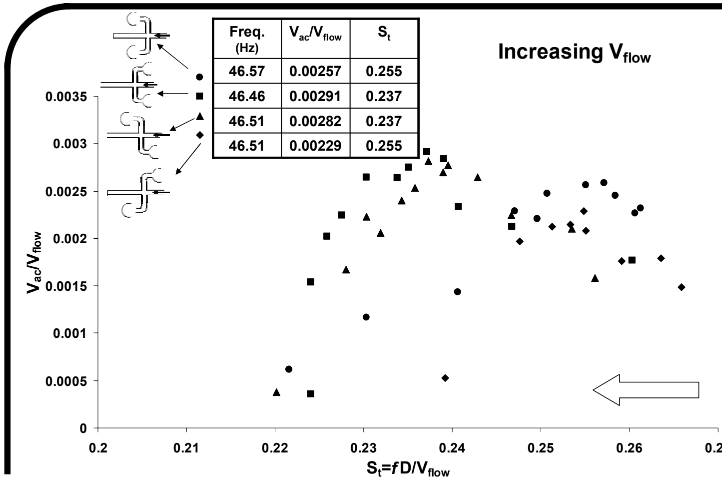
Therefore: $$P_{ac} = \frac{\rho_o c_o^2 S}{V_o}\frac{\upsilon_{ac}}{\omega} \longrightarrow \upsilon_{ac} = \frac{\omega V_o P_{ac}}{\rho_o c_o^2 S}$$



$$v_{ac} = \frac{\omega V P_{ac}}{\rho_o c^2 S} \qquad Strouhal = \frac{fD}{v_{flow}}$$

Increasing V_{flow}

Freq. (Hz)	V_{ac}/V_{flow}	S_t
46.57	0.00257	0.255
46.46	0.00291	0.237
46.51	0.00282	0.237
46.51	0.00229	0.255



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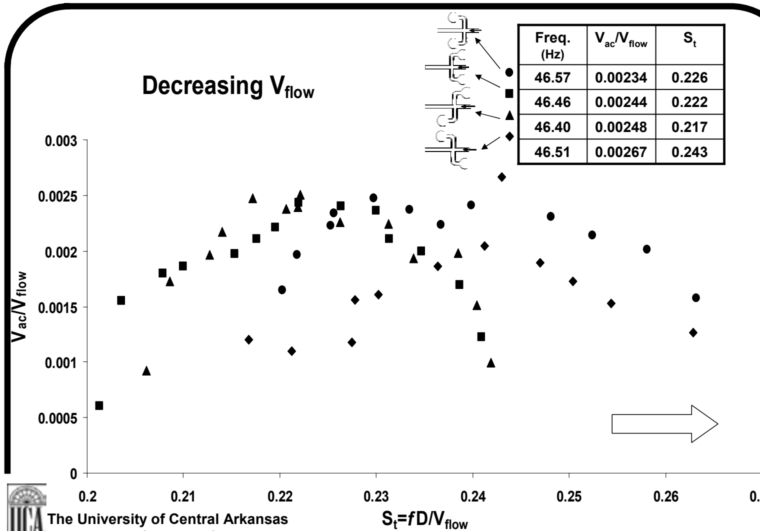
Decreasing V_{flow}

Freq. (Hz)	V_{ac}/V_{flow}	S_t
46.57	0.00234	0.226
46.46	0.00244	0.222
46.40	0.00248	0.217
46.51	0.00267	0.243



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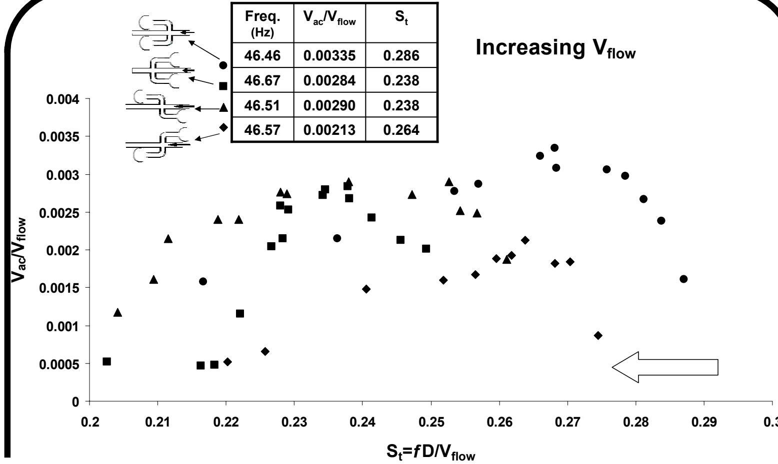
Increasing V_{flow}

Freq. (Hz)	V_{ac}/V_{flow}	S_t
46.46	0.00335	0.286
46.67	0.00284	0.238
46.51	0.00290	0.238
46.57	0.00213	0.264



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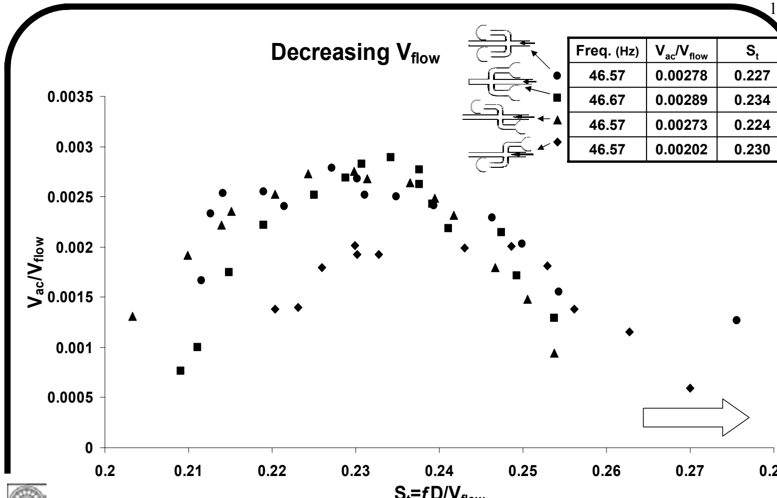
Decreasing V_{flow}

Freq. (Hz)	V_{ac}/V_{flow}	S_t
46.57	0.00278	0.227
46.67	0.00289	0.234
46.57	0.00273	0.224
46.57	0.00202	0.230



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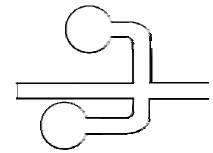
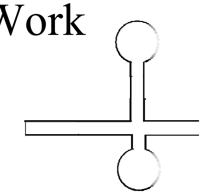
Overall Summary

- S_t < for decreasing V_{flow}
- V_{ac}/V_{flow} > for increasing V_{flow}
- V_{ac}/V_{flow} > for bends then straight pieces
- S_t > for bends then straight pieces

Future Work



Asymmetric Geometries



Asymmetric Geometries
With Different Lengths

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