World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:12, No:06, 2018

Design Optimization of Chevron Nozzles for Jet Noise Reduction

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Abstract : The noise regulations around the major airports and rocket launching stations due to the environmental concern have made jet noise a crucial problem in the present day aero-acoustics research. The three main acoustic sources in jet nozzles are aerodynamics noise, noise from craft systems and engine and mechanical noise. Note that the majority of engine noise is due to the jet noise coming out from the exhaust nozzle. The previous studies reveal that the potential of chevron nozzles for aircraft engines noise reduction is promising owing to the fact that the jet noise continues to be the dominant noise component, especially during take-off. In this paper parametric analytical studies have been carried out for optimizing the number of chevron lobes, the lobe length and tip shape, and the level of penetration of the chevrons into the flow over a variety of flow conditions for various aerospace applications. The numerical studies have been carried out using a validated steady 3D density based, SST k-ω turbulence model with enhanced wall functions. In the numerical study, a fully implicit finite volume scheme of the compressible, Navier–Stokes equations is employed. We inferred that the geometry optimization of an environmental friendly chevron nozzle with a suitable number of chevron lobes with aerodynamically efficient tip contours for facilitating silent exit flow will enable a commendable sound reduction without much thrust penalty while comparing with the conventional supersonic nozzles with same area ratio.

Keywords : chevron nozzle, jet acoustic level, jet noise suppression, shape optimization of chevron nozzles
Conference Title : ICAMAME 2018 : International Conference on Aerospace, Mechanical, Automotive and Materials Engineering
Conference Location : Paris, France
Conference Dates : June 25-26, 2018