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INVESTIGATION ON THE NEAR-NOZZLE FIELD FLOW OF LIQUID JET IN A SUPERSONIC CROSSFLOW

Abstract

Based on the Particle Image Velocimetry (PIV) equipment, a observation method was presented to investigate surface waves of the liquid jet in a Mach 2.1 supersonic crossflow in the paper. Using the method the transient surface structures of the liquid jet were captured at high spatiotemporal resolution. While high-speed laser schlieren photograph was employed for showing the continuous transient structures of the separation zone and shock waves. And high-frequency pressure sensors were Utilized for wall pressure measurement. Circular injectors with diameters of 1.0mm and 2.0mm are specifically designed to provide round nonturbulent water jets, which were flush mounted on the bottom plate of a rectangle supersonic wind tunnel. Freestream properties stayed constantly with a Mach number (Ma) of 2.1 and a static pressure (P) of 101325 Pa respectively. Wide range of pressure drop specifically from 0.5MPa to 4.0MPa was tested. The generation and development process of liquid jet surface waves were gained by employing the method mentioned above. All the time-dependent jet images were analyzed for the in-depth investigation of the length, amplitude and frequency characteristics of the jet surface wave. Studies have certified the presence of the liquid jet surface waves in a supersonic crossflow. The wave spatial scale is the order of 0.1 times the nozzle diameter. It could be concluded that the separation zone and the bow shock are unstable structures, and have specific oscillation frequencies. The frequency domain characteristics closely associate with injection pressure drop and orifice diameter. The pressure instability before the jet resulted from oscillation phenomena is also proved to be important in distortion and growth of surface waves.