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# Analysis Of The Effects And the Forces Breed Of Phase Transfer Interaction in Dispersed Liquid Jets

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***Abstract:*** *Two-phase flow characteristics of liquid drops is described. The interaction of the two phases give rise to phase between the forces which affect the development of the flow. The research scopes the definitionof these features that should be considered in solving the problem.*

***Key words:*** *Two-phase Flow, Forces, Drops.*

## INTRODUCTION

The main effects and related with these forces of interfacial interaction have characteristics of the flowing gas-liquid drops. Basic forces of mentioned above are expressed in dynamic pressure in the medium of a particle and means the increasing of its expected weight. The influence of added mass can have an effect only in the area of heavy braking drop, i.e. in the base of the flame, where gas is absent.

The air resistance is represented as:

$$\vec{f}_R = C_R S \rho_g \frac{\overrightarrow{v_R}}{2} \tag{1}$$

where: $C_R$ – coefficient of air resistance; $C_R = f\left(Re\right)$. S- middle section of the drop; $v_R$ - relative velocity;

The force of own weight is represented as:

$$\vec{f}_{mn} = g m_p \vec{g} \tag{2}$$

where $m_p$ is the mass of drop;

Formula (2) can be expressed as:

$$\overrightarrow{f_n} = \frac{1}{12}\pi d_\kappa^3 \rho_\partial \frac{d}{d\tau}\left(\vec{V}_{rel}\right) \tag{3}$$

The relation between (3) and strength force gives: $\vec{f}_R / f_n \, \square \, 10^3 (\sim 10^5)$, so the influence of this effect can be ignored.

The ratio between the mass force and strength force is represented as:

$$\frac{f_R}{f_{mn}} = \frac{3 c_\kappa \rho_\partial V_{om}^2}{2\pi d_\kappa \rho_m g (1 - \rho_\partial / \rho_m} \tag{4}$$

If drops are sprayed in the air with $V_{rel} \approx 0{,}1 m/s$ and $d_\kappa \approx 0{,}1 mm$ the result of (4) should be equal to 1, therefore, $f_c$ and $f_{mn}$ are commensurable.

Basset- Boussinesq forces take into account the flows deviation from the current flow and represents the hydro-dynamic resistance:

$$f_в = \frac{3}{2} d_\kappa^2 \left(\pi \rho_\partial \mu_\partial\right)^{0,5} \int_{t_p}^{t} \frac{dV_{rel} / d\tau}{\sqrt{t_p - \tau}} d\tau \tag{5}$$

In case of Stokes type of flow the neglecting these forces doesn’t give more than 4%. When the Basset forces and the mass are taken together their magnitude must be considered only when the density of the continuous phase is the same order, or the density of the dispersion particles is the same order or higher.

Bernoulli's forces rises of the passing difference between the velocities related to the turbulence pulsations. They can influence generally the pulsation compounds velocities discontinued in a turbulence flow.

The evaluation of the secondary distribution of the drops and their merging in many cases significantly increases the accuracy of the calculated process in the spraying device.

For specific dispersion characteristics of the spraying device sampling of the mixture is performed at a considerable distance from the outlet (primary) section, the results, including empirically derived equations already reports the disintegration of primary drops caused by the impact of the surrounding gas. If the section of the device is the equal, the gas velocity does not change, and there is no need for reporting secondary disintegration of drops.

In devices with variable section, for example, a profile of the Venturi Tube, the velocity of the gas phase is replaced within wide limits: in confusor is increasing rapidly, and in the diffusers falls, this creates the conditions for secondary decomposition of large drops. In this case, when $d_{агр}$ is equal to the diameter of the droplet of the coarse fraction in the accepted hypothesis for the collapse of the decomposition. For example, the assumption with enough accuracy is that unsustainable drops are divided into two equal parts can be performed restatement of dispersion characteristics of the mixture.

In most cases, in the spray apparatus merging of droplets may not apparently occur because the probability of collision between them is unlikely: first, in the vicinity of the atomizer difference in the speeds of the single drops is very insignificant; second, by removing from the place of exit concentration drops sharply declined, and already at a distance of several centimeters tends to zero. An exception can only be a case of parallel operation of several pulverizers. However, usually, a finding that also in this case a collision is observed only at very tight mounting of the spraying device, which is done very infrequently. This hypothesis is confirmed experimentally. Torches of two centrifugal jet nozzles placed at a distance of 150 mm, is to be "transparent" for each other.

In conclusion it can be said that some basic effects to a lesser extent into account other parameters. So the effect of the first four partially or fully accounted for in terms of formulas to account for the resistance coefficient. Examples of such formulations is at work [1, 2]. The impact of poludispersnost of totality drops, merger and dissolution into account when determining the average diameter of the drops.

