

Research Activities on Rocket-Base Combined-Cycle Engine at JAXA

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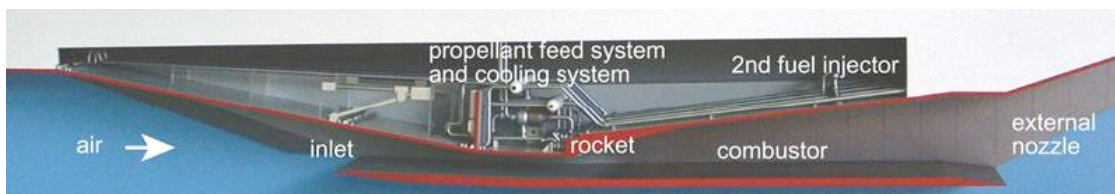
New transportation systems are required for economical space activities and new business. High reliability and measures against accidents are also required for credible and safety space transportation of payload /passengers. In order to serve such requirements, weight margin is necessary for additional/redundant systems. In Japan Aerospace Exploration Agency (JAXA), studies of air-breathing engines started to produce the margin to the space transportation system by increase of the specific impulse.

Large energy is necessary to reach an orbit. Kinetic energy is proportional to square of speed. The scramjet engine was selected, being expected to attain the energy in supersonic/hypersonic flight. In the study, larger thrust coefficient was produced at Mach 6 condition than that by the scramjet engine of X-43. First productions of net thrust were succeeded at Mach 8 and 10 conditions by JAXA engine models. Production of thrust was also succeeded at Mach 12 to 14 conditions.

The scramjet needs other engines from take-off to supersonic flight and for flight in a low dynamic pressure condition or space. Furthermore, it has been made clear that the air-breathing engines cannot produce a sufficient effective specific impulse in hypersonic speed. In order to compensate the shortcomings, study of the Rocket-Based Combined-Cycle Engine (RBCC) has been started. The engine is a solution to the shortcomings. The engine is composed of the rocket and the ramjet engines. The engine operates as an ejector-jet in subsonic speed, a ramjet in supersonic speed and a thrust-augmented scramjet in hypersonic speed. In a low dynamic pressure condition or space, it operates as a rocket engine.

Operations were demonstrated at still-air and supersonic conditions, respectively, at the ramjet engine test facility of Kakuda Space Center. Testing at the hypersonic condition is scheduled. From the studies, several problems have been made clear. For example, one is insufficient mixing and combustion in the ejector-jet and ramjet modes. Another is insufficient air-breathing ability in the ejector-jet mode. For this problem, a flight test of the ejector was conducted by a small hybrid rocket, CAMUI, with Hokkaido University in March 2009.

RBCC and the combined-cycle engines have long histories and several types. JAXA has conducted these studies. In the lecture, research activities in JAXA and several topics on RBCC will be presented.



RBCC display model.