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Theoretical investigations of the interaction of acoustic apparatus with technological environment working process

***Abstract**. The qualitative and quantitative transformation of the ultrasonic apparatus force action on the processing environment is presented. The features of the interaction of the ultrasonic apparatus with the technological environment with different rheological properties are investigated and determined. The criteria to assess the energy, power, acoustic and temporal parameters of the process are found. They also determine the ratio of the wave resistance of the cavity region to the initial resistance of the environment. The condition for the effective implementation of the cavitation process is proposed. The waves of the acoustic apparatus fluctuations and the environment are harmonized in a single phase space by minimizing energy consumption.*

***Streszczenie.** Przedstawiono jakościowe i ilościowe oddziaływanie urządzenia ultradźwiękowego na środowisko robocze. Określono cechy interakcji aparatu ultradźwiękowego z otoczeniem technologicznym o różnych właściwościach reologicznych. Określono kryteria oceny parametrów energetycznych, mocy, akustycznych i czasowych procesu. Określają również stosunek oporu falowego obszaru wnęki do początkowej rezystancji otoczenia. Zaproponowano warunek skutecznej realizacji procesu kawitacji. (**Teoretyczne badania interakcji aparatury akustycznej z procesem pracy środowiska technologicznego**).*

Keywords: acoustic apparatus, technological environment, rheological properties, acoustic parameters.
Słowa kluczowe: aparatura akustyczna, otoczenie technologiczne, właściwości reologiczne, parametry akustyczne.

Introduction

The ultrasonic wave moving from the acoustic apparatus to the technological environment creates compression and dilution zones in it; they change each other during each half-period of oscillation. The general idea of the process of oscillation of any environment is described by the classical theory of acoustics equations. However, the cavitation process is characterized by a much more complicated motion of the dispersed environment. The dispersed environment after obtaining a certain level of energy varies significantly both qualitatively and quantitatively depending on the type of treatment.

The process of changing the environment state during its processing is typical. It is the following. The environment ceases to be solid under the influence of energy. Vapor-gas bubbles are beginning to form. They make a significant contribution to changing the rheological properties of the cavernous environment. The process parameters (density, viscosity, etc.) change, it affects the speed of sound velocity, absorption coefficient and wave resistance. It is possible to change the shape and nature of the wave process velocity. Existing dependencies, as a rule, describe the process of cavitation processing by equations with constant coefficients of parameters and rheological properties of environments. Practically there are no studies of the estimation of the environment impact on the technological process and the effects of the interaction between the apparatus and the environment. At the same time, ultrasonic cavitation technologies are widely used in the chemical, food and building industries to process materials with different properties and create new ones. Their efficient use requires consideration of these different properties for setting modes and processing parameters.

Therefore, an urgent problem is the search for new methods for studying the change and assessing the impact of these changes on the processing process, including the process of interaction of the ultrasound apparatus and the processing environment. The solution to this problem will allow you to improve the modes and settings of the processing of environments of different technological applications.

Literature review and problem statement

The modern presentation of the process under the influence of cavitation, as a method of processing the technological environment is the following. It is characterized by processes of formation in bubbles, their development and slamming [1, 2]. Therefore, the study and establishment of a physical pattern of bubbles behavior is given considerable attention [3]. Since the process of formation and development of bubbles in the entire volume is too complex, the study of the cavitation process was carried out on the example of one bubble [4]. At the beginning it was assumed that the bubble has a spherical shape, no viscous properties were taken into account and a number of other prerequisites and assumptions were adopted [5, 19]. Then [6, 20] the viscous properties, the presence of surfaces and the ability of the bubbles to compress at certain stages of their development were taken into account. The results of the study were used [7, 8] to describe the behavior of the entire cuvette volume of the environment, using the so-called cavitation coefficient [9]. Such an assumption does not fully correspond to the real conditions of the cavitation process. The problem of describing the process of technological environment cavitation processing has not been solved yet, the presence of shock waves are being discussed now [10, 11, 21]. So, the cavitational treatment of the technological environment causes significant changes of its rheological properties. These changes should be taken into account determining the parameters.

The acoustic apparatus as an energy source has been researched in [12, 13, 22]. The main tasks are the formation of a resonance mode of the cavitator for different wavelength conditions. The process of interacting with the environment and the definition of the system acoustic apparatus - environment as a system conquered by a single vibration acoustic process was not considered.