## EQUATIONS FOR CALCULATION OF THE RESISTANCE COEFFICIENT

The accuracy of the theoretical description of the movement of two-phase gas-liquid flows largely are determined by the selection of the equations for calculating the resistance coefficient $C_R$ [1]. Hoagland [2] notes that the error when calculating the coefficient of resistance is equivalent to the change in particle size, for example of the second order.

When displaying equations to calculate the flow is based on so-called standard curves resistances $C_R = f\left(Re\right)$, obtained by wrapping a sphere of incompressible isothermal gas flow of infinite length. Many famous equations appear approximation of a standard curve with various additional terms for the actual conditions.

At equal values of the Reynolds number of the resistance coefficient in an unsteady flow may be considerably higher, as compared with the established [4, 5].

Acceleration of the flow [5] is considered with an additional factor:

$$A_c = \frac{d_к}{\left(V_д - V_к\right)^2} \frac{dV_к}{d\tau} \tag{6}$$

The addition of this factor, obviously, disregarding offset in the equations of the total density of members causing acceleration and handling of their actions on the forces of resistance. This assumption is confirmed by the fact that at a substantially uncertain nature of flows around the particle and then Re and We are no longer a determining criterias for the process of this acceleration.

Significant influence on the coefficient of resistance has the turbulence of the flow, and in this case the high concentration of particles themselves begins to act as spectacular turbulizer grid. At this the scale of turbulence becomes comparable with the particle size. Examines the impact of turbulence in [1, 3] shows that CR the decrease with an increase in the number Re.

At sufficiently high concentration of particles ($\chi$) in the field of heterogeneous traffic environment in a continuous wrapping adjacent particles may overlap. In this case, the resistance coefficient is significantly different from the coefficient of resistance of a single particle. In [13] border mark is taken equal to 0,015. When $\chi \geq 0,015$ the flow of the particles can be provided in the form of a grid, through which the gas phase are filtered with a noticeable resistance, and when $\chi < 0,015$ the particles are to be regarded as a single. Similar results have Gibbs, noting further that the effect of narrowing is more significant in the laminar region wrapping.

For calculating the coefficient of resistance in terms of narrow movement comes [6, 7] generic term to be presented as a product of two functions, one of which is a $C_R$ as a single piece, and the other ($E_\beta$) depends on the amount of concentration of particles. Such, for example, empirical correlations of Richardson-Zaki and Todes obtained in experiments on hydrodynamic fluidized boundary and having a form:

$$E_\beta = (1-\chi)^{-n} \tag{7}$$

In the first case n = 4,65, and in the second: n = 4,75. In [14] is noted the relation:

$$n = 4,7\frac{1+0,15Re^{0,687}}{1+0,253Re^{0,687}} \tag{8}$$

Upon evaporation and combustion of particulate coefficient of resistance is reduced and can be calculated from equation [9]:

$$C_R = 27Re^{-0,84} \tag{9}$$

Upon increase the size of the drops the nature of their wrap is clearly characterized by the nature of the wrapping of the solids, because among previously examined begin to appear, and other effects (ripple drop shape due to mobility of the surface and uneven distribution of pressure on the thereof, the internal circulation of the liquid, decomposition and so on).

The critical droplet diameter $d_{кр}$, corresponding to the reference boundary may be determined by the equation obtained in the study of the absorption drop with different diameters [9]:

$$\frac{\sigma}{d_{кр}\gamma_T} = 1,25.10^{-3}\left(\frac{V_{oT}\mu_g}{\sigma}\right)^{0,78}\left(\frac{\sigma^3\rho_g^2}{\mu_\partial\gamma_T}\right)^{0,42} \tag{10}$$

The diameter $d_{кр}$ match the critical number Re, defined by the equation:

$$Re_{кр} = 4,55\left(\frac{\sigma^3\rho_g^2}{\mu_\partial^4\left|\rho_T-\rho_g\right|g}\right) \tag{11}$$

(eg for water $Re_{кр} = 1000$). In $Re \geq Re_{кр}$ value of $C_R$ increases.

Boris Rauschenbach offers [11] to consider the involve of a correction factor considering the ripple forms. Very convenient it would be to account in a similar way, other factors determining the structure of the liquid droplet. However, the possibility of such a representation is complex enough because it is not always for any function $f(x,y)$ exist values $\varphi(x)$ and $\psi(y)$, for which $f(x,y)=\varphi(x)\psi(y)$. Therefore, the most common relations for $C_R \neq C_{тв.\,р}$ (where $C_R$, $C_{тв.\,р}$ - coefficients of resistances respectively droplets and solid particles).

## CONCLUSIONS

Analysis and quantitative comparison of the equations for calculation of the coefficient of resistance are reported in [1, 2]. According to these studies, most of equations obtained from experiments with the solid particles and drops give similar results, lying in the area of the standard curves. Choosing one or the other dependence must be determined on a specific mode of the flow.

For the case best - justified should be seen equation by Rivkind and Riskin, [12], which is used in developing the hydrodynamic model of gas-liquid torch.

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