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Experimental verification of cylindrical adjustable inertance tube for pulse tube refrigerators

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The performance of the Stirling type pulse tube cryocooler increases significantly with optimal use of an inertance tube. The phase angle produced by the inertance tube is very sensitive to its diameter(s) and length(s). Recent developments are reported here regarding an adjustable inertance tube whose length and diameter can be adjusted in real time during the operation of the cryocooler. The length will increase from 1.372m to 3.088 m and the diameter will increase from 6.9 mm to 8.7mm while the outer screw of the inertance tube turns from bottommost to the topmost position. A fluid impedance measurement has been carried out to verify the performance of this adjustable inertance tube. From the fluid impedance calculation, with an air mass flow rate of 0.77 kg/s and a pressure supply of 1532 Pa (gauge) at the inlet, the fluid resistance increases from $1.874e7$ 1/s-m to $2.559e7$ 1/s-m, the fluid compliance increases from $2.303e-11$ [m³-kg/J] to $2.702e-11$ [m³-kg/J], and the fluid inertance increases from 37243 [1/m] to 62242 [1/m], while rotating the outer screw from the bottommost to the topmost position. This particular adjustable inertance tube has the potential to change the phase angle at the cold end of Stirling pulse tube cryocooler by almost 30° at a working frequency of 27Hz.

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