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# A CONCEPTUAL DESIGN OF PERMEABLE NOZZLE FOR ALTITUDE COMPENSATION AND THRUST VECTORING

**Abstract**

Conventional rocket nozzles are only efficient in specific altitude. A new concept of permeable nozzle with double layer structure is proposed in this paper to achieve altitude compensation as well as thrust vectoring. The inner layer is a high altitude nozzle with large expansion ratio, whose rear part is slotted to allow the ambient air flow in and prevent the backflow at low altitude. The outer layer is rotatable around the axis of the nozzle, which acts as baffle to block portion of the slots on the inner layer. During the ascending stage of the flight, the slots are blocked gradually from the front part to the rear part of the expansion nozzle to achieve a relatively high efficiency over the entire altitude range. Thrust vectoring can be achieved by blocking the slots unsymmetrically on the nozzle. The flow fields are analyzed by numerical simulation. Compared with the conventional altitude compensating nozzles (aerospike or expansion deflection nozzle, etc.), this new permeable nozzle allows for smooth transition from low altitude to high altitude without obvious mode shift. There is also no significant loss of efficiency in the altitude variation.