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Development of a Capillary Tube Orifice for Expansion Device of Joule-Thomson Cryocooler

J. Kim, H. Lim, S. Han, Korea Aerospace Research Inst., Korea

An expansion device is necessary for Joule-Thomson cryocoolers to achieve the refrigeration effect by the expansion from high pressure to low pressure. Generally, an orifice or a capillary tube or a valve is used as the expansion device. However, these traditional expansion devices have limits in some special conditions such as high pressure, low flow rate, and cryogenic temperature especially in aerospace applications. For the aerospace applications, a single hole orifice is the best option because its structure is simple and the weight is light. On the other hand, the single hole orifice is easy to be plugged by the foreign object particles or ice particles of residual gas at cryogenic temperature when the diameter is less than 0.1 mm. To solve these problems, we developed a new three dimensional orifice modifying the conventional capillary tube orifice. A prototype of the new expansion device is fabricated and tested in various conditions to ensure the reliability of the compartment. In this paper, the concept of newly developed expansion device is introduced, and the test results of life test, vibration test, strength & leak test, rupture test, and temperature environmental test are summarized.