Contribution ID: **351** Type: **Poster**

C2Po1D-01: Experimental Study of Two-phase Transition cryogenic Cooling of Aluminum Conductors for Single Stator Slot Tests

Tuesday 11 July 2023 09:15 (1h 45m)

In order to develop higher power density motors and generators for aircraft applications, the higher magnetic field generated by stators is needed to create larger torque. The current density of conductors of stators should also be higher to generate a large magnetic field. Therefore, cryogenic liquid cooling for stators is needed to prevent overheating problems. The Ohio State University developed a demo one slot of a stator. This slot was constructed using two aluminum bars with a cooling slot between them. These two aluminum bars were made of 1100 commercial purity Al alloy. The two bars were placed in parallel with a 1.6 mm gap in between, which acted as a flow channel for the cryogenic coolants. And these two bars were connected in series and carried a maximum current of up to 90 A/mmˆ2. The coolant (LN2) was continuously flowing through the channel while the aluminum conductors were carrying a high density of current. Thermocouples were used to capture the temperature data during the experiment every second. This work was compared to FEM modelling, where the heat transfer coefficient of two-phase transition cooling (both nucleate boiling and film boiling) was calculated by these data of temperature and current. Our analysis shows that this approach to stator cooling is able to meet the requirements of the cryogenic stator design.

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Session Classification: C2Po1D: Thermophysics III: Numerical Studies