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The Experimental Study of Acoustically Resonant Cooling System

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Thermoacoustic engines (TEs) and pulse tube cryocoolers (PTCs) have attracted more and more attentions in recent years for their high reliability, high potential efficiency and use of environmentally-friendly working gas. Utilizing a TE to drive a PTC can produce a heat-driven cryocooler with no moving parts. However, the cooling capacity of the most existent heat-driven cryocoolers at the temperature bellow 150K is very low. This is an obstacle to the practice application in the field such as natural gas liquefaction. A novel heat-driven cryocooler named multi-stage acoustically resonant cooling system is presented in this paper. A 3-stage experimental prototype is built, which consists of three identical travelling-wave thermoacoustic heat engine units. The three heat engine units form a closed loop through resonant tubes. At the end of each heat engine units there is a branch to a PTC. Experimental results show that with the mean pressure of 3.5MPa and the heating temperature of 923K, the cooling system reaches the minimum temperature of 76K, and obtains total cooling capacity of 100W at 130K. In addition, the performance of the cooling system is tested under different working conditions, which indicates that the system will performs better as the mean pressure and heating temperature increase. The preliminary experimental results inspire us so much. As the matching mechanism further improved and the dimensions further enlarged with more stages, the acoustically resonant cooling system will obtain much larger cooling capacity with higher efficiency. It shows great application future in the field of nature gas liquefaction.

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