
SESSION 4: Stirling and Stirling-type Pulse Tube Coolers

Paper 4.5

Tuesday ORAL Session

3:15 PM

A Duplex Stirling Cryocooler with a Flexible Acoustic Resonator

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A duplex Stirling cryocooler, featuring a thermally-driven mechanism and a synergic effect, holds promising prospect in non-conventional methane liquefaction. Building upon preliminary validation of a resonance tube-coupled duplex Stirling cryocooler, this study introduces a flexible resonator to minimize footprint and enhance adaptability to various environments. Simultaneously, a linear alternator is integrated to facilitate system startup and provide electricity, catering to off-grid applications. Utilizing a lab-developed free-piston Stirling engine and cryocooler, a numerical model was initially developed to assess system performance with varying resonator dimensions. Following iterative optimizations, a hybrid flexible resonator was selected as a compromise between performance and availability. This configuration enables the system to deliver 1000 W of cooling power at 130 K while generating 1300 W of electricity concurrently. Subsequently, an experimental setup was constructed and tested to validate these predictions. In experiments, a cooling power of 370 W at 130 K and an electric power output of 1152 W were achieved under a heating power of 15 kW, resulting in a commendable system-level exergy efficiency of 16.64%.