Thus, for a long time the majority of researches were devoted to a separate study of the behavior of technological environment or acoustic emitters. Obviously, these circumstances are the reason for the absence of a generally accepted model to describe the process of interaction of the ultrasound apparatus and the processing environment. Therefore, there is a need to find such parameters of the interaction of the ultrasound apparatus with the environment; these parameters create conditions for the formation of bubbles in a specific volume; these bubbles can close intensively in the cavitation area. The determining of the interaction conditions and rational transformation are a criterion for the technological process effectiveness.

An important aspect of obtaining reliable results is the method of measuring the parameters of the cavitation process. Methods of measuring the acoustic field parameters are divided into direct and indirect ones. Direct methods include methods for measuring the cavitation bubbles parameters, for example, the pressure that occurs when the cavitation bubble is slammed. Indirect methods include methods to study technological or physical action of ultrasonic cavitation: by the action of cavitation on chemical processes in a liquid; erosive action of acoustic cavitation; by the action of acoustic cavitation on biological objects; the nature and intensity of acoustic noise accompanying cavitation and others [23,24,27,28].

Aim and tasks of the research

The purpose of the research is to determine the key parameters of the power interaction of the ultrasound apparatus on the processing environment.

The tasks are the following.

1. Determine the parameters that affect the value of the contact resistance by the acoustic system oscillation.
2. To investigate the change of contact resistance in technological environments with different rheological properties.
3. Coordinate the wave supports of the contact zone of the acoustic apparatus – environment system, with maximum energy transfer to the technological process of cavitation processing.

Research methodology of interaction of the system acoustic apparatus – environment with the determining of key parameters of influence on the work process efficiency

The movement of the subsystem acoustic apparatus and the subsystem environment represents a united system. This condition was accepted as a method of conducting research. This system is subjected to a single vibration acoustic process [14, 26, 27].

The following signs were taken into consideration. The interaction of the acoustic subsystem with the environment subsystem is evaluated by these signs. The sign of a qualitative interaction picture is the harmonic and impulsive load of the acoustic apparatus on the technological environment. The sign of the physic-mathematical model assumes that the acoustic apparatus is a system with discrete parameters and the technological apparatus is a system with distributed parameters. The elastic and dissipative properties of the oscillatory system of the apparatus are linear and the law of changing the dissipative properties of the environment is determined by specific viscous or plastic properties. A model of dissipative properties on the frequency of oscillations is taken for viscous environments. A model with dependence from amplitude of oscillations is accepted for plastic environments. For both models the direction of action of the dissipative forces is the opposite direction of the velocity of oscillation.

By physical and dimensional characteristics, the environments are divided into:

– acoustically limited with permanent dimensions, having constant physical parameters;
– acoustically limited with variable dimensions or having variable physical parameters;
– acoustically unlimited with constant physical parameters;
– acoustically unlimited with variable physical parameters.

The environments are divided into liquid; dispersed and solid by physical characteristics.

When the contact interaction is determined, the following pressures are taken: the pressure of the apparatus and the hydrostatic are external stresses on the environment; fluid pressure; internal pressure in cavitation bubble; gas pressure; the pressure of the saturated vapor in the liquid and the pressure from the forces of surface tension and viscous friction forces.

Theoretical investigations of the interaction of acoustic apparatus with technological environment working process

1. Investigation and setting of parameters that affect the resistance of the oscillation resistor of the acoustic system

Investigation of the processes of interaction of the acoustic apparatus with the environment is reduced to the determination of the resistance of the technological environment. The environments are distinguished among themselves by the accepted model in the form of discrete or continuum [14]. However, the resistance of the technological environment consists of elastic-inertial and dissipative parts. Inertia-elastic components define the so-called reactive resistance, and the dissipative component define the so-called active resistance. This general resistance is called the impedance of the oscillatory system by analogy with electrical engineering. Impedance is a complex quantity, its active part z_a is connected with dissipative losses in the oscillatory system, the reactive part z_p is connected with the processes of the periodic exchange of kinetic energy of motion with the potential energy of body deformation:

