Design Models for the Development of Helium-Carbon Sorption Cryocoolers

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We have developed models for predicting the performance of helium-based Joule-Thomson continuous-flow cryocoolers using charcoal-pumped sorption compressors. The models take as inputs the number of compressors, desired heat-lift, cold tip temperature, and available precooling temperature and provide design parameters as outputs. Future laboratory development will be used to verify and improve the models. We will present a preliminary design for a two-stage vibration-free cryocooler that is being proposed as part of a mid-infrared camera on NASA's Next Generation Space Telescope. Model predictions show that a 10 mW helium-carbon cryocooler with a base temperature of 5.5 K will reject less than 650 mW at 18 K. The total input power to the helium-carbon stage is 650 mW. These models, which run in MathCad and Microsoft Excel, can be coupled to similar models for hydrogen sorption coolers to give designs for 2-stage vibration-free cryocoolers that provide cooling from ~50 K to 4 K.

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