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PRESSURE MEASUREMENT OVER TRUNCATED LINEAR AEROSPIKE NOZZLE IN DIFFERENTIAL THROTTLING CONFIGURATION

Abstract

In current paper, some experimental and numerical simulation data (of PhD second year) is presented for static flowfield characterization of truncated linear aerospike nozzle, both at non-differential throttling and differential throttling configurations. The data acquired is in the form of pressure measurements and thrust angle (which is calculated from thrust components at differential throttling configuration). Pressure measurements are obtained over the top and bottom walls of the plug and at the base of truncated linear aerospike nozzle. This nozzle is truncated at 40% of its ideal length. For experimental testing (cold tests), an existing nozzle test rig at Aerospace department of our university has been used. In order to be able to carry out differential throttling experiments, existing truncated linear aerospike nozzle has been redesigned and upgraded mechanically to subject nozzle inlets, on either side of the plug, to different Nozzle Pressure Ratio (NPR). New pressure measuring ports have also been added at the truncated base of existing nozzle model. Commercial CFD software Ansys-Fluent has been used to solve steady state flowfield around the nozzle for both configurations. RANS equations have been solved using the density-based solver of the software with Spalart-Allmaras (SA) turbulence model. Experimental pressure data over the plug surfaces, in non-differential throttling configuration, is used for validation purpose and is compared with data from Future European Space Transportation Investigations Programme (FESTIP). For both non-differential (NDTC) and differential throttling configuration (DTC), numerical simulation pressure data over the walls of nozzle plug and its base has been obtained for NPR 6.5. In DTC, a differential factor (DF) is introduced for the variation of NPR between bottom and top inlets of the nozzle with an increment of 10%, ranging from 0% to 100%, where 0% DF define non-differential throttling configuration, while with 100% DF one of the inlet is in closed position. The experimental data matches closely to the FESTIP data while CFD data also shows the same flow structure and behaviour, however, there is some longitudinal shift in pressure development pattern as the current CFD data is based on 2D CFD analysis while the experimental data is of 3D model. For all DF values, resultant base pressure distribution clearly illustrates the skewness of base flow. For considered NPR and at DF of 100%, differential throttling technique of thrust vectoring has resulted in a maximum thrust angle of around 9.3 degrees.