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Fast cooling high field pulsed magnet with distributed mini cooling gaps

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Enhancement of the repetition rate of high field pulsed magnets is significant for the efficiency of the experiments under pulsed high magnetic field. Adding a liquid nitrogen cooling gap of 3-5 mm has been proven to be a feasible method to increase the cooling efficiency and improves the repetition rate of pulsed magnets. Study indicated that the cooling efficiency increased with the number of the cooling gaps[1]. But the radial dimension of the cooling gaps has to stay rather small in order to limit their influence on the maximum field and coil efficiency, especially when we tried to set a cooling gap adjacent to every layer of conductor. Since heat transfer between boiling liquid in mini gaps of less than 3 mm is a rather complicated process, the heat transfer laws based on the large space pool boiling are no longer applicable. The heat transfer coefficient in the mini gaps will change greatly with the change of heat flux, mass flow rate and size of the gap, which even might drop sharply due to dryout of the liquid nitrogen. In order to find out the effectiveness of mini gaps to increase the cooling efficiency of the pulsed magnets, an apparatus was developed to test the heat transfer properties of a mini gap with radial dimension of 1 mm. Simulations were carried out to optimize the cooling gaps in a pulsed magnet based on the tested results. In this paper, the experiment of the testing process will be described. The simulation of a 40 T fast cooling pulsed magnet will be presented.
[1] Frings P, Witte H, et.al, Rapid Cooling Methods for Pulsed Magnets. Applied Superconductivity, IEEE Transactions on, 2008, 18(2): 612～615

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