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Process analysis and experimental verification of compact JT cryocooler at liquid helium temperature region

A compact 4He Joule-Thomson(JT) cryocooler using two-stage Gifford-McMahon(GM) cooler as pre-cooling stages has been successfully designed and developed. The GM refrigerator cools the incoming helium gas to 91K at the first stage and 14K at the second stage. The JT system consists of three tube-in-tube heat exchangers(HEX), two spiral heat exchangers and a JT orifice. Experiments discussed in this paper are carried out in the two styles of open loop and closed cycle. A new JT compressor with single cylinder and check valves is used in the closed cycle to provide high pressure gas. The curves of throttling are given and the cooling power is measured. In open loop the no-load temperature of 3.4K and the cooling power of 30mW@4.5K are obtained, while in closed cycle 4.27K and 5mW@4.5K are obtained respectively. The optimum operating frequency of JT compressor is also investigated. The heat exchanger is verified to be efficient when the temperature at second stage of GM refrigerator is changed to 20K.

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