POWER SPECTRUM OF THE CAVITATION NOISE AT ULTRASONIC CAVITATION

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The picture of the cavitation region at ultrasenic cavitation is rather complex. The oscillating cavitation bubbles chaotically move from one place to another. They grow during the strain half-periode of the driving ultrasonic field and they are compressed during the stress halfperiode. While oscillating the bubbles radiate the pressure waves into the liquid. Because the bubbles collapse and radiate the pressure pulses mostly during the stress halfperiode, the groups of the more or less overlapping pressure pulses occur at the place of an observer periodically.

To be able to create a mathematical model of the cavitation noise we have to make a number of assumptions, the mest important of which are; the bubbles are mutually independent, they perform only one oscillation during their lifetimes and any interaction emong radiated pressure pulses and bubbles may be neglected. It may be shown [1], that under these assumptions the cavitation noise may be represented by the Poisson periodic pulse process. The expression for the power spectrum of this process was derived in the paper [2] in the form

$$W(\omega) = W_{C}(\omega) + W_{D}(\omega) = (1)$$

$$=\frac{2\overline{N}}{T_{\bullet}}\left|\left|\left(\omega,\hat{a}\right)\right|^{2} + \frac{2\overline{N}^{2}}{T_{\bullet}^{2}}\left|\left(\omega,\hat{a}\right)\right|^{2}\left|\chi_{y}(\omega)\right|^{2} 2\pi \sum_{k=0}^{\infty} d(\omega-k\omega_{0})$$

This expression has two terms. The first q_1q_0 , $W_C(\omega)$, represents the continuous part of the spectrum, the second one, $W_D(\omega)$, represents the discrete part of the spectrum. The power spectrum of the cavitation noise at ultrase-

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nic cavitation has been measured, for example, by Esche [3], Behn [4] and lately by Haussmann [5]. The measured spectra also have two parts - the continuous part and the discrete part which is composed of the basic component f_0 and the number of ultraharmonic and subharmonic components. In this work only the ultraharmonic components will be considered. The peak level of these components falls quite slowly with the growing frequency and it is usually possible to discriminate the components kf_0 for $k \ge 30$ in the spectrum. The peaks of the lowest ultraharmonic components exceed the continuous part of the spectrum at about 35 - 40 dB.

The mentioned experimental data may be compared with the expression (1). To match the extent of ultraharmonic components present in the measured spectra, the mean equare reet of the random variable φ would have to be rather small - approximately $\sigma \varphi \doteq T_0/30$. However, such a value of $\sigma \varphi$ is in contradiction both to an intuitive feeling and to experimental results (e.g. Radek [6]), from which it may be estimated that $\sigma \varphi \doteq T_0/4\pi 40$,

Now the height the ultraharmonic components exceed over the continuous part of the spectrum will be examined. Let us denote L_C the level of the continuous part and L_D the level of the discrete components peaks. If we consider the first components only, then $|\chi_{\varphi}(\omega)|^2 \doteq 1$ approximately. Putting $|s(\omega, s)|^2 \doteq \overline{|s(\omega, s)|^2}$ and taking into account that $W_D(\omega) \gg W_C(\omega)$, the following approximate formula may be obtained from (1) after some rearrangements

$$\bar{N} \doteq \frac{1}{\omega_0} = 10^{-L_c}$$
 (2)

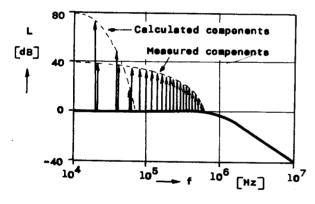
Substituting L_D = L_C = 40 dB and f_e = 20 kHz we get $\overline{N} < 1$! The results obtained both experimentally and theoreti-

cally are schematically shown in the figure. The energy in spectrum seems to be shifted from the lower ultraharmenic components to the higher enes. We believe this is due to

the nonlinear interaction of the pressure waves with the bubbles because the assumption about nonexistence of this interaction is evidently the most unmaintainable." According to our hypothesis the email bubbles serve as frequency convertere that about the wave energy from the lewer spectral components and radiate it at the frequencies of their natural oscillations that coincide with the frequencies of the higher spectral components,

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