(1) $$z = z_p + iz_a$$

where i is an imaginary number indicating a z_a rotation relative to z_p on an angle $\pi/2$. There is a mutual compensation of the consolidated masses and elasticity in the resonance of the oscillatory system. The reactive resistance of the system is equal to zero as a result the module of impedance takes the minimum value. Changing the reactive component of the medium load z_p leads to a change in the resonance frequency of the ultrasonic vibrational system. Active ingredient z_a determines active losses in the processing environment (including useful work). This component of the resistance is associated with a decrease of the oscillatory velocity amplitude. Consequently, the task of studying the parameters that influence the value of the contact resistance of the oscillation of the acoustic system is to calculate the components of the impedance. The wave environment resistance to the action of the acoustic apparatus is the ratio of acoustic pressure p_a to the vibrational velocity υ of the particles of the environment:

(2) $$Z_a = \pm p_a / \upsilon,$$

In formula (2) the upper sign (plus) identifies the wave that has passed from the apparatus in the environment (incident wave) and the lower sign (minus) is for the wave going in the opposite direction, that is, it returns to the apparatus (the wave is reflected from the boundary of the system apparatus – the technological environment). The coefficient z_a is important because it is a characteristic of the interaction of the acoustic apparatus – environment system both as a resistance and characteristic of the wave motion.

The change of parameters is possible when the subsystems of the apparatus and the environment interact. Then only a part of the wave power moves into the environment, and the other part will be reflected from the contact point to the device. The periodic compression and expansion of each

environmental layer is a result of the action of the alternating pressure p_a (see formula 2).
The amplitude of the pressure is calculated by the formula:

(3) $p_a = \rho c \upsilon,$

where ρ is density; c is the waves velocity in the environment. The product of speed and density (ρc) is the acoustic resistance of the environment, it characterizes the scattering of the energy of the wave in this environment. The velocity of waves in the environment c_K is calculated by the formula:

(4) $c_K = \sqrt{E/\rho},$

where E is modulus of the environment elasticity. The waves velocity determines the ratio of elastic (E) and mass (ρ) characteristics of the environment; they have a definite influence on the process of cavitation. Dependence (4) is appropriate for elastic environments. The formula is used for fluids that are saturated with gas:

(5) $c_K = 1/\sqrt{\rho \beta_{ac}},$

where β_{ac} is coefficient of adiabatic compressibility, it is equal to the relative volume change $\Delta V / V$ when pressure changes on Δp. Coefficient β calculated by the formula:

(6) $\beta = -\dfrac{1}{V}\dfrac{\Delta V}{\Delta p}.$

Comparing (4) and (5) it can be noted that the parameters E and β_{ac} correlate as $\beta_{ac} = 1/E.$ The elastic wave velocity of does not practically depend on frequency and is related to the wavelength λ by simple formula:

(7) $\lambda = c / f$.

Acoustic wave spreading in the environment transmits energy. It is estimated by the intensity of ultrasound I:

(8) $I = \dfrac{p^2}{2\rho c} = \dfrac{1}{2}\rho c \omega^2 A^2 = \dfrac{1}{2}\cdot\dfrac{\rho c}{\omega^2}a^2 = \dfrac{1}{2}\rho c v_m^2,$

where A, ω – amplitude and frequency of oscillations; a – acceleration.
Intensity change depending on density and contact amplitude of oscillations different values (fig.1.) is evidence of the need to take into account the interplay of parameters at all stages of acoustic cavitation processing of technological environments.

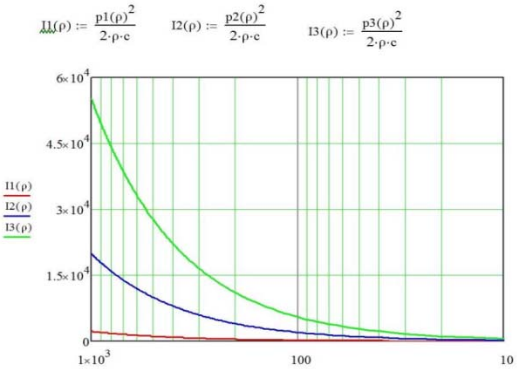

Fig.1. The dependence of the intensity of the sound *I* on the density *ρ* for the three values of the amplitude of oscillation *A*

Using the dependence (8) it is possible to obtain numerical values of pressure, amplitude, velocity and acceleration of the contact zone fluctuations according to the known values of the waves propagation velocities, intensity and density of the environment:

(9) $p = \sqrt{2\rho c I}$; $A = \dfrac{1}{\omega}\sqrt{\dfrac{2I}{\rho c}}$; $v = \sqrt{\dfrac{2I}{\rho c}}$ $a = \omega\sqrt{\dfrac{2I}{\rho c}}$.

