Theoretical dependences are given relating the critical values of the amplitude, frequency, and nozzle diameter to the physical properties of the liquid or gas in the course of drop or bubble formation at a cylindrical nozzle vibrating longitudinally at the frequency of sound.

Recently, in gas-liquid dispersion technology, there has been wide use of vibrodispersion equipment, which serves to intensify heat and mass transfer, chemical reaction, the production of granulated material from a melt, and the preparation of mixtures and conclusions.

The construction of most vibrodispersion equipment is based on the use of outlet and nozzle attachments excited by longitudinal harmonic oscillations at frequencies of up to 1 kHz. The equipment may operate through jet or drop (bubble) emission of the medium being dispersed. The size of the resulting particles is regulated in the range from 100 μm to 2 mm with a high degree of homogeneity (70-90%).

For the successful design of vibrodispersion equipment, it is necessary to have calculation dependences between the particle diameter, the vibrational intensity, the attachment geometry, and the physical properties of the medium.

The design of jet vibrodispersion, as a rule, is based on Rayleigh-Weber concepts regarding the instability and decay of moving particles. The following expression is often used to determine the jet-excitation frequency \( f \) in particle formation [2]

\[
    f = 0.627 \left( \frac{\sigma}{\rho_d d_j} \right)^{\frac{1}{2}}.
\]

The excitation wavelength \( \lambda \) and the nozzle diameter \( D \) corresponding to this expression must be held within the limits [3]

\[
    3.5d_j < \lambda < 7d_j, \quad 0.5 \text{mm} < D < 1.5 \text{mm}.
\]

Investigations have shown [4, 5] that vibrodispersion with drop (bubble) emission (Re < 13•10^4) may be of three main types:

1) the formation of stable particles of diameter

\[
    d_s = \left[ \frac{6D\sigma}{g\Delta \rho + \left( \rho_1 + \frac{1}{2} \rho_2 \right) A\omega^2} \right]^\frac{1}{3} ;
\]  \hspace{1cm} (1)

2) nonsteady decay of unstable particles;

3) steady decay of unstable particles to others of smaller diameter, given by the formula

\[
    d_p = \left[ \frac{2\sigma}{g\Delta \rho + \left( \rho_1 + \frac{1}{2} \rho_2 \right) A\omega^2} \right]^\frac{1}{2}.
\]  \hspace{1cm} (2)

The first and third types yield particles of homogeneous size. The second case corresponds to transitional conditions of vibrodispersion, when homogeneity of the particles is low.

The parameters of the transitional stage will now be determined.
As already found [6], the critical diameter of the stable particles forming at a cylindrical nozzle vibrating longitudinally at the frequency of sound is

\[
(d)_{cr} = \left[ \frac{8\sigma}{g\Delta \rho + \left( \rho_1 + \frac{1}{2} \rho_2 \right) A \omega^2} \right]^{1/2}. \tag{3}
\]

Comparison of Eqs. (1) and (3) allows the vibration intensity \((A\omega^2)_{cr}\) corresponding to the transition from the formation of stable particles to the decay of unstable particles to be determined

\[
(A\omega^2)_{cr} = \frac{1}{\rho_1 + \frac{1}{2} \rho_2} \left( \frac{128g}{9D^2} - \Delta \rho g \right). \tag{4}
\]

If the vibrator has fixed values of \(A\) and \(\omega\), transitional conditions may be eliminated by appropriate choice of the outlet diameter, which should not exceed the value

\[
D_{cr} = \left[ \frac{128g}{9g\Delta \rho + \left( \rho_1 + \frac{1}{2} \rho_2 \right) A \omega^2} \right]^{1/2}. \tag{5}
\]

Thus, if particles of homogeneous size are to be obtained, the following condition must be satisfied

\[(A\omega^2)_{cr} > A\omega^2 > (A\omega^2)_{cr}\]

or

\[D_{cr} > D > D_{cr}.\]

To obtain particles in a broadly regulated size range, the critical values of \(A\) and \(\omega^2\) must correspond to the middle of the vibrator operating range.

The usefulness of the proposed recommendations for the design of vibrodispersion equipment operating with drop (bubble) emission was confirmed experimentally for the example of the dispersion of molten paraffin in air \((\rho_1 = 0.78 \text{ g/cm}^3, \rho_2 = 1.2 \times 10^{-3} \text{ g/cm}^3, \sigma = 27.63 \text{ dyn/cm})\) and for the dispersion of air in distilled water \((\rho_1 = 1.2 \times 10^{-3} \text{ g/cm}^3, \rho_2 = 1.02 \text{ g/m}^3, \sigma = 72.75 \text{ dyn/cm})\). The diameters of the cylindrical nozzles employed were: 0.3, 0.5, 0.6, 0.7, 0.8, 0.9, 1.2, 1.6, 2.0, 2.8, and 3.6 mm.

The calculated and experimental data are compared in Fig. 1.

\[\text{NOTATION}\]

\(\sigma\), interphase surface tension; \(\rho_1\), density of medium being dispersed; \(\rho_2\), density of surrounding medium; \(\Delta \rho\), absolute value of density difference; \(d\), jet diameter; \(A\), vibrational amplitude; \(\omega\), vibrational angular frequency; \(g\), acceleration due to gravity.

\[\text{LITERATURE CITED}\]