EXPERIMENTAL INVESTIGATIONS OF A LIQUID JET INJECTION INTO A CROSSING HYPERSONIC FLOW

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Liquid jet injection into supersonic/hypersonic cross flow topology has been widely investigated in recent years. Some applications of it are fuel injection in supersonic combustion ramjet (SCRAMJET) engines and thrust vectoring of high speed vehicles. Film cooling for reentry vehicles falls into this flow topology as well.

This project is a continuation of previous year studies with the aim of understanding and investigating this flow topology. To achieve so, different experiments have been carried out at the H3 Hypersonic Wind Tunnel. Water jets have been injected into a crossing Mach 6 flow for three different injector shapes (circular, streamwise rectangular and transverse rectangular) and relevant injection ratios.

High speed camera measurements have been performed in different experimental setups to obtain diverse type of information. Classical Schlieren technique has been used to study the characteristic shock pattern of the flow topology. Front-light illuminated movies have been taken to obtain a wide view of the flow field and study the jet from a macroscopic way. Back-light illuminated movies have been recorded to obtain a close-up view of the jet and study the jet from a microscopic way. Top view movies have been acquired to study the spreading of the jet in the lateral extension.

Previous year developed data processing algorithms and in-house developed “Vecorr” PIV algorithm have been used in order to obtain valuable results.

With the acquired data, the effect of the injection ratio and the injector shape in the penetration height and lateral extension of the jet has been studied and a correlation for round jet trajectories has been proposed. Probability density functions have been used to identify different flow features and the stated PIV algorithm has been utilized to obtain mean velocity fields of the water jet. Characteristic differences between high and low injection rate jets have been observed and their diverse fluctuating nature has been studied. A frequency study of these fluctuating flow features has been performed by fast fourier transform method and the creation of frequency maps, although this part needs further investigation.

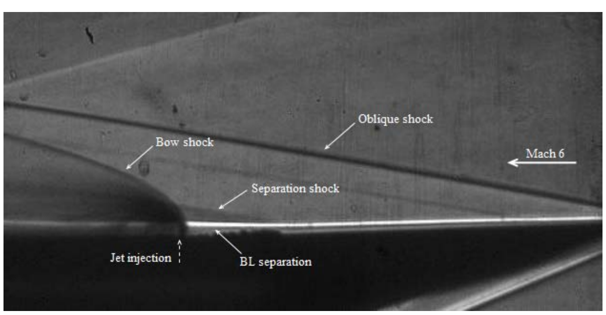

Figure 1: Shock pattern of flow topology (Schlieren image)

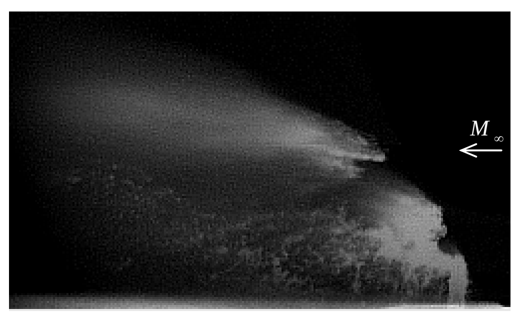

Figure 2: Processed image of round jet break-up (close-up view of jet injection)