Modeling and calculation of the trajectory of droplets in a multistage channel mass-transfer apparatus

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Abstract: The research paper is focused on the development of mathematical model of the drops movement in the gas flow in the mass transfer apparatus multi-stage channel. Dynamic characteristics of the gas in the laminar regime is obtained by numerical solution of the Navier-Stokes equations. Gas velocity in the turbulent regime is found by the solution of the Reynolds equations. Solvability of the mathematical models and convergence of the used numerical systems have been illustrated. The equation of motion drops has the form [1]:

$$\frac{d\left(m_d \vec{W}_d\right)}{dt} = -\xi\left(\frac{\rho}{2}\right) f_d w^2 \vec{e} + m_\kappa \vec{g}. \qquad (1)$$

Using by the method of [1], for determining the values of $w(t)$ and $\gamma(t)$, we have

$$\begin{aligned} \frac{dw}{dt} &= -Kw^2 - g\sin\gamma - \left(P_x\cos\gamma + P_y\sin\gamma\right) - w\left(e'_x\cos\gamma + e'_y\sin\gamma\right) \\ &\quad - wA - A\left(W_g^x\cos\gamma + W_g^y\sin\gamma\right), \\ \frac{d\gamma}{dt} &= -\frac{g\cos\gamma}{w} + \frac{\left(P_x\sin\gamma - P_y\cos\gamma\right)}{w} - e'_y\cos\gamma \\ &\quad + e'_x\sin\gamma - \frac{A\left(W_g^x\sin\gamma - W_g^y\cos\gamma\right)}{w}. \end{aligned} \qquad (2)$$

The components of gas velocity $W_g^{\tilde{o}}$, $W_g^{\acute{o}}$ and associated quantities P_x, P_y, e'_x, e'_y had been calculated in [2].

Numerical solution of equations (2) determine the path of movement of droplets for different diameters, the path length of the droplets and their stay in the contact zone. The obtained data were used to calculate the overall mass transfer between the gas and liquid droplets.

Keywords: mathematical model, mixture of gas and droplets, multistage channel.

References:

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