

Mixed-refrigerant cooled 10 kA current leads for superconducting applications

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Current leads for superconducting magnets or power cables contribute significantly to the cryogenic heat load of the otherwise well isolated system. The thermodynamic optimization of current leads requires cooling not only at the cold end, but along their entire length. For larger scale systems, cooling with boil-off nitrogen or helium gas is well established. For compact or stand-alone applications, however, a liquid nitrogen or liquid helium infrastructure is usually not available to realize a closed-cycle cooling system with vapor-cooled current leads.

For the latter applications, a novel type of cryogenic mixed-refrigerant cooled current leads (CMRC-CC) offer a highly compact and efficient closed-cycle solution. In this case, the current leads fulfil both their electrical, as well as the thermal purpose as internal heat exchangers in a Linde-Hampson cycle operated with a wide-boiling refrigerant mixture. We present the prototype design of such 10 kA micro-structured current leads, which will be tested in our new test facility COMPASS. The paper gives an overview on the design process and presents the results of numerical studies on the current lead design and operation in different load scenarios.

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