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DESIGN OF SUPERSONIC EJECTION SYSTEM FOR HIGH SPEED COMBUSTION INVESTIGATION AND RESULTS OF WIDE RANGE COMBUSTION CHAMBER TESTS

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Abstract

The paper will present experimental results of investigation of configuration and performances of supersonic low mass flow ejector systems for connected pipe ground testing of ramjet combustion chamber in different simulating flight conditions.

The detailed scientific study of combustion in high speed flow on a wide range of operating conditions requires different features. In some combustion modes, the ambient back pressure can modify the regimes in the experimental combustion duct. In flight at moderate hypersonic speeds (Mach 5 or 6 for example) the combustion start or stop or regime can be different between connected pipe test on ground, with exit ambient pressure of 100 000 Pa and flight operation, with local back pressure of 2000 Pa for example. To obtain the correct exhaust phenomenon during ground test, an ejector system.

Generally, the air or steam ejector system is based on supersonic ejectors, special design of duct (with upstream box and optimised converging part before the exhaust tube) and an amount of ejection air that is 2 to 10 times bigger than the incoming air entering the combustion chamber.

In the MAI aerospace propulsion test bench, such a big mass flow is not available. For current high speed combustion investigation, the available ejector mass flow is only half of the incoming air flow.

Specific study was conducted at MAI in cooperating effort with French partners (especially provided 2D and 3D computational results) in different subscale ejectors.

The paper will present different experimental and associated computational results, for different geometries and injection position and conditions, both with entry subsonic flow and supersonic incoming flow, both in cold conditions and with preheated air. An example of pressure distribution along the duct is shown at Fig.1. Such ejector was used during the tests of model combustion chambers.

With the aim to simulate a stable work and high level of thrust in the wide range of flight conditions the combustion chamber model with a mechanically-driven flow path it was designed. The combustion chamber model duct was rectangular. The upper wall was mechanically-driven. Also movable flame holders were used. The stable burning was received during the tests for simulating flight with Mach number 2-6. The pressure distributions in the combustion chamber model duct at various working regimes (corresponding to flight conditions) are presented at Fig 2.3.3.2

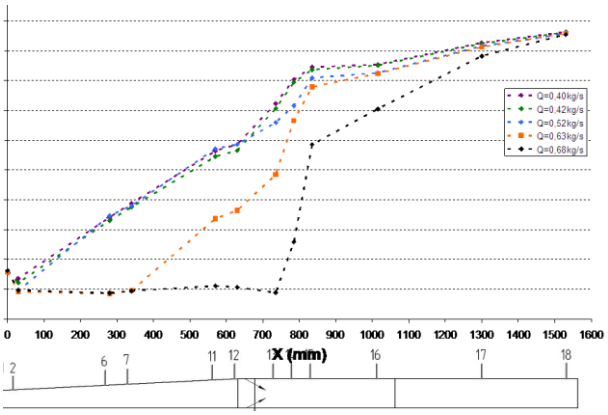

Fig. 1. Example of subscale ejector results as tested at MAI

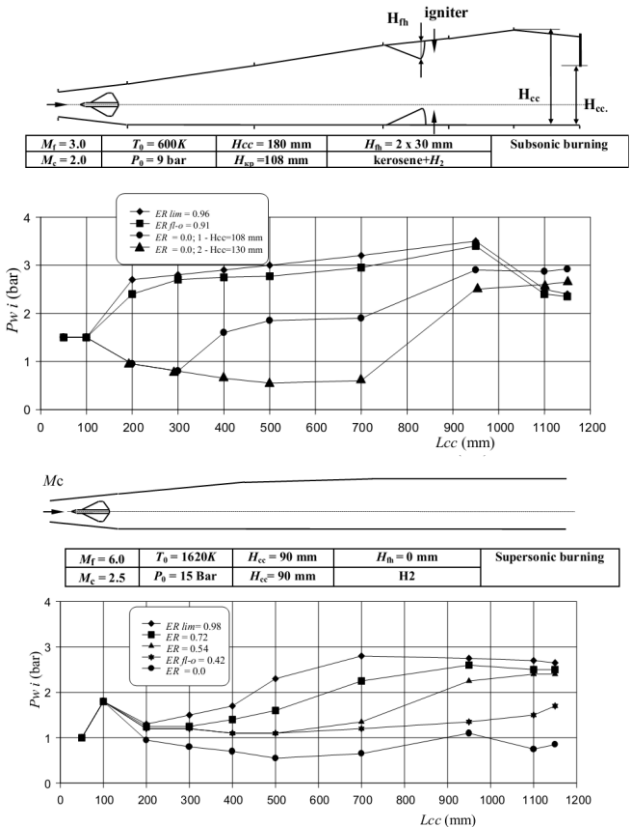

Fig 2. Pressure distribution.

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