

§23. Field Reversed Configuration (FRC) Fusion Rocket

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Fusion rockets have potential advantages over conventional ones such as chemical rocket. These advantages include (1) high characteristic exhaust velocity (or specific impulse), (2) high engine thrust-to-weight ratio, (3) high power level and (4) long mission life. Thus, design studies have so far been carried out both for magnetic confinement fusion(MCF) scheme and for inertial confinement fusion(ICF) one.

Of the fusion reactions considered, a fusion reaction using D-³He fuel is characterized by its low neutron production rate and high power fraction carried by charged particles. Hence, the D-³He fuel is desirable for use in space because it could reduce the radiation shielding mass and increase the power available for thrust.

Recently, the D-³He fueled FRC reactor has been proposed by Momota et al. [1] as a power source for terrestrial application. In the FRC, the plasma is confined by closed lines of force for good confinement and surrounded by open field lines of force for extraction of charged particles. The design study revealed the attractiveness of the reactor in that the reactor is environmentally acceptable in terms of radioactivity and fuel resource, and the estimated cost of electricity is low compared with a light water reactor.

The purpose of the present study is to carry out the conceptual design of the FRC for use in space in order to clarify the critical issues that need further study and illustrating its attractiveness provided.

A cross-sectional view of the possible configuration of the FRC rocket considered here is illustrated in Fig.1. An overview of the rocket is given in Fig.2.

The masses are calculated for each

component shown in Fig. 1 and a total system mass is obtained by summing up the component masses. It is found that the coil mass amounts to 448 ton , and occupies as high as 42 % of the total system mass which is 1070 ton, although we employed, as a stabilizer in the SCM, light weight Al rather than Cu adopted in the ARTEMIS design, and a carbon composite rather than stainless steel as structural material. (The mass of the magnet coils amounts to 1760 ton in the terrestrial reactor ARTEMIS[1].) The contribution from the shield is also large, amounting 28 % of it.

The specific power defined as the ratio of the thrust power to the total system mass is 1kW/kg, being about ten times better than nuclear electric fission systems. This vehicle is capable of interplanetary flight to Mars in 90 days with a payload fraction of 0.35.

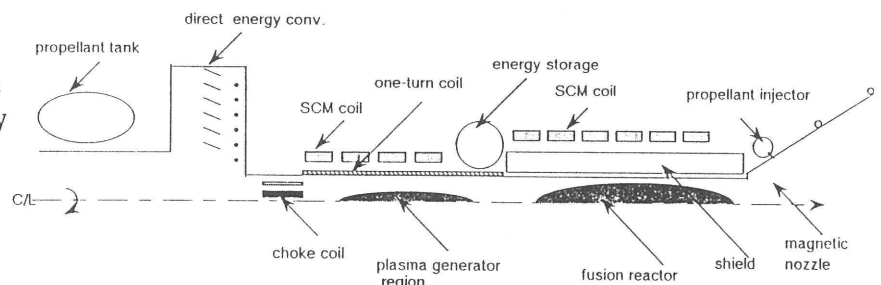


Fig 1. A Schematic Illustration of an FRC Rocket

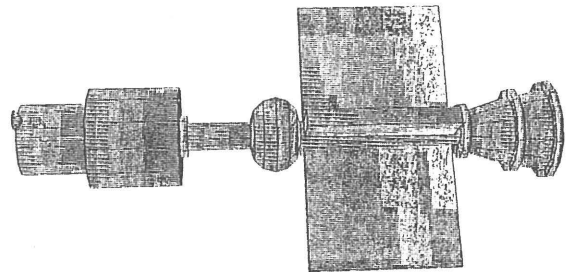


Fig 2. An Overview of the FRC Rocket

Reference

- 1) Momota, H., et al., Fusion Technol., 21 (1992) 2307.