Surface Vibrations of Flue Organ Pipes

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Introduction

The goal of the described experiment was to show how vibrates the body of sounding organ pipe, on which frequencies, and what is the course of amplitudes of this surface vibration. Two flue organ pipes were measured using Single beam laser vibrometer. Scanning position was changed to show the course of vibrations in different angle and position along the pipe.

Method of measurement

Single beam laser vibrometer is an equipment which measures mechanical motion of surface from a remote position using interferometric technique. This method allows non-contact measurement of the deformation in different points of circle pipes. Two real organ pipes (tin and zinc), tuned for C4 (f = 261 Hz), were measured. They were scanned in four angles (0°, 90°, 180° and 270°) and from mouth to open end in 1 cm steps. To keep the possibility of repeating temperature and speed of air, which was flowing into the pipe, were marked and the motion was calibrated using signal from generator. The frequency of vibration with highest amplitude was chosen to show the course of measured amplitudes (see figures bellow).

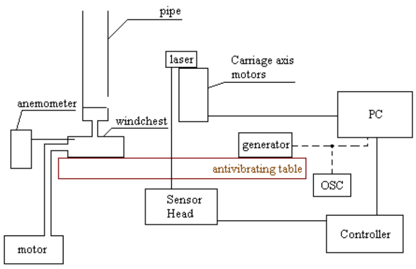


Figure 1: Scheme of measurement.

Table 1: Used equipment

	Type	Notes
Organ pipes	principal tuned for C4	material: tin, zinc
Motor, windchest		
Anemometer	Airflow TA35	
Single beam laser vibrometer	Polytec: Controller OFV-2802 Sensor Head OFV-508	sensitivity of OFV-2802 5mm/s/V
Carriage axis motors		[4]
PC		software SpectralLab, Matlab
Cables		
Antivibrating table		material: steel
Generator	Instek GFG 8020H	
Oscilloskope	Goldstar OS 30-20	

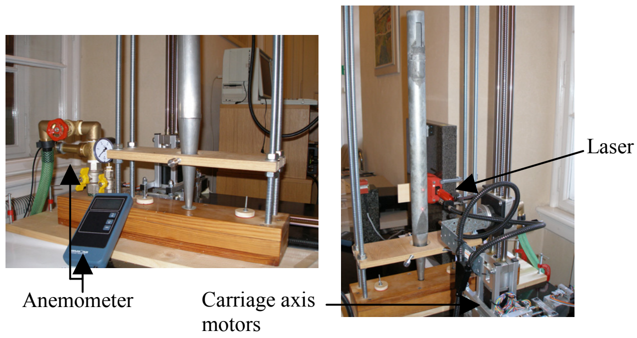


Figure 2: Place of measurement.

Results

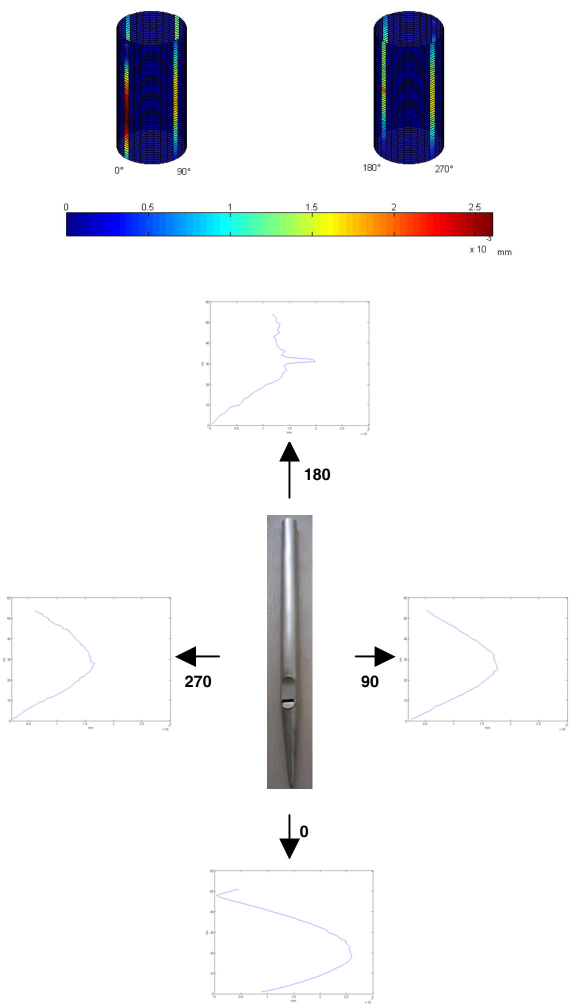
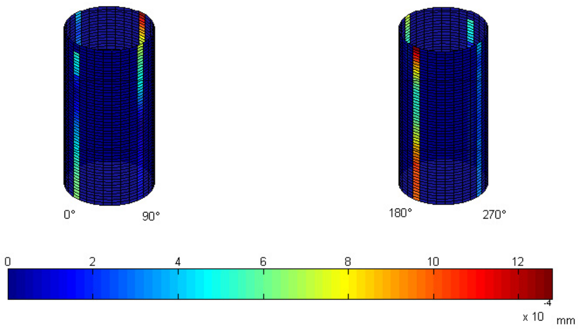


