Experimental investigation of 20 K two-stage layered active magnetic regenerative refrigerator

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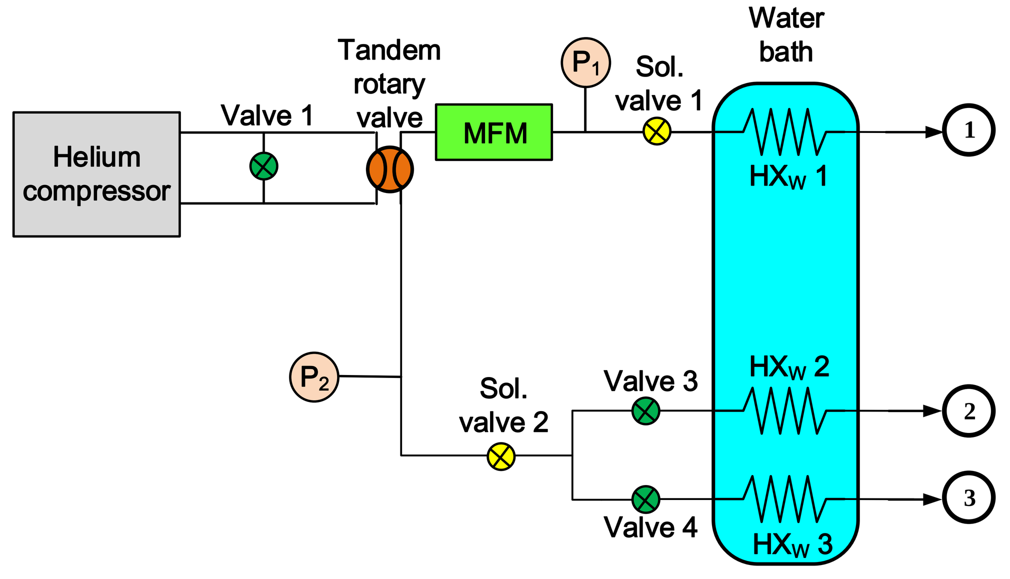
Introduction

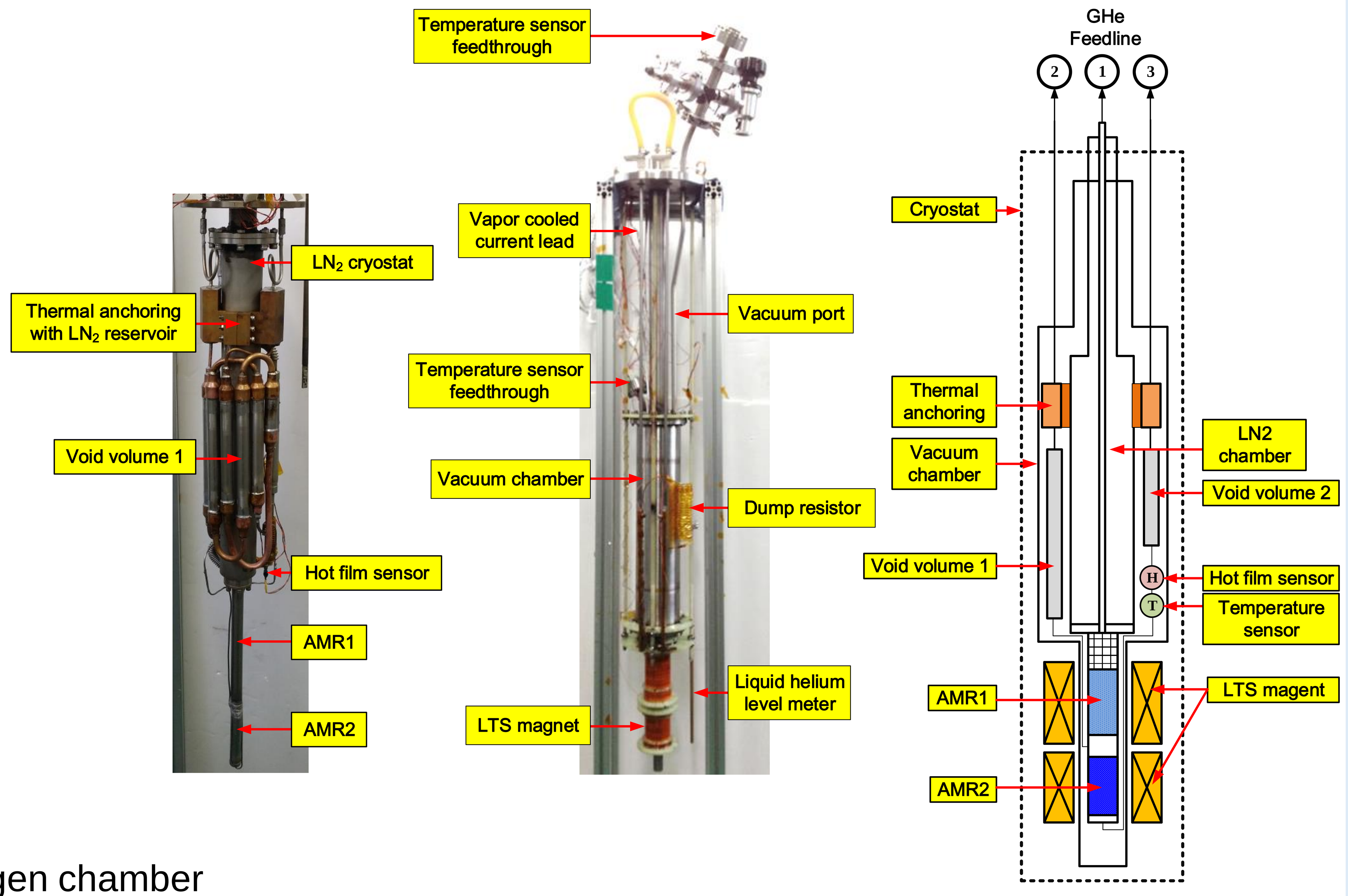
√An AMRR utilizes magneto-caloric effect (MCE) of a magnetic refrigerant for cooling.

