



FLOW STRUCTURE VISUALIZATION BEHIND THE SHOCK WAVE IN THE SHOCK TUBE

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ABSTRACT

Currently the shock tube is used more and more frequently in the study of the kinetics of chemical reactions in the gas phase and in the heterogeneous transformation of matter. An important advantage of the shock tube is the simplicity of obtaining the required thermodynamic conditions behind the incident and reflected shock waves. In the experiments, it is assumed that the flow behind the shock wave is uniform and undisturbed, or, at least, is that the effect of the perturbation caused by the boundary layer is small. To study this phenomenon visualization of the flow structure behind the incident shock wave was made by the averaged Talbot-interferometry method.

The 50×50 mm shock tube was used to generate shock waves in the air with intensity $M=1.3-1.6$. Grids with square cells (12×12 and 3.5×3.5 mm) were used to initiate turbulence in the flow behind the shock wave. Interaction of the incident shock wave with the turbulizing grid creates velocity and density pulsations after the shock wave passage. Flow pulsations cause fluctuations of the local refraction index, which can be measured by Talbot-interferometer.

Local deflection angles in the flow behind the shock wave were experimentally measured. The data for the deflection angles can be numerically integrated, if the value of the refractive index of undisturbed medium is known. So distributions of time-averaged density of the air throughout the whole flow field were calculated for both grids. It is found that the thickness of the boundary layer in the observation area is about 7–9 mm, and the density in the boundary layer behind the shock front raises sharply. This leads to an increase of 6–7 % of the average density of the flow at about 3 mm from the shock tube wall. The area occupied by the boundary layer reaches half the cross sectional area of the shock tube. Thus shown that the flow behind the shock wave can not be considered uniform and undisturbed due to the influence of the boundary layer.

Keywords: shock tube, visualization, Talbot-interferometer