INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: THERMODYNAMIC ANALYSIS OF ACTIVE AND PASSIVE DRAG REDUCTION TECHNIQUES FOR ELEVATED ENTHALPY HYPERSONIC REACTING FLOWS

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SHORT ABSTRACT

Initial investigations are based on counter flow injection and spike based drag reduction techniques to compare them on a common platform. Test case of supersonic flow over hemisphere, provided with counterflow injection, portrayed monotonic variation for percentage drag reduction and percentage exergy destruction for increase in injection pressure ratio. However, injection effectiveness, suitable assessment parameter for counterflow injection, shows inversion characteristics with a peak at specific injection pressure ratio. Mounting of a spike also shows similar trend for percentage drag reduction and percentage exergy destruction. Present investigations recommend percentage exergy destruction as a unified performance assessment parameter for passive and active drag reduction techniques. Afterwards, investigations are carried to examine the effect of higher freestream stagnation enthalpy on flow field alteration for counter−jet drag reduction technique for a hemispherical object. Drag coefficient is found to reduce with freestream total enthalpy in the presence of real gas effects. Higher pressure ratio of the jet has resulted in lower surface pressure and Stanton number on the object. Then, efforts are further continued to reveal the thermodynamic behaviour of opposing jet technique which includes variation of entropy generation rate, exergy destruction and drag force analysis considering real gas effects. Results revealed that linear reduction in drag forces and sharp rise in entropy generation rate and exergy destruction is obtained with jet momentum ratio irrespective of freestream and jet parameters. At last, real gas effects on surface pressure and flow field are analysed for the combinatorial technique (opposing jet and cavity) for hypersonic flow over the blunt body. A new thermodynamic parameter named entropy generation rate is proposed which can be used as a tool to analyze the performance of any drag reduction technique. Results showed that perfect gas assumption over−estimates the surface pressure and wave drag. Introduction of cavity reduces the surface pressure, drag and entropy generation rate but significant reduction in these parameters is noted when the opposing jet is turned on. For given jet pressure ratio, opposing jet technique predicts lower drag and entropy generation rate as compared to combinatorial technique.