Advanced combustion for aeronautics

Design session : the Rijke tube

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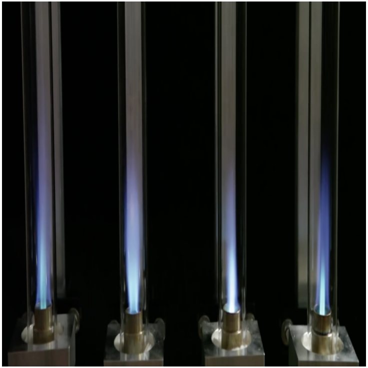
Introduction

Exercise

Given your present knowledge, the your objective is now to explain the following experiment of the flame organ and :

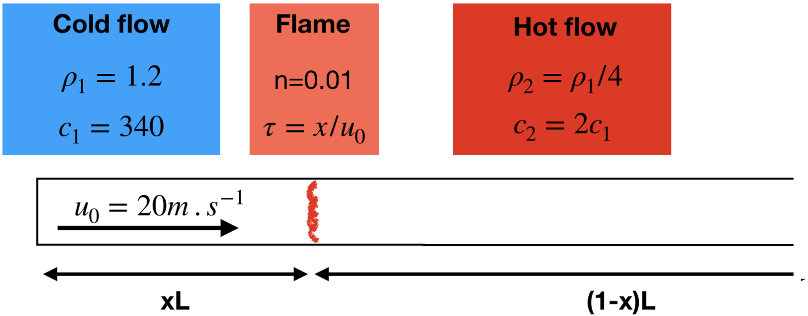
- Identify the expected acoustic frequencies
- Plot the structure of the standing pressure eigenmodes inside the tube



Credit: CentraleSupelec, EM2C

Simplification of the problem

We will simplify it a little and consider the following configuration



Known quantities

The variables of interest have the following values:

- $L = 1.783\ m$ is the length of the tube
- $n = 0.01$ is the normalized flame response
- $c_1 = 340.0\ m/s$ is the speed of sound in the first part of the tube
- $\rho_1 = 1.2\ kg/m^{-3}$ is the air density in the first part of the tube
- $x = 0.2$ provides the position of the flame
- $U_0 = 20\text{m/s}$ is the mean speed of the flow

Your work

Questions and Delivrables

Answer the following questions:

- Identify the system of equations to be solved for this specific problem
- Identify the most unstable acoustic frequenc(y)(ies) between 200 and 10000Hz (i.e. Build the stability map of the Rijke tube). You can for example use the Newton-Raphson algorithm in the complex plane.
- Use an online tone generator to identify and provide the associated tones (https://www.szynalski.com/tone-generator/)
- Plot the structure of the standing pressure unstable eigenmode(s) inside the tube
- Explain the unstable nature of the mode(s) using the Rayleigh criterion

Delivrables:

- Report (10 pages max with illustrations)
- Computational source file (fortran;matlab;python,c++,...) with comments!