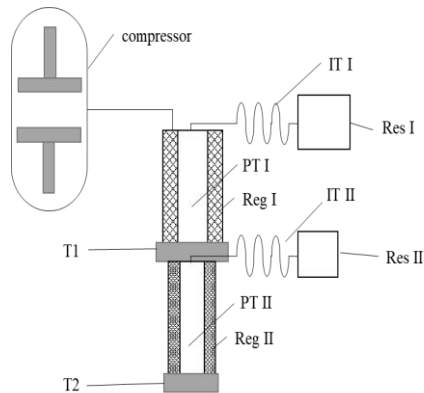


Abstract

Small Stirling-type pulse tube cryocoolers can be used to cool small optical devices due to the absence of moving elements in the cold head, long life, low vibration, and compactness. Therefore, it is necessary to study small Stirling-type pulse tube cryocoolers below 20K. This paper reports a small two-stage Stirling-type pulse tube cryocooler that achieves a no-load minimum temperature of 20 K with 500 W of input electrical power. In addition to this, the effect of the second stage double-inlet on the P-U phase of the regenerator and the pulse tube is also simulated, and it is found that the double-inlet has a significant effect on increasing the P-U phase difference between the inlet of the regenerator and the outlet of the pulse tube, which is much better than the effect of the length of inertial tube of this stage on the P-U phase.

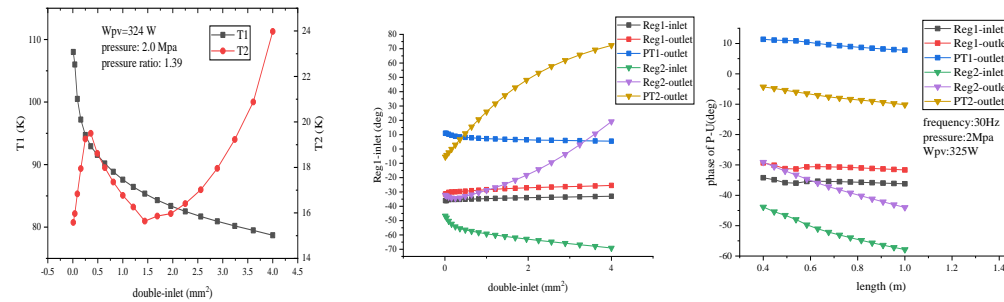
Schematic diagram



Prototype



Simulation calculations



- ◆ Use of double-inlet between the inlet of the **second stage** regenerator and the inlet of the second IT.
- ◆ The second stage temperature shows a **cubic-like relationship** with the area of the double-inlet holes.
- ◆ The double-inlet mainly affects the P-U phase of the inlet and outlet in the **regenerator**, while the inertia tube mainly affects the P-U phase of the inlet and outlet of the **pulse tube**.

Conclusion

- The lowest no-load temperature of 20K was experimentally obtained at 500W input electrical power after 4.5h.
- Cooling capacity of **0.5W@25K** and **1.5W@35K**.
- about 1.6 h after the second level of the lowest temperature drops to below 25K.
- Double-inlets have a more important effect on P-U phase regulation within the vasculature compared to inertial tubes.
- Theory suggests that the effect of the direct current from the double-inlet causes the second stage temperature to exhibit a cubic rather than parabolic relationship, a point that needs to be verified experimentally.

Parameters of SPTC

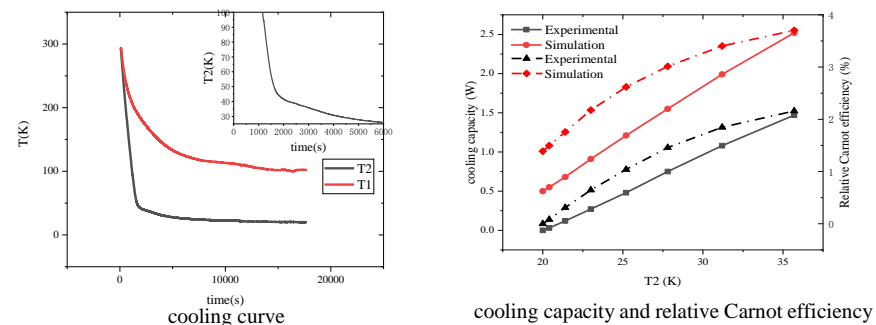
Table 1. Structural parameters of secondary Stirling-type pulse tube cryocooler cold heads

parameters	PT I	PT II
cold storage material	300#SS304	400#SS304
Length of regenerator	35mm	35mm
Length of regenerator	15mm/30mm	9mm/18mm
IT	0.7m@2mm+2m@3mm+4m@4mm	0.5m@1mm+0.5m@2mm
reservoir	600cc	100cc

Table 2. experimental operating parameters.

Parameters	value
frequency	30Hz
Input power	500W/375W(PV)
pressure	1.8Mpa
pressure ratio	1.41
Double-inlet	0.09mm ²

Experimental results



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