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C2Po1A-02: Research on Optimization Strategies for Heat Switches Based on Helium Adsorption Models

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Heat switches play a crucial role in cryogenic systems, regulating thermodynamic cycles or accelerating cooling processes. Among them, active gas-gap heat switches (AGGHS) are extensively employed, typically utilizing activated carbon and helium as the adsorbent-gas pair. Thermal conductance in AGGHS is controlled by driving gas adsorption or desorption through heating or cooling of the adsorbent. Due to significant variations among different activated carbons and other adsorbents, and the substantial variations in design requirements for AGGHS, systematic research on the performance optimization of AGGHS remains very challenging and is currently lacking. To address this, this study investigates optimization strategies for heat switches based on the cryogenic adsorption characteristics of helium. Specifically, parameters for evaluating the filling ratio are defined, and a suitable design range for AGGHS operation is determined. Further, targeted optimization directions for the filling ratio are provided to address diverse application needs, such as adjusting the switching temperature range of the adsorption pump or speeding up the response time of AGGHS.

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