AUBURN UNIVERSITY
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COLLEGE OF ENGINEERING
AEROSPACE

AERO 4970/7970 **Rocket Propulsion I** **SET VII**

Combustion of Liquid Propellants

1. For a particular liquid propellant thrust chamber the following data are given:

Chamber pressure	68 MPa
Chamber shape	Cylindrical
Internal chamber diameter	0.270 m
Length of cylindrical section	0.500 m
Nozzle convergent section angle	45^{o}
Throat diameter and radius of wall curvature	0.050 m
Injector face	Flat
Average chamber gas temperature	2800 K
Average chamber gas molecular weight	20 kg/kg-mol
Specific heat ratio	1.20

   Assume the gas composition and temperature to be uniform in the cylindrical chamber section. State any other assumptions that may be needed. Determine the approximate resonance frequencies in the first longitudinal mode, radial mode, and tangential mode.
   Answers: 1,182 Hz; 2,189 Hz; 695 Hz.

2. Explain how the three frequencies from Problem 1 will change with combustion temperature, chamber pressure, chamber length, chamber diameter, and throat diameter.

3. Estimate the resonant frequency of a set of 9 cavities similar to Figure 1 below. Here the chamber diameter is D = 0.2 m, the slot width is 1.0 mm, and the width and height of the cavity are each 20.0 mm. The walls separating the individual cavities are 10.0 mm thick. Assume $L = 4.00$ mm, $\Delta L = 2.00$ mm, and $a = 1050$ m/s.
   Answers: 3,254.8 Hz.

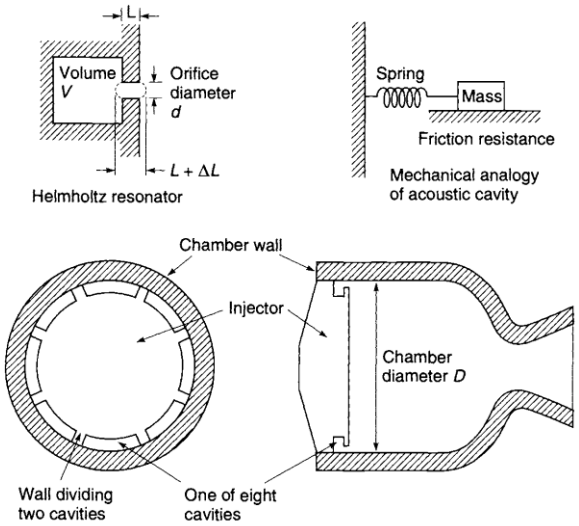

Figure 1. Diagram of acoustic energy absorber cavities at the periphery of an injector. In this thrust chamber the cavity restriction is a slot (in the shape of sections of a circular arc) and not a hole. Details of the chamber cooling channels, injector holes, or internal feed passages are not shown.