# Atomization of liquid film in annular flow: Studying tracks of droplets at the initial stages using high-speed LIF system.

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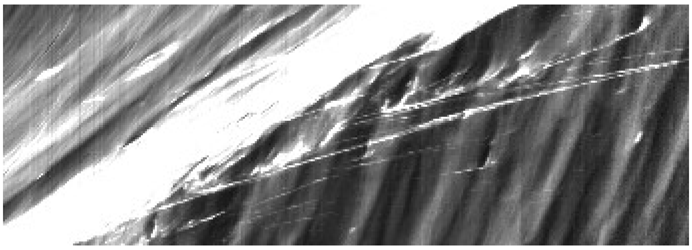
**Abstract**

Atomization of liquid film in annular flow essentially changes the integral characteristics of flow. The most part of atomization mechanisms, available in literature, are related to the wavy structure of liquid film. In our recent works (e.g., [1]) we applied high-speed laser-induced fluorescence technique to studying the wavy structure of liquid film in annular flow. Local intensity of fluorescent light was recalculated into local film thickness. The technique allowed us to study the temporal evolution of instantaneous distribution of film thickness over one longitudinal section of the pipe with high spatial (0.2 mm) and temporal (0.1 ms) resolution. Analyzing such data, one can easily distinguish disturbance waves; slow ripples, covering the base film; fast ripples, covering crests of the disturbance waves.



One more type of structures is visible in the experimental data: very short and abnormally high ‘waves’, moving with velocity several times greater than that of disturbance waves. Normally these trajectories begin at the disturbance waves. No such trajectories were observed in regimes without liquid entrainment. The most reasonable explanation is that such objects represent tracks of droplets, which travel along the investigated section of the pipe not far from the film surface. The Figure shows evolution of film thickness in space (abscissa) and time (ordinate). Wide bright band represents disturbance wave, narrow bright lines – to the droplets. Thus, though the technique was originally aimed for film thickness measurements, it can be also used for investigation of droplets dynamics. Advantage of the method is the possibility to study the droplets at the initial stage of their evolution in both space and time. Disadvantages of current realization of the method are related to the use of two-dimensional (longitudinal distance and time) measuring system and relatively low spatial and temporal resolution.

Processing of tracks of droplets was performed in view of three mechanisms of entrainment. The first one is the disruption of fast ripples, moving over crests of disturbance waves [2]. Velocity and longitudinal size of just-entrained droplets were estimated. The second mechanism of entrainment is the coalescence of disturbance waves (see Figure) [3]. Comparison of the number of droplets, observed right after the coalescence event, to the average number of droplets, generated by single disturbance wave, didn’t show any essential difference. The third mechanism is the secondary entrainment after the impingement of a depositing droplet into the surface of the base film. It was observed that the depositing droplet normally impinges into a slow ripple, and, in part of cases, the new secondary droplet appears. It rapidly accelerates, reaching nearly the same value of velocity as that of ‘primary’ droplets.

References:

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