Figure 3: Wall vibrations of tin organ pipe for f = 256 Hz



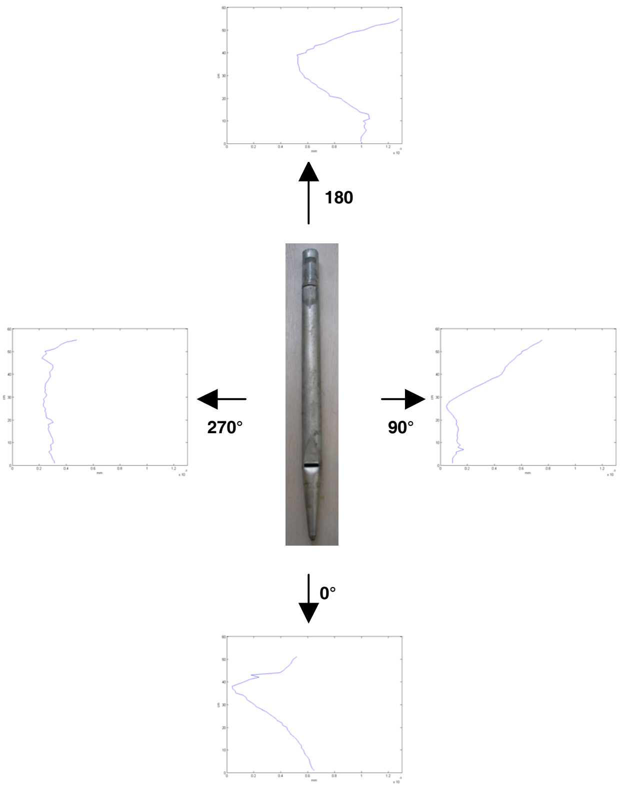


Figure 4: Wall vibrations of zinc organ pipe for f = 253 Hz.

Discussion

The highest amplitudes arised on harmonic frequencies of producing tone with the maximum on the 1-st harmonic frequency. Other frequencies have no effect on sounding pipe vibration (for both materials). Course of amplitudes for measured pipes are different (see for example asymmetry for 90° and 270° in figure 2). To find the reasons of this the barrier was put into the mouth (on the left and right side) and it revealed that air jet was attached itself to right side of the pipe only in case of zinc pipe. So the main reason for the asymmetry of wall vibration is the asymmetry of air jet. This method of scanning wall vibrations (in different angles) can help to see properties or quality of voicing.

References

[1] Miklós, A., Angster, J.: Properties of Sound of Flue Organ Pipes. Acta Acustica united with Acustica 86 (2000), 611-622

[2] Kob, M.: Influence of wall vibrations on the transient sound of a flue organ pipe. Acta Acustica united with Acustica 86 (2000), 642-648

[3] Backus, J. a Hundley, T. C.: Wall vibrations in flue organ pipes and their effect on tone. JASA 39(1966), 936-945

[4] M1486 step-motor controller: `http://www.microcon.cz`