Theoretical and Experimental Investigations on the HoCu2 and GOS as Regenerative Materials at 4-20K

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It is still hard for the Stirling type pulse tube refrigerator (SPTR) to work at liquid helium temperatures with high efficiency. One of the reasons is the large regenerative loss under such low temperatures. In this work, the cooling performance of the regenerative materials, HoCu2 and GOS, at liquid helium temperatures are theoretically and experimentally investigated. A Sage model is established based on a three-stage SPTR, and simulations on the regenerative performance in different proportions of HoCu2 and GOS are carried out. Theoretical investigations indicate that under different precooling temperatures and refrigeration temperatures, the preferable proportions of HoCu2 and GOS will be different. The influence of heat conduction and specific heat should be taken into consideration comprehensively. A three-stage SPTR is tested and the experimental results show that the components and proportions of the regenerative materials have a great effect on the cooling performance. Only when the temperature decreases to about 5.2 K can GOS contribute to improving the regenerator performance, since its specific heat ratio is higher than the HoCu2's one at this temperature zone. While using HoCu2 as the only regenerative material, the SPTR can achieve a lower refrigeration temperature better than using GOS. The experimental results are consistent with simulations.