Portfolio Paper

Streak Line Pattern of Supersonic Transverse Jet into Mach 6 Freestream over a Sharp Cone

Dhananjaya Rao, G.*[1], Swaminathan, S.*[1] and Rathakrishnan, E.*[2]

*1 AFDG, Vikram Sarabai Space Centre, ISRO, Trivandrum-695022, India.
    E-mail: gdhanurao@gmail.com
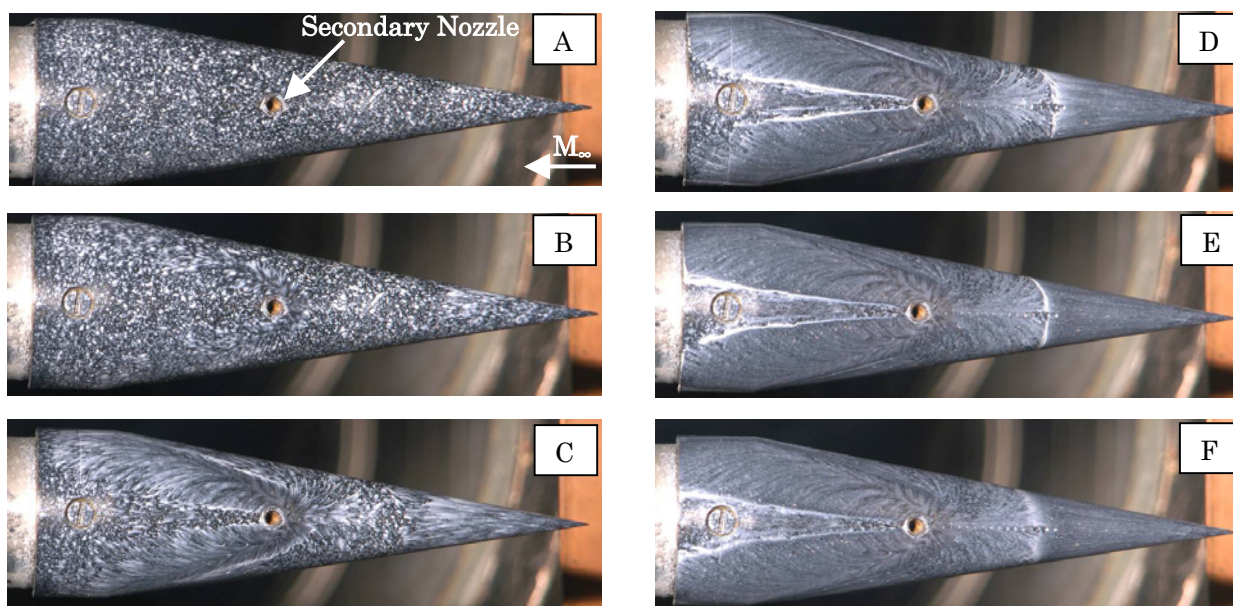*2 Department of Aerospace Engg, IITKanpur, Kanpur, U.P., India.

Fig. 1. Streak line pattern of transverse jet into Mach 6 freestream over a sharp cone obtained from oil flow technique, Frames from tunnel starting condition (A) to Tunnel shutdown (F).

An oil flow technique for obtaining good quality streakline patterns around the transverse injection into a Mach 6 freestream over a sharp cone of nose angle 20 degree[1] has been demonstrated. The freestream Reynolds number based on cone diameter is 0.53 million and total pressure of Mach 2.5 transverse jet is 12 bar. The oil viscosity should be low enough for its streaks to align with flow without being swept away completely during start of the blowdown. After many trials, it is found that, 1:5 mixture (by volume) of titanium dioxide powder (as white pigment) and paraffin oil gives good result. Three drops of oleic acid in 0.5 cc of this mixture give good coagulation properties. This mixture is sprayed as sparsely distributed fine droplets on the model painted black. A still camera is used from outside the tunnel to capture the pictures through the tunnel window (quartz glass) during the blowdown.

Six pictures from starting to shutdown of the tunnel are shown in Fig. 1. Frame-A is before tunnel starting, Frame-B is immediately after start of the tunnel, Frames-C and D are during the test, Frame-E is after 4 seconds of run time and Frame-F is after shutdown of the tunnel. The time difference between Frames-C and D is 1 ±0.3 s. It is observed that, the oil streaks take sufficient time to align with surface streamlines, also a good amount of oil is washed away during the 4 seconds run time of tunnel and oil is partially disturbed during the shutdown. Frame-D shows full details of the streaklines around the transverse jet on surface of the cone. The present results reveal that, the oil flow pattern has to be captured during the run.

References : (1) Dhananjaya Rao, G. et al., AIAA Paper, 2007-4349 (2007).