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DESIGN AND ANALYSIS OF A FOUR-DUCTS INWARD TURNING INLET FOR XTENDER ENGINE

Abstract

To accomplish the requirement of future hypersonic vehicles with high impulse, wide working range, as well as the ability of horizontal takeoff/landing and reusability, a four-ducts combined cycle engine, namely Xiamen Turbine Engine and Dual-mode Ejector Ramjet (XTENDER) engine, has been raised by Xiamen University. In the present work, emphasis is put on the design and analysis of the engine inlet, which must work properly and provide sufficient air for different flow paths from Mach 0 to Mach 6. The combined inlet is constructed based on a three dimensional hypersonic inward turning inlet which is derived from a well-designed basic flow field. The inward turning inlet operates between Mach 4.5 and 6 with a nice performance. Two side-positioned turbojet flow paths for flight speed below Mach 2.5 is added to the inward turning inlet on the compression side, with a rotational flap controlling the open/close of the turbojet flow paths. An additional ejector flow path for Mach range 2.5-4.5 is arranged on the topside, with also an individual rotational flap on the compression wall. Each flap system is designed with two plates, the driving plate and the driven plate. The former one is mainly used to control the throat area of a path to guarantee the startability of the combined inlet, whereas the later one is purposed for getting a higher aerodynamic performance of the path. This four-ducts inward turning inlet shows many advantages to other inlet concepts for combined cycle engines. First, it owns a symmetric structure which allows single engine implementation for flight vehicles. This would expand a lot of applications from industrial point of view. Second, the throat area of each flow path can be adjusted according to requirements individually. For instance, at low flight Mach number, the four ducts can all open to promise the start of the inlet, and the mass flow rate of each flow path can be regulated according to the throat area. Third, the ejector flow path plays the role of absorbing the boundary layer for turbojet mode (i.e. Mach number below 2.5), which allows a nicer uniformity of the air flow for the turbine engine. Fourth, the actuator system is comparably easier to other combined inlet concepts, since only two flap systems are required. Fifth, the high speed duct is a pure ramjet engine with a relatively clean flow path, which guarantees nice performance of the inlet under cruise speed.