Empirical model of the interaction of water droplets with a high-speed gas flow

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Present work is devoted to the development of a mathematical model that allows to predict the distribution of droplets diameters depending on the conditions of the gas flow as well as the physical properties of the liquid. To develop the model empirical data published by the authors earlier [1, 2] as well as original computational algorithms were used. The applied algorithm takes into account non-stationary of the processes of gas-dynamic breakup, relative droplets velocity, temperature and other parameters necessary for the analysis of experimental results. 18 experiments were carried out for different velocities of the gas flow [3] (Russian Science Foundation Grant No. 19-49-02031). Based on the recorded parameters of droplets a model has been developed that takes into account the dependence of gas-dynamic droplets breakup rate on the Reynolds, Weber and Mach numbers. The change in the fraction of droplets with the given diameter was calculated by the formula $\frac{dP}{dt} = -K_1 \cdot P \cdot We^{K_2} \cdot Re^{0.025}$ The dependences of the two coefficients used in the model on the trajectory-averaged number Re for droplets are obtained. After generalizing the simulation results, a single function is proposed for the first coefficient $K_1 = \alpha \cdot exp[\beta \cdot (Re + \gamma)]$ and a constant value for the second $K_2 = 0.2$. The standart deviation between the experimental and simulated droplet diameter distributions doesn't exceed 3.6 %.

[1] Arefiev K Y and Voronetsky A V 2015 *Thermophysics and Aeromechanics* **22**

[2] Arefyev K Y, Prokhorov A N and at al 2020 *High Temperature* **58**

[3] Minko A V, Arefyev K Y, Guskov O V and Saveliev A S 2021 *Applied Sciences* **11**