

Evaluation of vibration characteristics of a 1.5W 4K pulse tube cryocooler with improved first stage cooling capacity

Wednesday 24 July 2024 14:00 (2 hours)

Pulse tube (PT) cryocoolers are a type of cryogenic refrigerator used to achieve ultra-low temperatures of approximately 4.2K. They are renowned for their low vibration characteristics during operation, as they lack an internal displacer, which is present in GM cryocoolers. As a result, PT cryocoolers are extensively utilized in various applications, including dilution refrigerators for quantum computers and physical property measurement systems that require minimal mechanical vibration-induced noise. In the field of physical and chemical applications, there is a growing need for enhanced first stage cooling capacity. To address this demand, Sumitomo Heavy Industries has developed the RP-182C2S as an upgrade to our existing 1.5W 4K PT cryocooler, the RP-182B2S. This upgrade offers a substantial improvement in first stage cooling capacity, increasing it from 36 W at 48K to 42W at 45K, while maintaining the second cooling capacity and interface on the cylinder side. From a vibration standpoint, increasing the cooling capacity can potentially have negative effects on vibration characteristics. This is primarily due to factors such as the larger cylinder size and changes in operating pressure conditions. Another factor to consider is the alteration in the gas intake and exhaust direction of the cold head piping, transitioning from a horizontal design (used in 1.0W 4K PT cryocoolers) to a vertical design (implemented in 1.5W 4K PT cryocoolers). These modifications may also impact the vibration characteristics. Moreover, while vibration measurements of cryocoolers are typically conducted in room temperature environments, it is essential to perform such measurements in cryogenic environments to achieve more accurate and realistic results. In this study, we developed a test bench enables vibration measurements in a second stage condition at 4.2 K. We used this setup to conduct vibration measurement on the RP-182C2S, the upgraded version of the current 1.5W 4K PT cryocooler (RP-182B2S) , as well as the RP-082B2S, a smaller 1.0W 4K PT cryocooler, which served as the comparative cryocoolers. Our aim was to evaluate the impact of the upgrade and changes in piping direction on the vibration characteristics of PT cryocoolers.

Submitters Country

Japan

Primary author: Mr SATO, Ryoya (Sumitomo Heavy Industries, Ltd.)

Co-author: Mr MATSUMURA, Yosuke (Sumitomo Heavy Industries, Ltd.)

Presenter: Mr SATO, Ryoya (Sumitomo Heavy Industries, Ltd.)

Session Classification: Wed-Po-2.3

Track Classification: Tracks ICEC 29 Geneva 2024: ICEC 04: Cryogenic applications: cryocoolers