Design of a recorder flute

Goal

Design a recorder flute dimensioning the bore, the last two finger holes, the flue channel and the instrument mouth.

First component: resonator

The resonator is shaped as a cone whose conical semiangle is 0.75°. The instrument is aimed at being a treble recorder, with a length of 0.45m. For the sake of simplicity we consider that only two finger holes are present.

Question 1

Find the diameter of the cone at the resonator head and foot so that the note produced when all the finger holes are closed is F4 (349.23 Hz).

Question 2

Find the position of the last finger hole (i.e. the one closest to the resonator foot) in order to produce the note G4 (392 Hz) when it is open. Consider the finger hole diameter to be equal to the bore diameter at the resonator foot (simplification).

Question 3

Find the position of the second last finger hole in order to produce the note A4 (440 Hz) when the two finger holes are open. Consider the finger hole diameter to be equal to the bore diameter at the resonator foot (simplification).

Second component: flue channel and mouth

The instrument is aimed at producing a spectrum whose centroid is at 2.0 kHz when the pressure difference between the player mouth and the flue channel entrance is 62 Pa.

Question 4

Find the flue channel thickness that complies with the above specifications. For this pair of thickness and jet velocity, compute the Reynolds number Re and assess the jet regime that is undergoing at the flue channel exit and in the instrument mouth (laminar, turbulent, etc).

Question 5

Consider that the flue channel length is 20 mm. Find the thickness of the boundary layer at the flue channel exit for the specifications defined above (Question 4).

Question 6

Predict the magnitude of the oscillation of the jet at the labium, using the jet receptivity model, when the sound pressure level at the flue channel exit is 50 dB and the mouth length (distance between the flue channel exit and the labium) is 0.4 cm.

Important information

Deadline: send the report by January 03, 2022.

- Answer concisely;
- Describe – concisely - the procedure used to obtain the results: if an error is present, I cannot identify the reason – numerical or conceptual - if the procedure is not described: in grading I will be forced to use the worst-case option.

- **All students must upload the report.**

In the PDF file and possibly in the filename, specify the name, surname and ID of all the students participating to the HW, if more than one student worked on it.