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C3Po1E-01 [25]: Analysis and optimization of the liquid nitrogen pre-cooling stage for EAST helium refrigerator

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Pre-cooling of helium with liquid nitrogen is a good alternative for large scale helium refrigerators for initial cool-down from room temperature to about 80 K due to higher exergy efficiency, higher cooling capacity, and lower demand of heat exchanger area. However, during the initial coo-down, two problems have to be faced for improper liquid nitrogen pre-cooling stage arrangement. Temperature difference between helium and nitrogen at the cold end in the first heat exchanger became very large, which leads to high thermal stress. The outlet temperature of nitrogen steam of the heat exchanger is lower than room temperature, thus the efficiency will decrease and more liquid nitrogen will be consumed. In this paper, performance of liquid nitrogen pre-cooling stage of EAST 2kW/4.5K helium refrigerator during cool-down phase will be analysis. Then a new arrangement will be proposed to avoid larger temperature difference and underutilization of nitrogen cold energy. Thermodynamic parameters of this new pre-cooling stage will be analysed and optimized. The current work may help to design, optimize and operate the liquid nitrogen pre-cooling stage for large scale helium refrigerators.

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