A Study of Non-Contact Power Supply Systems

Takayuki KASHIWAGI
Assistant Senior Researcher, Electromagnetic Applications, Maglev Systems Technology Division

A non-contact power supply system has many potential advantages compared with a normal (contacting) power supply system. A non-contact system significantly eliminates the danger of electric shocks or leaks and has low-noise and maintenance-free features. However, the transmission of energy through space tends to drop the energy supply efficiency and adversely affect system surroundings with leakage fluxes. Thus it is important to develop a higher efficiency system.

We have started the development of a non-contact power supply system for rolling stock. As the energy storage equipment installed on battery EMUs and hybrid DMUs constitutes a significant portion of the total weight of the trains, it is important to make the equipment as lightweight as possible. A potential way to satisfy this requirement is to reduce the energy storage equipment capacity necessary for a day by frequently charging the equipment through the non-contact power supply system whenever trains stay at stations.

Major factors that drop the efficiency of the non-contact power supply system are the loss caused by the ON-resistance of the power converter to generate power for transmission and the copper loss in the power transmission/reception coils. Inverters using silicon carbide (SiC) for power elements are now being commercialized as power converters, and these are expected to reduce loss and improve efficiency. While reduction of loss is not expected much for coils, research to improve coil efficiency and reduce costs is proceeding. Indeed, we have already confirmed that it is possible to improve efficiency and reduce costs by adopting sets of thin wires used for power cables of household appliance in place of Litz wires, or the special wires used for high-frequency purposes (see Fig. 1).

To apply the non-contact power supply system to railways, it is may be possible to install power supply coils between the bottom of cars and rails to ensure the precision of installation. Unfortunately, as rails are magnetic and are close to the coils, the power supply characteristics are affected. The rails attract the magnetic fields and the resulting eddy currents cause significant losses. It may be possible to reduce the nearest leakage magnetic field, however, by using coils of the low-leakage magnetic field type that contains bipolarity within the gauge (see Fig. 2).

Based on the results of these discussions, we will manufacture a power supply test machine aiming at commercialization of the system in the near future, implement power supply and running tests by using RTRI's hybrid railway test vehicles with fuel cells and batteries (see Fig. 3) and establish the characteristics of non-contact power supply equipment that suits railway applications.

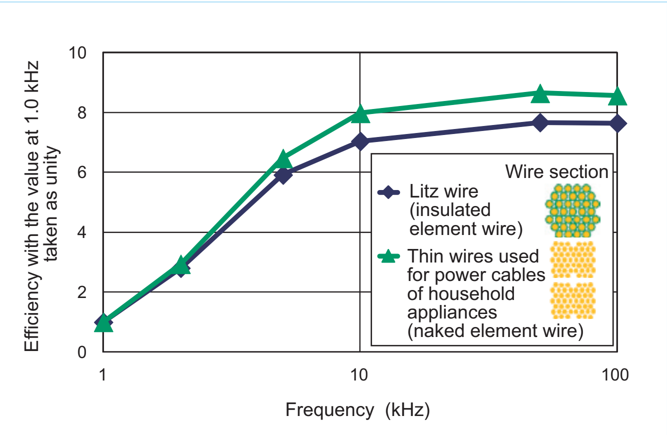

Fig. 1 Efficiency of the system using different materials

Fig. 3 Hybrid railway test vehicles with fuel cells and batteries

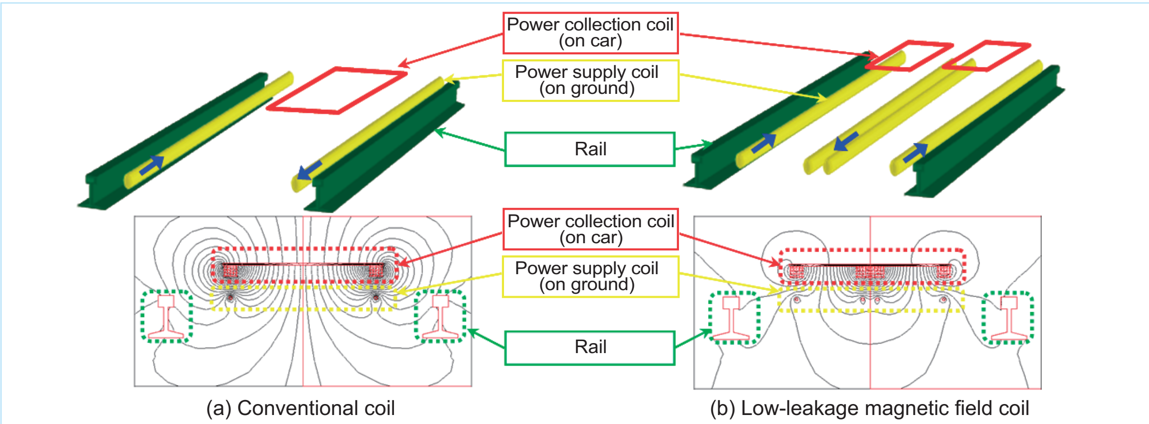

Fig. 2 A case of magnetic field analysis and analysis models (flux line diagram)