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# M2Po3B-04: Experimental assessment of the parasitic thermal load on cryogenic envelope for superconductive cables

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In the context of the hydrogen economy, transporting hydrogen in liquid state (LH2), instead of the gaseous one, is considered appealing due to the maximization of the energy density. The liquefaction of hydrogen is, however, an expensive process as it requires cryogenic conditions, typically in the range between 20 K and 30 K, depending on operating pressure. To maximize the economic revenue from the transfer of H2 in its liquid state, the combination with other technologies requiring cryogenic operation can be considered, such as the power transfer through superconductors. The main goal is to transfer significant quantities of hydrogen and electricity (typically DC at medium voltage) into a hybrid line where the LH2 is used as coolant to keep the superconducting state of the cable. The MgB2 can be considered an enabler in this application as its operational temperature perfectly matches the LH2 temperature range. In this setting, accurately quantifying the parasitic thermal load affecting the cable typically housed in a cryogenic envelope (Envelope), is critically important. The Envelope is made of coaxial tubes usually designed with a thin corrugated structure to ensure flexibility and resilience against thermal contraction, facilitating connections between terminals and joints positioned at specific intervals. Existing literature provides some scattered data on the parasitic load to the cryogen through the Envelope, and systematic investigations are still scarce. This study analyzes and compares distinct measurement methodologies for assessing the parasitic load through the Envelope. At least the following two methods will be investigated in terms of feasibility, repeatability, safety and accuracy: the first method is based on the Temperature-Pressure correlation on the saturation curves, the second method is based on boil-off measurement and relies on the correlation between the parasitic heating and vapor generation rate from liquid cryogen. For the purposes of this analysis, liquid nitrogen is selected as the cryogen, for the sake of availability, safety and cost. For each method a proper lumped model will be produced in order to describe the behavior of the system. The configuration of the test bench, based on the best measuring approach according to the made comparison, is described in detail and designed so that operative conditions can be easily translated into a numerical model. A methodology is proposed to extrapolate the results to the temperature range relevant for the LH2 operation and extension of the methodology to assess thermal performances of rigid Envelope will be assessed.

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