

Magnet Hysteresis Loss in Adiabatic Demagnetization Refrigerators

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Adiabatic demagnetization refrigerators (ADR) are often combined with mechanical cryocoolers to extend the operating range to lower temperature or to improve efficiency. For example, new architectures have been, and are being, designed to enable continuous operation at temperatures below 1 K using a 4 K-class GM, pulse tube, or Joule-Thomson cryocooler. Continuous operation involves cyclic magnetization and demagnetization of the refrigerant on short time scales – from 10s of minutes to 10s of seconds. This is achieved by charging and discharging a superconducting magnet over field excursions of up to a few tesla. The hysteresis heat generated can be a significant fraction of the total heat rejected during operation, and therefore can significantly reduce efficiency. Recent measurements of magnet hysteresis heat generation have been made at NASA/GSFC using magnets (NbTi and Nb₃Sn) produced for both flight (Astro-H) and research projects. Results of these measurements, which have been used to derive scaling laws, will be presented.