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C1Po3A-06: Design and optimization of return gaseous helium heater for 2 K cryogenic test bench

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Superconducting radio frequency (SRF) cavity technology is typically operated at 2 K temperature to minimize the RF surface loss by reducing the BCS resistance, thereby achieving a high-quality factor (Q0). To maintain a 2 K environment, LHe(liquid helium) is normally converted to saturated HeII by using a sub-atmospheric vacuum pumping system to pump down the pressure of the helium chamber to 31 mbar. To ensure the safe and high efficiency operation of the pump system, the inlet temperature of the vacuum pump and the pressure drop from the helium chamber to the inlet of the pump system are strictly controlled. For this purpose, a return gaseous helium heater using electrical heater rods and aluminum alloy fins has been designed to raise the temperature of the helium gas from 3 K to 300 K. The fin structure is dedicated designed and optimized to balance the total size, heating efficiency, and pressure drop budget. A 3D model has been simulated using CFD methods, demonstrating that the pressure drop remains within 100 Pa for a helium flow rate of 15g/s. Based on the design and CFD results, the 2 K heater has been manufactured and subsequently installed on-site. This paper gives an overview on the wide range of design considerations, CFD optimization, manufactory process, and commissioning result of the installed 2 K heater.

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