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Experimental and Numerical Studies on Flow Field of Single and Coaxial Engine Exhaust Jets for Future Hypersonic Vehicles

（将来型極超音速機のための単一および同軸型エンジン排気噴流の流れ場に関する実験的数値的研究）

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Achieving a sustainable hypersonic flight cannot take place without a highly efficient propulsion system, such system must produce a sufficient thrust that can overcome the vehicle drag along with accelerating the aircraft and sustaining its velocity as it maneuvers, hypersonic propulsion systems will exhaust a high pressure underexpanded jet, that can be produced by a single cycle engine such as a scramjet engine, or a multiple cyclic engine such as the RBCC (rocket propelled combined cycle engine) Part of the studies conducted in this research; are on a single jet that can be produced from a single engine cycle with a cylindrical configuration, the other part is related to the coaxial jets that can be generated from a combined engine cycle engines with a cylinder coaxial configuration.

The general Objectives of this research is to Model exhaust jet flow numerically and experimentally to Analyze the exhaust jet flow field and the factors that can affect its flow, such objectives will be accomplished by studying a single jet flow and the impact of the factors that can affect it.(ambient pressure, chamber pressure, angle of attack , Forebody shape, jet total temperature). On the other hand and with the purpose of understanding the effect of two jets on each other; a coaxial axisymmetric configuration of two jets in the hypersonic flow was investigated, such study will analyze the interaction of two axisymmetric exhaust jets, and there mixing, along with examining the effect of changing the pressure ratio between both jets.

Coaxial engines exhaust jets flow has an impeded complexity in regards how to model the exhaust jet flows as well as the flow structure within and outside the body, not to mention the effect of using a cold airflow in the experiment to simulate the actual hot exhaust engines jet flow; taking the previous into consideration the current master's thesis starts by examining and understanding single jet flow being expand in the hypersonic free stream environment, such understanding includes: studying the general flow structure of the jets as it developed inside the pressure chamber and after it being exhausted out of the nozzle into the free stream surrounding the hypersonic body, the effect of body and its wake, the forebody shape, the body angle of attack, back pressure effect, chamber pressure and temperature.

In general we can conclude that the Exhaust jet flow is a robust and hard to be affected, and using a Cold flow discharge is a very effective exhaust simulation method, in the case of the Coaxial jets it can be noted that the jets flow is hard to be mixed even with the existence of a common discharge channel, and the coaxial jets pressure ratio has a high impact on the flow field and overall exhaust jets shape.