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RESEARCH ON AERODYNAMIC DRAG CHARACTERISTICS OF SOLID FUEL RAMJET

Abstract

A solid fuel ramjet engine is operated at supersonic conditions, unlike rocket engine systems, additional oxidizer tanks are not required, use oxygen from ambient air. Also, using shock waves, high-temperature and high-pressurized air is supplied into the combustor, and due to its high combustion efficiency under supersonic, it is mainly used for missiles operating in atmosphere.

A drag force is that a fluid exerts on an object in the flow direction, and it is most important to design the solid fuel ramjet accurately. When the drag is overestimated, excessive thrust is generated and the system deviated from target point. Reversely, when the drag is underestimated, due to the lack of thrust, the launch is falling or performance could not be satisfied.

But it is very hard to measure the exact drag of the solid fuel ramjet system. Since, the center of solid fuel ramjet is hollow for intake air, that difficult to gauge the frontal area, and operated under supersonic conditions. So, the solid fuel ramjet is designed using surrogate drag coefficient from projectile of which external shape and operation conditions are similar with ramjet. Therefore, it is necessary to study the drag force of solid fuel ramjet considering the bypassed air characteristics. In this study, using CFD simulation, the drag force of solid fuel ramjet was calculated.

For minimizing the difference of drag according to the shape, the diameter was fixed at 150 mm and length at 1,000 mm. The free stream velocity was Mach 2.65, and k- SST viscous model was used for considering compressibility.

As a result, the drag coefficient of solid fuel ramjet was 0.54 that was higher than general projectiles of which drag coefficient was 0.3-0.4. It was thought that, the compression and expansion were repeated inside the ramjet, that generated much of shock waves, which is irreversible. Therefore, the drag is increased as the total pressure decreased.

A simple solid fuel ramjet system in which only air passages exist, the drag coefficient was 0.43 which was lower than normal solid fuel ramjet. In this system, due to the passage was straighten, since only small number of oblique shock waves were generated, drag force was lower. Summarizing results, the bypassed air affected the drag force and the drag coefficient of solid fuel ramjet was 0.54, and when using this drag coefficient, it is possible to calculate trajectory of solid fuel ramjet more accurately.