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C3Or2C-05: Low-loss cryostat for high-Tc-superconducting cables

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As the demand for electric energy continues to grow, high-T_c-superconducting (HTS) power cables are an attractive opportunity to strengthen the electrical grid, owing to the fact that they can carry high amount of currents with low losses and a relatively compact cross section.
However, all practical superconducting materials still require operation at cryogenic temperatures. These temperatures need to be maintained over a long cable length with minimal amount of cooling power. Engineering and manufacturing a low-loss thermally insulating pipe is thus one of the crucial building blocks in order to enable commercialization of superconducting power cables.
In order to achieve a low thermal inleak, vacuum super-insulation has proven to be the most promising approach. Vacuum-insulated cryogenic lines are commonly used for transport of cryogenic liquids such as nitrogen, helium and liquefied natural gas.
Superconducting power cables, however, pose more stringent requirements on the vacuum insulated line: In addition to the extremely low thermal leaks that are needed to enable long transmission length, mechanical constraints play an important role. The most relevant of these constraints are the weight of the cable, a low bending radius for transport and installation in urban environments, and high forces during cable pulling.
This contribution presents a novel design for a vacuum-insulated cryogenic tube, taking into account the specific requirements for HTS power cables. The thermal performance of a 12-m prototype was measured with boil-off calorimetry in different load scenarios, showing a < 1 W/m thermal leak even under unfavorable conditions such as mechanical load from the cable and bends.

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