Thus, the contact resistance R_k of the system acoustic apparatus – environment is dependent on the following parameters:

(10) $R_k = f(E, \beta, \rho, I, c, \omega, Y, T, A, \upsilon, a).$

These parameters are included in the main characteristics of the cavitation process:

(11) $R_k = f(p_a, I, c, \lambda)$

Parameters and characteristics have a wide range of their numerical values. For example, the speed of acoustic waves in the air (25°C) is 333 m/s; it is about 1500 m/s in water. When an elastic wave is spreading in water at a speed of ≈1500 m/s with an ultrasound frequency of 1 MHz the wavelength $\lambda = 1{,}5\cdot10^{-3}$ m. The higher the frequency f, the smaller the wavelength λ. Much attention is given to definition of the parameter c_K because it has the significant influence on the process of cavitation. It is noted that the speed of sound in technological gas-liquid environments depends on the ratio of gas and liquid components in [15]. The range of variations c_K of water with gas bubbles has fluctuates within rather broad limits of values: 20 ... 100 m/s [15]. According to the work [16], the numerical values c_K in the cuvette fluid vary in the narrower limits c_K = 25 ... 30m/s.

The particle velocity amplitude is υ=0.1m/s, acceleration is a= 700m/s^2 and environment particles fluctuate with amplitude A = 0.02μm if they spread in water or environments with acoustic impedance close to an ultrasonic wave at a frequency of 1 MHz at an intensity of 1 W/cм^2. Amplitude of acoustic pressure in ultrasonic wave is $p_a = 1{,}8\cdot10^5$ Pa under these conditions.

The change in the wave resistance of the liquid saturated with its cavitation bubbles in [17] is calculated by the ratio of the total acoustic power P_a to the square of the vibrational velocity of the surface of the cavitation apparatus υ^2:

(12) $Z_a = 2P_a / \upsilon^2 = 2IS / \upsilon^2,$

where S is surface of the apparatus that emits energy into the technological environment.

The crossplot of Z_a / S on from the square of the amplitude of the vibrational velocity (fig.2) shows if $\upsilon^2 < 500\ (\mathrm{cm/s})^2$ then ratio Z_a / S changes a bit. If speed increases the wave resistance will drop sharply but the intensity increases. However, at the beginning of cavitation the magnitude of the intensity is within 1 ... 1.5 W / cm^2, if speed increases the intensity will be 3.5 ... 4.5 W/cm^2.

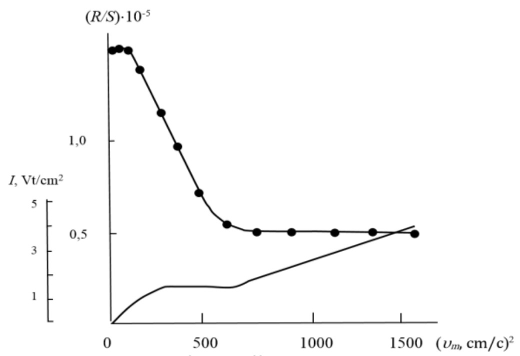

Fig.2. The dependence of the effective water resistance (curve 1) and the actual intensity of the sound (curve 2) on the square of the vibrational velocity of the cavitational apparatus

The dependence of the relative value of the change in the wave resistance of the cavity environment on the wave resistance of the initial state of the environment $\frac{\rho_c c_c}{\rho_i c_i}$ shows (Fig. 3) a significant change in the resistance from the sound pressure.

