Subject: ACS 597 - Module 1 Assignement

Date: January 19, 2025 (Submitted)

Problem 1a

The lowest cut-on frequency for a rectangular duct with air flow is given by equation,

$$f_{cut-on} = 0.5 \cdot \frac{c}{L} \tag{1}$$

where c is the speed of sound in air, 343 $\frac{m}{s}$, and L is the largest side of the rectangular cross-section.

With cross-sectional dimensions of L_x = 12 cm and L_y = 20 cm, the lowest cut-on frequency for this rectangular duct is,

$$f_{cut-on} = 0.5 \cdot \frac{343 \ \frac{m}{s}}{0.20 \ m} = \mathbf{857.5 \ Hz}$$

Problem 1b

The lowest cut-on frequency for a circular duct with air flow with the same cross-sectional area as the rectangular duct in part (a.) can be calculated using equation,

$$f_{cut-on} = 0.568 \cdot \frac{c}{d} \tag{2}$$

where c is the speed of sound in air, 343 $\frac{m}{s}$, and d is diameter of the circular duct.

The cross-sectional area of the rectangular duct is,

$$\text{Area}_{\text{ rectangular duct}} = 0.12 \ m \ \cdot 0.20 \ m = 0.024 \ m$$

The corresponding diameter for this area is,

$$\text{diameter} = \sqrt{\frac{0.24 \ m^2}{\pi}} \cdot 2 = 0.17 \ m$$

Using Eq. 2, the lowest cut-on frequency for this circular duct with air flow is,

$$f_{cut-on} = 0.568 \cdot \frac{1,500 \ \frac{m}{s}}{0.17 \ m} = \mathbf{1,114.5 \ Hz}$$

Problem 1c

The lowest cut-on frequency for this circular duct with water flow can be calculated using Eq. 2,

$$f_{cut-on} = 0.568 \cdot \frac{1,500 \ \frac{m}{s}}{0.17 \ m} = \mathbf{4,873.9 \ Hz}$$

The lowest cut-on frequency for water is considerable larger than it is for air flow.

Problem 1d

The speed of sound in air is calculated by,

$$c = \sqrt{\gamma \cdot R \cdot T_K} \tag{3}$$

where γ is the ratio of specific heats, $R = 287\ \frac{J}{kg \cdot K}$ is the gas constant, and T_K is the absolute temperature in Kelvin.

speed of sound in air, 343 $\frac{m}{s}$, and d is diameter of the circular duct.

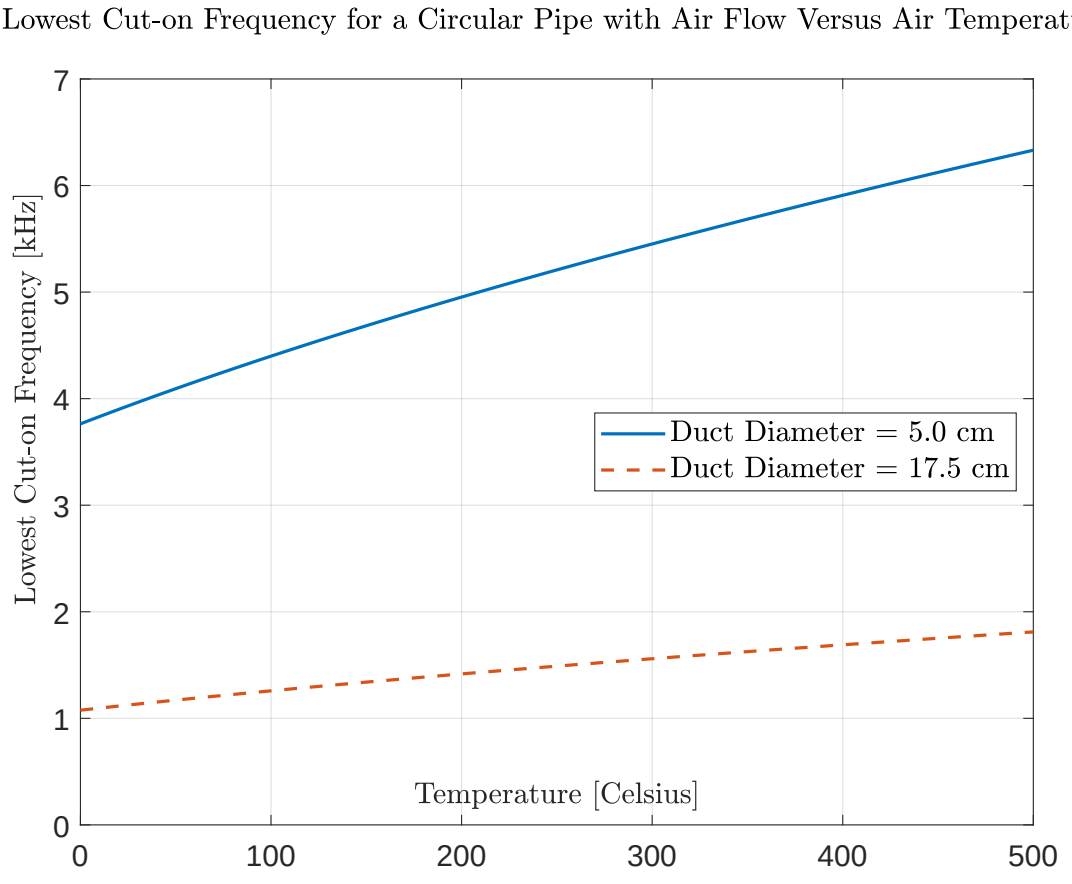

Figure 1: ph.

Problem 1e