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Thu-Af-Po.06-01: Non-Insulated HTS Magnet Parameter Identification

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OpenStar Technologies Ltd is pursuing a levitating dipole reactor (LDR) for fusion energy production. As part of the first LDR prototype, a 5.6 T, 1.44 kA HTS magnet, Junior, has been successfully designed, built and tested.

Junior consists of 14 non-insulated (NI), solder impregnated HTS coils connected in series. Coil parameters such as radial resistance and joint resistances are carefully designed parameters which impact magnet performance and place constraints on other systems, such as the on-board HTS Power Supply (Flux Pump). These parameters must be estimated to validate that they met design specifications. Two factors complicating the Parameter Identification process included mutual coupling between coils and joint resistances being embedded in coil voltage measurements.

Each of the 14 coils are inductively coupled, described by an inductance matrix, M, and estimated using COMSOL. Circuit models (ODE's) were derived for magnet charging and discharging cases, from which radial and joint resistances could be estimated using experimentally obtained coil and coil interface voltage measurements. Curve fitting was performed using Non-Linear Least Squares.

The results showed good agreement between estimated parameters and experimental data. It was also revealed that coil radial resistances impact the zero-field region in the magnet torus center, which is a requirement set by the on-board HTS Power Supply due to the transient response of coil currents during charging. This was a result predicted by field modelling and verified experimentally. While these results are of specific interest for dipole fusion magnets, the estimation approach can be applied to any magnet comprised of multiple NI HTS coils.

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