Some formulas useful for Kundt's tube measurements

Sound propagating through waveguide is assumed to be in the form of plane wave if

$$\lambda = 1.7\ D\ , \tag{1}$$

where D is a diameter of the waveguide.

In Kundt's tube (acoustic interferometer) the waveguide is closed by the tested material and sound waves are reflected by this material. Absorption coefficient is defined as

$$\alpha = \frac{W_{\mathrm{pohl}}}{W_{\mathrm{dop}}}\ , \tag{2}$$

where W_{pohl} is energy absorbed by the material and W_{dop} is incidenting energy.

Derivation of the formulas is based on implementation of velocity potential for both plane waves (incidenting and reflecting) and searching of maxima and minima created by interference phenomenon. From this derivations it is possible to find the formula for absorption coefficient

$$\alpha = \frac{4}{2 + m + \dfrac{1}{m}}\ , \tag{3}$$

where

$$m = \frac{p_{\mathrm{max}}}{p_{\mathrm{min}}} \approx \frac{u_{\mathrm{max}}}{u_{\mathrm{min}}}\ , \tag{4}$$

p_{max} and p_{min} are the magnitudes of the sound pressure in the possitions of nodes and antinodes – the pressure is proportional to the voltage on the microphone.

For the calculation of the specific acoustic impedance Z_{s} it is necessary to know wavelenght and distance between the sample surface and the first minmum of the sound pressure.

$$Z_{\mathrm{s}} = \rho_0 c \frac{1 - k\,\mathrm{e}^{\mathrm{j}4\pi l/\lambda}}{1 + k\,\mathrm{e}^{\mathrm{j}4\pi l/\lambda}}\ , \tag{5}$$

$$k = \frac{m - 1}{m + 1}\ , \tag{6}$$

where ρ_0 is a density of air, c speed of sound in air, m is done by expression (4), l is distance of the first minimum of the sound pressure from the surface of the sample of tested material and λ is wavelength.