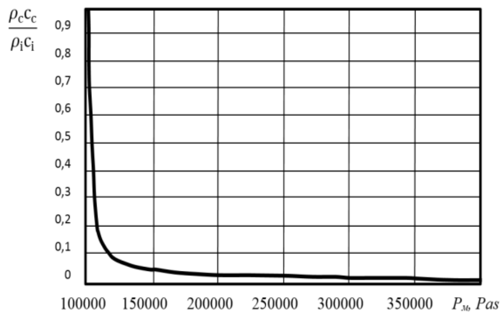

Fig.3. Dependence of the relative wave resistance of the environment on the sound pressure

2. Investigation of contact resistance change in technological environments with different rheological properties.

If dissipative component is dependent on the speed the acoustic pressure p_a will be calculated by the formula[18]:

$$p = \upsilon_0 \rho \omega \sqrt{\frac{(\sin kl \cos \psi l)^2 - (\cos kl sh \psi l)^2}{(k^2+\psi^2)\left[(\cos kl ch \psi l)^2 + (\sin kl sh \psi l)^2\right]}}, \quad (13)$$

where υ_0 is the speed of apparatus oscillation in the contact area; *ρ* is the environment; *ω* is frequency of the contact zone oscillation; *k* is wave coefficient dependent on the waves velocity *c*, oscillations frequency *ω* and dissipative coefficient of resistance *ψ*; *l* is the length of the environment layer towards the longitudinal wave spreading.

If dissipative component is dependent on the amplitudes of oscillations the acoustic pressure p_a will be calculated by the formula[18]:

$$p(0,t) = \rho l A_1 \omega^2 \sqrt{\chi_{1n}^2 + \chi_{2n}^2}, \quad (14)$$

where A_1 is amplitude of the contact zone fluctuations; χ_{1n} and χ_{2n} are wave coefficients taking into account the influence of dissipative (χ_{1n}) and elastic-inertial (χ_{2n}) constituents on the contact pressure:

$$\chi_{1n} = \frac{\alpha_n sl 2\alpha_n l + \beta_n \sin 2\beta_n l}{l\left(\alpha_n^2+\beta_n^2\right)\left[cl 2\alpha_n l + \cos 2\beta_n l\right]}; \quad (15)$$

$$\chi_{2n} = \frac{\alpha_n \sin 2\beta_n l - \beta_n sl 2\alpha_n l}{l\left(\alpha_n^2+\beta_n^2\right)\left[cl 2\alpha_n l + \cos 2\beta_n l\right]} \quad (16)$$

The graphs (fig.4) of these coefficients and contact pressure changes with the velocity variation demonstrate such distribution.

The decrease in the velocity of waves spreading in the environment is taken into account for the accepted numerical parameters of the cavitational water treatment working process. At the same time, the density of the environment also varies. This approach is performed for the first time and clearly demonstrates (see fig. 4, a) the need to take into account the interaction of subsystems. The coefficient (χ_{2n}) has both negative and positive values. Their character proves the presence of a dominant influence on the process either elastic or inertial forces. The coefficient (χ_{1n}) determines the effect of the resistance energy component on the oscillation process, it has only negative values. We need to take into account the dissipative component (see fig. 4, b), it is the displacement of the resonant pressure curve in relation to the wave coefficients.

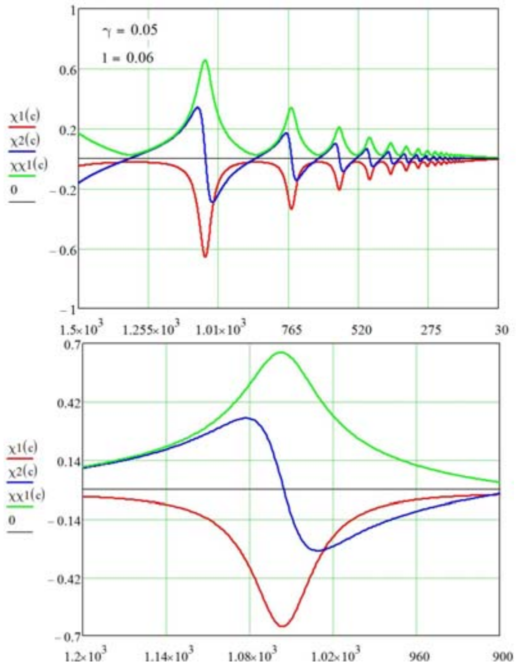

Fig.4. Change of contact pressure $\chi\chi^{1(c)}$, wave coefficients $\chi^{1(c)}$ and $\chi^{2(c)}$ depending on the waves velocity *c* in water with its ultrasonic cavitation treatment: frequency 24 kHz, coefficient of energy dissipation in the environment Υ= 0.05, acoustically limited environment *l* = 0,06 m; *a* – on the entire processing stage; *b* – within the limits of the first resonance

We should take into account the interaction of the acoustic apparatus with the environment because it is necessary from the position of the influence of resistance forces and we need it to determine the acoustic parameters of the process. This is especially important for acoustically confined environment with constant dimensions and constant physical parameters and acoustically confined environment with variable dimensions and variable physical parameters.

