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Analysis of Direct Oil Cooling Channel Configurations in an Electric Machine Stator

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With the rapid development of electric vehicles. High-power-density electric machines are essential for improving space utilization and reducing the overall system mass. Direct oil cooling has become an effective approach to enhance the thermal performance of electric machines. In this study, conjugate heat transfer simulations are conducted in Ansys Fluent to analyze the influence of stator oil cooling channel positions on the thermal performance of a 36 kW externally excited synchronous machine stator. Three cooling-channel configurations are evaluated under varying operating conditions, including a range of motor speeds, with each speed corresponding to a different balance between iron and copper losses. The results indicate that direct contact between cooling oil and the windings significantly improves cooling performance. Under low-speed operating conditions, where copper loss dominates, the difference in thermal performance between cooling channels located at the upper and lower winding regions is relatively small. However, as the rotational speed increases and the loss distribution changes, the cooling performance of the lower-positioned cooling channel decreases significantly.

Primary authors: YE, chengyang (Politecnico di Torino); TONOLI, Andrea (Politecnico di Torino); Mr ZENERINO, enrico (Politecnico di Torino)

Presenter: TONOLI, Andrea (Politecnico di Torino)

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