A singing pipe

Swinging an open corrugated pipe makes it ‘sing’. Increasing the angular velocity raises the pitch. Closing the inner end removes all traces of sound. Blowing through the pipe gives a cascade of notes with varying airflow rate. To demonstrate the mechanism of sound generation we connect a pipe to a bellows as shown below.

Fig 1 – bellows and corrugated pipe.

The bellows is 10 cm high and 10 cm in diameter. The pipe is 1.0 cm in dimeter with 3.0 rings per cm. A series of compressions gives a series of complex whistles that are recorded in Audacity. Each burst of recorded sound has a duration of 0.1 seconds. A sound spectrum is shown below for a pipe length of 80 cm.

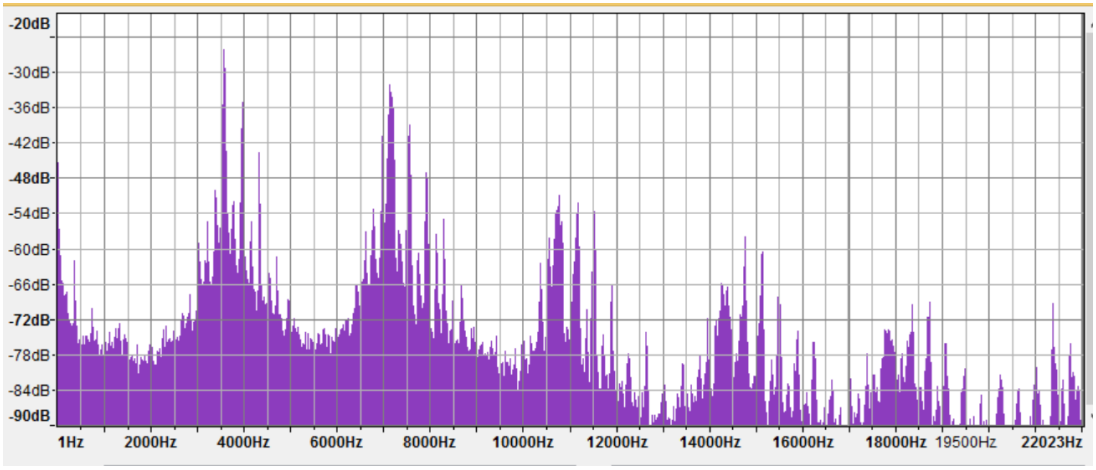

Fig 2 – an FFT spectrum of sound from the 80 cm pipe.

The reader is asked to show for themselves from the data above that the flow rate of air through the pipe is approximately 10 m/s and the lowest expected frequency of sound generated by airflow over the inner surface of the pipe is ~ 3000 Hz.

The peak at ~3500 Hz and the upper harmonics at ~7000, ~10500 Hz etc. (Fig 2 above) are divided at intervals of approximately 200 Hz.

A shorter pipe

A 34 cm pipe with *higher velocity* airflow of about 20 m/s gives a similar spectrum with increased intervals of close to 500 Hz. The expected lowest frequency is now around 6000 Hz because of the air flow rate is doubled. The measured frequencies are close to 5500, 11250 and 16250 Hz.

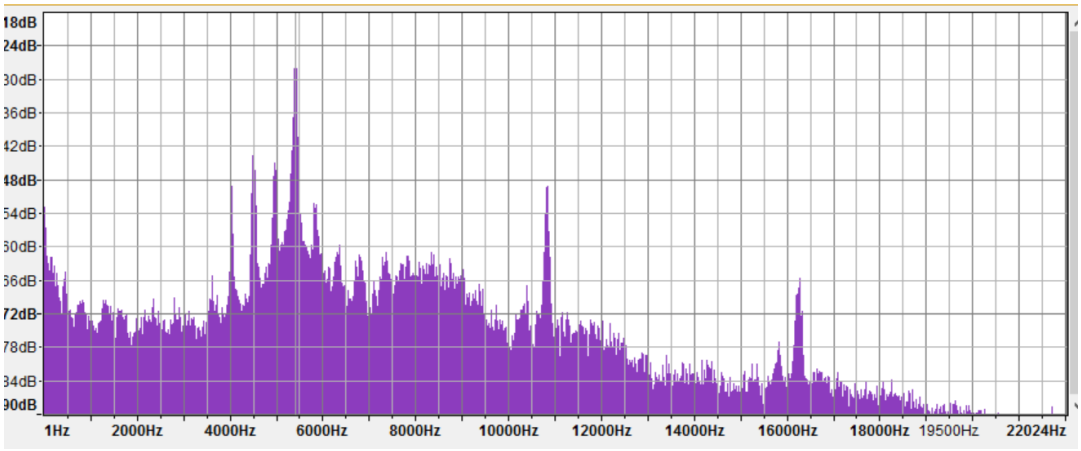

Fig 2 – FFT spectrum of sound from the 34 cm tube.

Resonance in open pipes is expected to involve ½, 1, 1½ etc. wavelengths with antinodes close to each open end,. The speed of sound in air as ~340 m/s.

The expected interval in the longer 0.80 m pipe is …

$$340/1.60 = 210 \text{ Hz}$$

The expected interval in the shorter pipe of 0.34 m is …

$$340/0.68 = 500 \text{ Hz}$$

Both values are in good agreement with the measured intervals showing that they are determined by the lengths of the pipes.

Note: *Coiling increases the interaction of airflow with the inner wall and increases the intensity of the sound for shorter pipes. The airflow velocities are estimates only. Unequal flow rates during each compression have not been taken into account and the pipe diameter of 1.0 cm is an average.*