

Abstract

Simultaneous development of new computers, numerical algorithms, physical and chemical models of flow physics are responsible for the great impact of CFD in both basic and applied scientific/engineering problems. Presently, CFD methods are employed routinely for the estimation of various complex propulsion flow parameters where experimental data cannot be obtained economically or feasibly. CFD has emerged as one of the important design tool alongwith other experimental testing and contributing significantly in reducing developmental cost and time for aerospace vehicle design. In India, the designers of missiles, launch vehicles, military and transport aircrafts are depending heavily on CFD techniques for the accurate prediction of various aerodynamic and propulsion parameters in the design exercise.

Starting from a very modest beginning, core competencies have been developed in numerical simulation of turbulent nonreacting and reacting flows in the country. Number of industry standard indigenous CFD codes are developed and applied for aerodynamic characterization of different aerospace vehicles in complete $M-\alpha-\delta-\phi$ envelope. Integration of 6-DOF trajectory program with CFD code has enabled the designers to study the store separation from aircraft and heat shield separation from launch vehicles without much dependence on wind-tunnel testing. Certifying agencies are relying heavily on CFD data to grant clearance of new stores from fighter aircrafts. Commercial codes were validated extensively against experimental results to find its error band and range of applications. Important contributions are made in the design and analysis of propulsion systems of various ongoing and future missile projects through numerical simulations. CFD studies guided the development of hydrocarbon fueled scramjet combustor of hypersonic air-breathing cruise vehicle. End-to-end simulations including nonreacting flow in the external surfaces, intakes and reacting flow in the combustor has enabled to obtain the aeropropulsive parameters in an integrated manner. Jet vanes of tactical and strategic missiles are routinely designed using CFD tools. Starting characteristics of air intakes and diffusers, estimation of exhaust plume - free stream interaction at base region in high altitude, port flow simulation of solid rocket motors etc. are some of the notable applications of CFD tools in missile propulsion design. New indigenous software for Large Eddy Simulation (LES) is developed and validated for many stringent canonical problems and are currently being applied to different complex propulsion problems. The speaker has worked for 35 years in VSSC/ISRO and DRDL/DRDO on many practical aerodynamics and propulsion design problems pertaining to ISRO's satellite launch vehicles and DRDO's strategic and tactical missiles. An overview of the development and application of CFD techniques for aerodynamic and propulsion characterization of various aerospace systems will be presented. Few challenges and critical areas in CFD development will also be highlighted

Bio

Prof. Debasis Chakraborty has worked for 36 years in VSSC/ISRO and DRDL/DRDO and Aerospace Engineering department of IIT, Bombay. Currently, he is working as a professor in the Department of Mechanical and Aerospace Engineering of Ecole Centrale School of Engineering, Mahindra University, Hyderabad. He has solved many practical aerodynamics and propulsion design problems pertaining to ISRO's satellite launch vehicles and DRDO's strategic and tactical missiles. He has developed number of industry standard compressible CFD codes (RANS and LES) for aerodynamic and propulsion characterization of different kind of aerospace vehicles. His contributions in CFD simulations of external and internal flows has enabled the designers to take some standalone design decision based on numerical results without any experimental testing. He has published many scientific articles (~260) in reputed referred journals, book chapters and conferences. He is the fellow of many prestigious professional bodies including Indian National Academy of Engineering, Telangana Academy of Science, Institute of Engineers etc. and received many awards. He is the review committee member of many national programs and member of editorial board of many aerospace journals. His research interest includes Aerodynamics, Propulsion, CFD (RANS, LES, Grid free methods), Combustion, High speed reacting flows, modeling of turbulence – chemistry interaction, unsteady flows etc