Effect of Nozzle Lip Thickness on Co-flow Jet Characteristics

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Co-flow jets find numerous combustion applications, due to their mixing characteristics. Also, co-flow jets are an integral part of many engineering devices where mixing of different fluids is required. They are used to provide the mixing between fuel and oxidizer in the combustor of propulsion systems, such as gas turbine systems. In combustion systems, mixing control can lead to the reduction of pollutants, improved combustion efficiency, reduced combustor size, longer combustor lifetimes and greater combustor stability. In the co-flow jet configuration, the mixing between the two jets strongly depends on the convective Mach number. This concept was introduced in supersonic plane shear layer. It has been reported in the literature that, the co-flow jets are very good for mixing enhancement applications like in combustion chambers. It is also found that, the co-flow retards the mixing of the primary jet, leading to potential core elongation [1]. Sharma et al. [2], reported that the co-flow acts as mixing inhibitor at all levels of overexpansion for Mach 2 nozzle. Near-field structure of a co-flow jet configuration is considerably complex. The effect of co-flow on the near field shock structure of underexpanded central jet is investigated [3]. Increase of NPR increases the supersonic core length of the central jet with the co-flow compared to the without co-flow case.

The mixing phenomenon in co-flow jets is strongly governed by the geometrical parameters of the central jet nozzle and the surrounding co-flow passage and the operating pressure. In the co-flow jet configuration, mixing between the two streams is strongly influenced by the lip thickness of the inner nozzle. In order to understand the effect of nozzle lip thickness on the co-flow jet characteristics, a study has been carried out with a constant annular gap, and varying inner nozzle lip thickness. Two co-flow nozzles have been studied in this investigation. One of the co-flow nozzles had inner nozzle lip thickness of 3 mm (thin-lip) and the other one was 15 mm (thick-lip). For the two co-flow nozzles annular gap is chosen as 4 mm. This study is carried out at various underexpanded conditions. Figures 1 and 2 show the centerline pitot pressure distribution for nozzle pressure ratios 3 and 5. These results clearly demonstrate the effect of inner nozzle lip thickness on the co-flow jet characteristics. The thick-lip nozzle promotes the mixing better compared to the thin-lip nozzle, for both the operating conditions. This clearly demonstrates that, the inner nozzle lip thickness plays a dominant role in promoting the mixing of co-flowing jets.

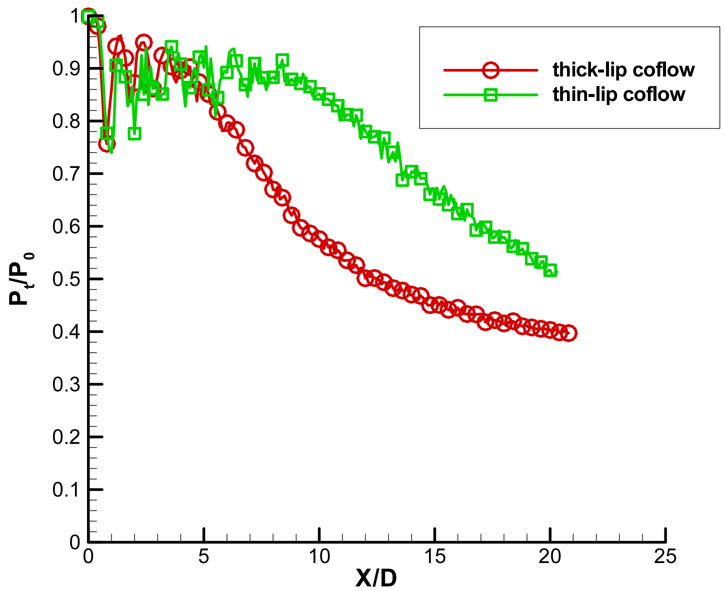

Fig. 1 Centerline pitot pressure distribution at NPR 3 Jet

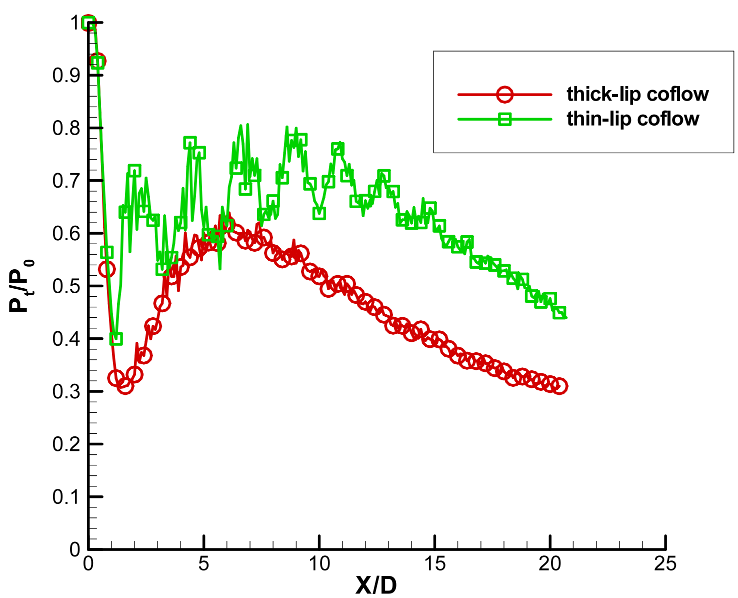

Fig. 2 Centerline pitot pressure distribution at NPR 5 Jet

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