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).

Table 1: Used equipment

<table>
<thead>
<tr>
<th>Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organ pipes</td>
<td>principal tuned for C4</td>
</tr>
<tr>
<td>Motor, windchest</td>
<td>material: tin, zinc</td>
</tr>
<tr>
<td>Anemometer</td>
<td>Airflow TA35</td>
</tr>
<tr>
<td>Single beam laser vibrometer</td>
<td>Polytec: Controller OFV-2802</td>
</tr>
<tr>
<td>Carriage axis motors</td>
<td>[4]</td>
</tr>
<tr>
<td>PC</td>
<td>software SpectralLab, Matlab</td>
</tr>
<tr>
<td>Cables</td>
<td>material: steel</td>
</tr>
</tbody>
</table>

Figure 1: Scheme of measurement.

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 arose on harmonic frequencies of producing tone with the maximum on the 1st 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**


http://www.microcon.cz

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