Figures of Merit for Multi-Stage Cryocoolers

J. Delmas, A.M. Kadin, R.J. Webber, and E.K. Track

HYPRES, Inc., Elmsford, NY 10523 USA

Abstract - The "coefficient of performance" (CoP) is often used as a measure of efficiency for single-stage cryocoolers, but such a parameter is not well defined for multi-stage cryocoolers. We propose a simple definition of an electrical “figure of merit” (FoM) representative of the distributed refrigeration power of multi-stage cryocoolers, that resolves this issue for applications where heat-sinking of power and signal leads at intermediate stages is an important end-user requirement. Two cases are considered which yield somewhat different results. A Power Lead FoM (PL-FoM) is derived, based on the largest electric current that can be flowed from ambient to the lowest temperature stage. A Signal Lead FoM (SL-FoM) is also derived, based on achieving minimum electrical attenuation on the signal leads. Each FoM represents a temperature-weighted combination of the heat lifts of the various stages. The two FoMs can aid in the selection of an optimal multi-stage cryocooler for operation of superconducting devices, for example.

Keywords: CoP, efficiency, current leads, signal attenuation

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