We have derived dissipative component of the environment's resistance from (13) and (14), it was marked as μ. We have got a formula for the work of the contact zone after simple transformations:

$$A_k = \pi m_c x_0^2 \omega^2 \mu, \quad (17)$$

where m_c is the technological environment mass; x_0 – amplitude of the contact zone; μ – wave coefficient of influence of the dissipative forces of the technological environment on the value of contact pressure. Then the average power P_{cp}:

$$P_{cp} = 0{,}5 m_c x_0^2 \omega^2 \mu \quad (18)$$

Formulas (17) and (18) are the formulas for determining the required parameters of the general work and the contact zone power.

The difference in dependence (18) on the existing [7, 19, 20, 22-29] is as follows. The notion of the connected mass of a technological environment is used in the cited works. This notion has a constant that is, unchanged, value throughout the technological environment processing. It is added to the mass of the cavitator in the calculated formulas. In reality, the mass of the medium is not constant because its dynamic action depends on the inertial elastic and dissipative properties. This is taken into account by the wave coefficient μ in the formula (18).

When the condition of the pulse loading in the contact zone is realized (fig.5), the concept of oscillations amplitude loses its definition, since the mode is no longer harmonic but nonlinear (asymmetric).

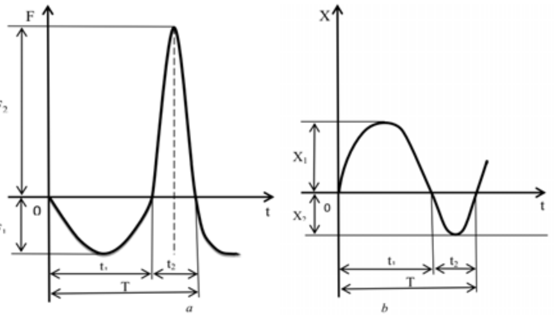

Fig.5. The nature of the change in the force F (a) and the displacement of X (b) in the contact zone under pulsed loading conditions

Then the concept of displacement in the corresponding periods of time is used: $t_n = t_1 + t_2$, where t_1 is part of the relocation period X_1 , t_2 is part of the displacement period X_2 . We have marked $\alpha = t_1 / t_2$ and $\omega_{cp} = 2\pi / t_n$ – averaged frequency value; F_1 , F_2 are amplitudes of forces in the corresponding periods of contact zone. So, variations have the following expression:

(19) $$\sigma(t) = \begin{cases} \sigma_c \sin(\dfrac{\pi t}{t_1}), 0 \prec t \le t_1; \\ -\sigma_p \sin\left[\dfrac{\pi(t-t_1)}{T-t_1}\right], t_1 \prec t \le T. \end{cases}$$

The relationship between the compression tensions of the technological environment and the tensile tensions in the zone of impulse power change realization from the ratio $\sigma_c \sin(\pi t / t_1) = \sigma_p \pi / (T - t_1)$ is the following:

(20) $$\sigma_c = \sigma_p (1-2)/\alpha \ ,$$

where the coefficient α represents the asymmetry of the action time:

(21) $$\alpha = t_1 / T \ .$$

The energy accumulated in the contact zone under the conditions of the pulsed loading taking into account (19) and (20) is the product of the tension (pressure) on the deformation velocity for the period T:

(22) $$E_{k.i\text{м}.} = \int_0^T \sigma(t)\dot{\varepsilon}(t)dt = \int_0^{t_1} \sigma(t)\dot{\varepsilon}(t)dt + \int_{t_1}^T \sigma(t)\dot{\varepsilon}(t)dt$$

We have got t_1 for energy from (22):

