WAVE AND VORTEX PHENOMENA IN TWO-PHASE FLOW

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Fundamentals of wave and vortex dynamics in two-phase flow in application to the problems of power engineering are presented. Recent advances in diagnostics and research of wave phenomena, vortex flows, multiphase media, falling liquid films, annular flows, flame structures and heat and mass transfer processes are described. In particular, methods of laser induced fluorescence and Particle Image Velocimetry including Tomographic were applied.

Results of theoretical and experimental study of nonlinear waves and transfer processes in the falling liquid films and rivulets are presented. Theoretical modeling was mainly carried out based on the integral Kapitza-Shkadov method. The structure of interface in the annular gas-liquid flow is described; the mechanisms of droplet entrainment from the crests of large waves are determined. The instability and formation of three-dimensional regular waves on the straight rivulets flowing down a vertical plane or over the lower outer surface of an inclined tube were studied theoretically and experimentally. The effects of wettability, thermo capillarity, and other parameters on the flow structure are shown.

Experimental results on the vorticial structures of the vortex filament type, formed in the swirl flows, are presented. The next main cases have been examined: swirl flow in a tangential chamber; swirl isothermal jet; swirl flame; swirl flow in a conical diffuser; two-phase swirl flow.

Special attention was paid to the vortex reconnection processes on the vortex spiral tube formed in a swirl flow. The processes of vortex reconnection underlie the simulation of quantum turbulence, and in the case of real liquids, they have the crucial importance. It is shown that vortex reconnection can lead to formation of both an isolated vortex ring and a ring linked to the basic spiral vortex tube. Some features of vortex reconnection, including the asymmetry effects, generation of Kelvin waves and formation of various bridges are described.

The basic wave- and vortex-based control methods of transfer processes are considered; they are divided into the passive (flow swirling, developed heat exchange surfaces) and active (mixing, periodic forcing, adding of second phase) methods. Examples of wave and vortex technologies application in power engineering, including heat exchangers, burners, furnaces, combustion chambers, hydro turbines and multiphase apparatuses of cyclone and condenser types, are described.