Geophysical Research Abstracts,
Vol. 11, EGU2009-13967-1, 2009
EGU General Assembly 2009

On non-linear effects in spriding of the waves in Airhorn

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During the wide amplitude waves spreading along a mouthpiece there appear non-linear effects: the major part of energy transforms into the second harmonic. The task of the second harmonics suppression is solved.

During the wide amplitude waves spreading along a air horn there appear non-linear effects: the major part of energy transforms into the second harmonic [1]. The task the of the second harmonics suppression is solved. In the work [1] mentioned as the size of amplitude of the second harmonic depends the section coordinate X for air horns of exponential, cathenoidal and conic forms.

Analytical expressions for three forms of air horns are $S_x = S_0 \exp(\beta x)$- is exponent, $S_x = S_0/(x-x_0)$ -is conic, $S_x = S_0 ch^2(\beta x)$-is cathenoid, where S_x, S_0 - are the current and first areas of the sections of the mouthpieces, β-is the coefficient of widening of air horn, x-is the coordinate alone of the longitudinal axis of one. The analytical expressions, describing the law of sound pressure $p_1(x)$ in linear processes from throat to mouth are usually known [1].

The change of the second harmonic amplitude $p_2(x)$ along the air horn is considered with regard for the theory of a wave of finite amplitude [1]:$p_2(x) = ?p_1^2(x)\, x$, where c-is non-linear parameter. The analytical expressions for function of change of amplitude analog speed of the second harmonic $p_2(x)$ is finds:

$$\frac{dp_2}{dx} + \frac{1}{x+x_0} p_2 = ?p_{m_1}^2 \frac{1}{(x+x_0)^2}, \text{ for conic form,} \frac{dp_2}{dx} + \frac{\beta}{2} p_2 = ?p_{m_1}^2 \exp(-\beta x), \text{ for exponent form,} \frac{dp_2}{dx} + \beta\, th(\beta x)\, p_2 = ?p_{m_1}^2\ c$$

Having used methods of calculus of variations, expression for the determination of axial section X coordinate value is also received, where the second harmonic achieves its maximum and its velocity equals to zero. Analytical expressions for amplitude of the second harmonic $p_2(x)$ for air horns of cathenoid and conic forms are received [1]:

$p_2(x) = \frac{?p_{m_1}^2}{x+x_0} \ln \frac{x+x_0}{x_0}$, for conic form $p_2(x) = \frac{2?p_{m_1}^2}{\beta} \left[\exp\left(-\beta \frac{x}{2}\right) - \exp(-\beta x)\right]$, for exponent form

$p_2(x) = \frac{2?p_{m_1}^2}{\beta\, ch(\beta x)} \left[arctg(\exp(\beta x)) - arctg\ 1\right]$. for cathenoid. form

The diagram of the second harmonic amplitude are received. Cures are constructed for working frequencies 17,20,23,26, 29 Hz. According to received analytical and calculated data constructive solutions on the second harmonic suppression in air horns are offered. The essence of the matter is the concession that in the section of the air horn where the second harmonic reaches the maximum, there resonators suppressers of certain size and shape should be set [2]. For example, resonators being pipes closed at one end. It that case length of resonators-suppressers equals to the 1/4 (one-fourth) of the wavelength of the second harmonic.