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Comparison of Solenoid-type and Annular-type Parallel Inductors Schemes in H-SFCL of Shipboard MVDC IPS

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Among the short-circuit fault current limiting devices in shipboard medium voltage dc-based integrated power system (MVDC IPS), hybrid-type superconducting fault current limiter (H-SFCL) has unique advantages. However, the H-SFCL prototype has to work under normal condition of 10kV/5kA and limit the short-circuit current of nearly 100kA in shipboard IPS, so it must have large current-carrying capacity. The current-carrying capacity of a single strip is poor, hence it is necessary to parallel the strip or coil. Due to the different magnetic field configuration, the unbalanced current distribution caused by parallel connection is prominent. In this paper, to solve the problem of unbalanced parallel current distribution, two typical structures of parallel inductors, solenoid-type and annular-type, are discussed. The current distribution characteristic analysis and electromagnetic optimization design of parallel inductors with two structures are carried out respectively. The magnetic field characteristics, coupling degree and strip consumption of two schemes are compared. Through comparison, it can be seen that these two schemes have their own advantages. Considering the operational stability and technical feasibility of the magnet, the annular type parallel inductors scheme is selected to be applied in H-SFCL. The results show that the H-SFCL prototype with annular type parallel inductors scheme meets the design requirements and has superior performance in current reduction and loss.

Index Terms—Electromagnetic design, shipboard MVDC IPS, hybrid-type SFCL, fault current limiting.

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