THE ALTITUDE ADAPTIVE DUAL BELL NOZZLE

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The dual bell nozzle has been found out to be one of the most promising concepts for alti-tude adaption of the nozzle jet. The wall contour inflection linking the base nozzle with the ex-tension provides two stable operating modes, circumventing the area ratio limitation inherent to conventional main stage engine nozzles. During the past decade, numerous experimental as well as analytical investigations have been conducted at the German Aerospace Center for a better understanding and the qualification of the dual bell concept for main stage engine application. Cold and hot flow tests aimed to point out the influence of the geometrical parameters on the flow behavior. The conditions for the transition from sea level to altitude mode and back, the hysteresis between these values, the duration of the transition and the resulting side load genera-tion were of particular interest. The contour optimization results in a trade-off between the tran-sition duration, stability and side load amplitude, all depending on the extension length. Out of the experimental work, it was possible to define the parameters for realistic dual bell nozzle geometries and to conduct an analytical study of the nozzle behavior during ascent of a parallel staged heavy launcher. The additional loss in sea level, the so-called drag effect, was evaluated for the chosen nozzle using DLR's CFD in-house code Tau. The present paper gives an over-view on current experimental and analytical dual bell research activities.