Contribution ID: **437** Type: **Poster**

C3Po1C-05: Experimental study on inclined two-phase flow cooling of multi-stranded aluminum cable

Wednesday 21 May 2025 09:15 (1h 45m)

An important aspect to enable widespread adoption of electric aircraft propulsion is to develop lighter and higher-ampacity cables to carry the high current and voltage at the same time. To address this, we developed a power transmission cable for electric aircraft that utilize cryogen-flow cooling to enhance transmission efficiency. The cable uses multi-stranded aluminum wire as the conductor, and "bubble breakers"made by polyether ether ketone (PEEK) with 15% volume silica is used to center the conductor and prevent overvoltage breakdown due to the high voltage. Liquid cryogen flows around the multi-stranded aluminum wire and bubble breakers to counteract the Joule Heat. Our previous study demonstrated that a three-meter horizontal multi-stranded aluminum cable with two-phase boiling liquid nitrogen flow achieved a current ampacity ranging from 30 to 70 A/mm^2, depending on the flow rates. Since cables in aviation are not always horizontal due to takeoff and maneuvering, we hypothesized that the inclination angle of the cable could impact its thermal hydraulic balance which changes the current ampacity of the cable due to gravity and bubble accumulation in two-phase boiling flow. In this study, we conducted a series of flow tests for multi-stranded aluminum cables at various inclination angles to investigate how tilting and flow rate affect current ampacity. The angles tested included 0 degrees (horizontal), 15 degrees inclined towards the outlet, 30 degrees inclined towards the outlet, 15 degrees inclined towards the inlet, and 30 degrees inclined towards the inlet. We first put the multi-stranded aluminum cable in a one-meter-long transparent glass cryostat and conducted ampacity flow tests with these angles of inclination to observe the bubble accumulation due to gravity. Then we placed the cable in the three-meter-long flexible cryostat for the same inclined ampacity flow test, to demonstrate the impact of cable length. The result revealed the influence of tilting angle and flow rate on the current ampacity of cryogen-flow multi-stranded aluminum cable. This study was supported by NASA ULI program (CHEETA).

Author: Mr GUO, Yang (The Ohio State University)

Co-authors: KOVACS, Chris (Scintillating Solutions LLC); COLLINGS, Edward (The Ohio State University); Mr KWON, Jin; SUMPTION, Michael; HAUGAN, Timothy

Presenter: Mr GUO, Yang (The Ohio State University)

Session Classification: C3Po1C - Thermophysical Properties and Transport Processes III