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FEASIBILITY STUDY ON ELECTRIC PUMPS FEEDING PROPELLANTS TO A ROCKET ENGINE

Abstract

Key Words : Liquid Propellant Rocket Engine, Liquid Propellant Feed System, Electric Drive Pump, High Speed Motor, Electromagnetic Loss.

In the engine system assuming a small rocket, there is a choice of the electric pump from the current technology as the propellant supply system. The engine system with the electric pump simplifies the system because the turbine, the gas generator and the pre-burner are not required.

The power required for the electric pump depends on the type of the propellant, but even with an engine with a thrust of several tens kN, the power is as high as 100 kW. Also, because the rocket engine electric pump is miniaturized, a high rotation speed is required. Therefore, the feasibility of the electric pump type engine strongly depends on the feasibility of the electric pump.

In this study, we are studying the feasibility of an electric pump that operates at high energy density (kW/kg) and high revolution as an electric pump system integrating electric motor, control system and pump system. In the study, AMESIM is used as a system simulation tool, and JMAG is used as a motor design tool.

The output required for the motor ranges from several tens to 100 kW, depending on flow rate, combustion pressure, and pump efficiency. On the other hand, in the rocket system, reduction in size and weight of the electric pump system is required. Therefore, it is necessary to use a high speed high power density motor and its corresponding inverter. However, in order to avoid vacuum discharge in outer space, it is necessary to design a motor with a large current by suppressing the supply voltage. Therefore, the motor core part generates heat due to Joule heat (copper loss). Furthermore, in order to meet the requirements of the pump, the motor is made so that the motor rotor part has a longer axis to make it a high torque design. Heat generation due to eddy current loss poses a problem for the long axis rotator of the magnet section. We examine such an electromagnetism viewpoint with an analysis model.