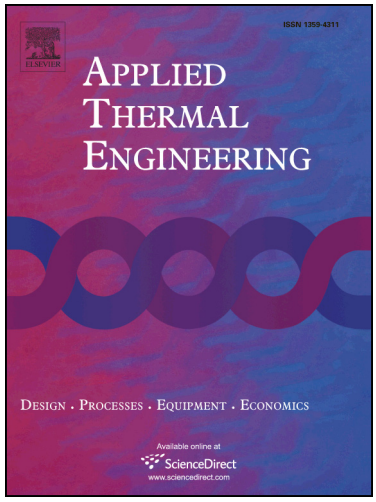

Far-Field Hot-Wire Measurements on Free Jet from Complex Supersonic Nozzles

Srisha M.V. Rao, Taiki Ikeda, Shingo Asano, Tsutomu Saito

PII: S1359-4311(17)31352-2
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2017.02.116
Reference: ATE 9997

To appear in: *Applied Thermal Engineering*

Please cite this article as: S.M.V. Rao, T. Ikeda, S. Asano, T. Saito, Far-Field Hot-Wire Measurements on Free Jet from Complex Supersonic Nozzles, *Applied Thermal Engineering* (2017), doi: http://dx.doi.org/10.1016/j.applthermaleng.2017.02.116

Far-Field Hot-Wire Measurements on Free Jet from Complex Supersonic Nozzles

Srisha M.V. Rao[a], Taiki Ikeda[b], Shingo Asano[b], Tsutomu Saito[b]

[a] *Department of Aerospace Engineering, Indian Institute of Science, Bengaluru, India, 560012.*
[b] *Department of Aerospace Engineering, Muroran Institute of Technology, Muroran City, Hokkaido, Japan 050-8585.*

Abstract

Complex nozzles use modifications to the exit geometry of supersonic nozzle to enhance the rate of mixing. Complex nozzles have significant beneficial effects when applied in air-breathing engines and supersonic ejectors. The far-field flow structure of supersonic free jets from complex nozzles have not been studied. This is relevant to applications such as thermal signature reduction, noise reduction, and in dynamics of explosive volcanic plumes. In this study, the centerline velocity decay rate is quantified from hot-wire measurements in the far-field of complex supersonic nozzles for the first time. Experiments are conducted on a reference conical nozzle of Mach number 1.8, a six chevron nozzle and an Elliptic Sharp Tipped Shallow (ESTS) lobed nozzle with six lobes, at Nozzle Pressure Ratio NPR=6. All the nozzles have the same throat dimensions and exit area. The hot-wire measurement method is validated by comparison of the behavior of a subsonic turbulent jet with previous results, and the velocity decay rates and velocity profiles are found to agree well. The centerline velocity decay rate is maximum in the ESTS lobed nozzle (by 30%), followed by the chevron nozzle (by 10.5%). Mean velocity profiles are found to be self-similar by 40D. Details of the study are provided in the article.

Keywords: Mixing Enhancement, Supersonic Jets, Complex Nozzles, Hot Wire Measurements

Email addresses: srisharao@aero.iisc.ernet.in (Srisha M.V. Rao), 12022013@mmm.muroran-it.ac.jp (Taiki Ikeda), 14042003@mmm.muroran-it.ac.jp (Shingo Asano), saito@mmm.muroran-it.ac.jp (Tsutomu Saito)