(23) $$E_{k.i\text{м}.} = \frac{\pi\sigma_c^2\gamma}{2E(1+\gamma^2)}\left[1+(1-\alpha)^2/\alpha^2\right]$$

The cavitation process energy consumption has two components. They are the energy for wave the compression E_{cm} and the energy for the dilution E_p :

(24) $$E_{cm} = \frac{\pi\sigma_{cm}^2\gamma}{2E(1+\gamma^2)};$$

(25) $$E_p = \frac{\pi\sigma_{cm}^2\gamma}{2E(1+\gamma^2)}\left[(1-\alpha)^2/\alpha^2\right].$$

The effectiveness of the cavitation process can be calculated by the coefficient of effectiveness as the ratio of specific energy E_{num} to total energy:

(26) $$\eta = \overline{E} / E_з \ ,$$

where $\overline{E} = E_{\kappa.i\text{м}} / T = (\sigma_c^2 / 2E)\cdot \pi\gamma / T(1+\gamma^2)\left[1+(1-\alpha)^2/\alpha^2\right]$.

3. Harmonization of contact zone wave resistances under the conditions of maximum energy transfer on the technological process of environment cavitation processing. If the plane acoustic wave along the X-axis from the cavitator to the environment boundary spread with the acoustic impedance Z_k and in the environment on the apparatus boundary it spread on the same axis X, the wave impedance Z_c will be generated due to the this resistance. It is clear that there is a reverse direction wave of the apparatus's contact with the environment. The wave resistance for its maximum passage can be calculated between the boundary of the apparatus and the environment of the compensator [21]. It serves as the load impedance and reflection of acoustic waves only in the area of the apparatus. The load resistance was equal to the wave resistance of the environment $Z_k = Z_c$.

The wave equation of frequency-dependent energy dissipation in the technological environment was used:

(27) $$\frac{\partial^2 u}{\partial t^2} = c^2\frac{\partial^2 u}{\partial z^2} + \frac{4\eta\partial}{3\rho\partial t}\left(\frac{\partial^2 u}{\partial z^2}\right),$$

where *u* is direction of waves spreading with velocity *c*; z is coordinate; η is coefficient of viscosity. The solution of equation (27) gives the dependence. It makes possible to calculate the resistance of the environment in the contact zone:

(28) $$Z_{\text{в}x} = -l = Z_a \frac{Z_c\cos k_1 l + iZ_a \sin k_1 l}{Z_a \cos k_1 l + iZ_c \sin k_1 l} \ ,$$

where l is the length of the environment in the direction of the wave spreading; k_l is complex constant of wave spreading with viscous friction the effect of. If there is a compensator (its length is $l = \lambda/4$, where λ is wavelength in the compensator) between the apparatus and the environment, we shall receive the following formula:

(29) $$k_1 l = (2\pi/\lambda)/(\lambda/4) = \pi/2$$

We obtain formula for determining the input wave resistance using (29) in (28):

(30) $$Z_{\text{в}x}(\lambda/4) = Z_a^2 / Z_c$$

So, choosing the value of the input resistance of the compensator in length λ/4, we obtain the condition of the maximum transmission, wave resistance of the apparatus and the compensator are aligned by this transmission. The acoustic resistance of the apparatus and the equivalent transmission line can be ensured by positioning the auxiliary layer of a material with an acoustic resistance between the device boundary and the environment. Then, the reflection from both boundaries of the additionally set wave layer will be equal to the amplitude and will move in the anti-phase direction, it will result in their mutual compensation. A shift between the phases motion by 180° is provided by the difference in the velocity of the waves between the boundaries at half the wavelength. The equilibrium of the amplitudes is ensured by the rational choice of the wave resistance compensator.

Conclusions

1. We have determined the parameters that affect the value of the contact resistance of the acoustic system oscillation. Qualitative and quantitative parameters are determined; they change their properties in the process of acoustic cavitation processing of technological environments.

2. The change of contact resistance in technological environments with different rheological properties is investigated. The change regularities in contact pressure were determined, they are dependent on the rheological properties of the environments. The mathematical model should take into account both elastic and dissipative properties of environments.

3. The wave supports of the contact zone of the acoustic apparatus – environment system have been harmonized. We have got maximum energy transmission for the environment cavitation processing. An analytical dependence is obtained for the coordination of the wave resistances of the contact zone.

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