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Experimental comparison of Pressure ratio in Alpha and Gamma Stirling cryocoolers with identical compression space volumes and driven simultaneously by a solitary novel compact mechanism

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Stirling cryocoolers are capable of satisfying the contemporary requirements of a low-capacity cooler. A compact mechanism that can drive Stirling cryocooler with larger stroke and thus enhance the cooler performance is the need at present. The increase in the stroke will lead to a higher volumetric efficiency. Hence, a cryocooler with larger stroke will experience higher mass flow rate of the working fluid, thereby increasing its ideal cooling capacity. The novel compact drive mechanism is capable of operating more than one cryocoolers of different Stirling configurations simultaneously. This arrangement makes it possible to compare different Stirling cryocoolers on the basis of pressure ratio obtained experimentally. The preliminary experimental results obtained in this regard are presented here.

The initial experimentation is carried out on two Alpha Stirling units driven simultaneously by the novel compact mechanism. The pressure ratio obtained during the initial stages is 1.3538, which is enhanced to 1.417 by connecting the rear volumes of the compressor pistons to each other. The fact that annular leak across the expander pistons due to high pressure ratio affects the cryocooler performance, generates the need to separate the expansion space from bounce space. This introduces a Gamma configuration that is operated simultaneously with one of the existing Alpha units by same drive mechanism and having identical compression space volume. The results obtained for pressure ratio in both these units prove the concept that cooling capacity of Alpha configuration exceeds that of Gamma under similar operating conditions. This has been observed at 14 bar and 20 bar charge pressures during the preliminary experimentation. These results are presented in this paper. Thus, the theoretical predictions regarding pressure ratio and hence the cooling capacity of Alpha and Gamma configurations for low-capacity units are confirmed experimentally in the present work.

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