Dynamics of aerosols and particles at nonlinear oscillations in tubes

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In the present work, longitudinal oscillations of an aerosol of different initial number concentration and dynamics of particles is considered in tubes of different length with various geometry on the end near to resonant frequencies.

Experimental investigations oscillations of an aerosol were carried out for different length of tubes in a shock-wave and shock-free modes near to subharmonic and natural resonances. Di-ethyl-hexyl-sebacate $C_{26}H_{50}O_4$ was used as the working fluid to generate aerosol. The majority of droplets have the geometric diameter 0.863 μm. Number concentration of drops for all experiments monotonously decreases with time and with growth of the excitation frequency. In the case of a closed tube, this process is defined by the coagulation of aerosol and deposition of droplets on the tube walls. In an open tube, the discharge of aerosol to the environment is observed in addition to the coagulation of aerosol and deposition of droplets on the tube walls. The dependence of the time of coagulation of aerosol on the excitation frequency likewise exhibits a nonmonotonic pattern with a maximum and a minimum when passing the resonance. It is established, that presence of a flange slows down process of a coagulation of an aerosol. Reduction of internal diameter of a flange results in increase in the time of coagulation. In so doing, the time of coagulation of aerosol in the case of an open tube is reduced by a factor of two and more compared to the time of coagulation in a closed tube. Nonlinear dependence of the time of coagulation of droplets is established at nonlinear oscillations of an aerosol in a tube from initial number concentration of an aerosol. It has been found that a decrease in the tube length and increase oscillation intensity results in a decrease in the time of coagulation of aerosol. It is shown, that with increase of intensity of the oscillations, the caused increase of amplitude, time of coagulation and deposition of an aerosol decreases. For the closed tube this dependence has nonlinear character, and for an open tube - almost linear. It is revealed that in a shock-free mode (for small amplitudes of displacement piston) time of coagulation and deposition aerosol in the closed tube in 2-4 times, and time of a clarification of an in an open tube at 6-12 time lower, than at natural deposition.

The numerical modeling of a drift of the solid spherical particles were in a suspension in a nonlinear wave field of the closed tube and open flat channel at excitation of oscillations of a gas column on three first fundamental frequencies is executed. These researches have been carried out about use of model of a single particle and with application of model of interpenetrating continuums. It is obtained, that easy particles drift under an operation of acoustical current, and heavy are displaced under an action of wave pressure. In result easy and heavy particles concentrate in different areas of the resonator: easy are displaced to antinodes of a standing wave of velocity, heavy – to nodes. Depending on a steepness of a wave front of compression, the same particles can behave as easy at small nonlinearity, or as heavy at steep enough fast-head wave front. Drift of heavy particles in the open channel proceeds in two stages. The first quickly proceeding stage is connected to the mechanism of drift due to asymmetry of a wave, and the second with drift under action of developed acoustic stream. Influence of radius of particles on distribution of temperature and average density of a disperse phase along an axis of the channel is revealed.

Dynamics of a single particle with various physical and geometrical parameters is experimentally investigated at the longitudinal oscillations gas in tubes. Along an axis of a tube the particle moves from the closed (open) end to the piston, near to a wall – to the return side, making longitudinal oscillations with increase in the oscillations swing that is caused by acoustic streaming. In a radial direction, the oscillating particle moves from an axis to a wall of the tube up to a boundary point. Outside of a tube, the particle moves from the open end to an exterior wave field practically without oscillations with nonlinear increase of coordinate from time. It is revealed, that the increase in lengths of a tube and excitation frequency of gas in up to - resonant modes gives in growth of an oscillations swing of a particle and increase of its average velocity. Nonmonotonic character for dependence of oscillations swing and average velocity of a spherical particle from excitation frequency of gas is detected. At approach to a resonance oscillations swing and average velocity are incremented, attain the maximum value on a resonance frequency and decrease behind a resonance. Effect of a weight and diameter of a particle on its oscillations swing and average velocity is investigated. Shift of a curve maximum for dependence of a particle average velocity from oscillation frequency aside magnifications of frequency is shown at increase of a weight or diameter of a particle.

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