√Since MCE is a reversible process, it facilitates high thermodynamic efficiency of an AMRR.

√Wide temperature span can be achieved by multi-layered structure of the active magnetic regenerator (AMR).

Experimental apparatus and methodology



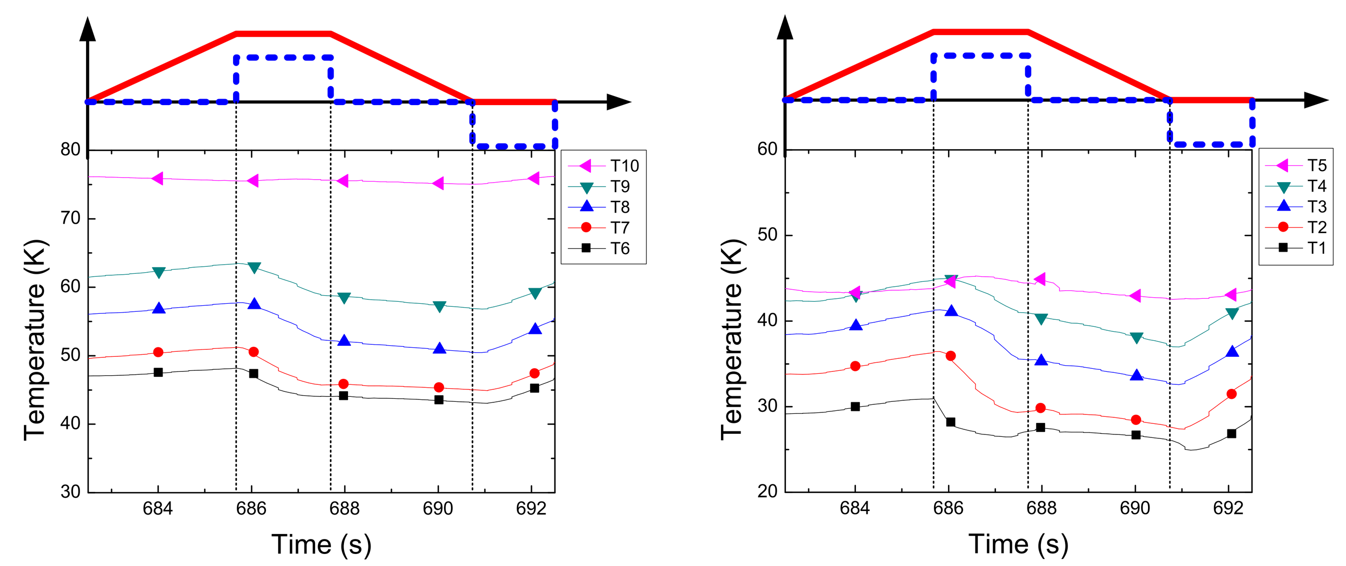


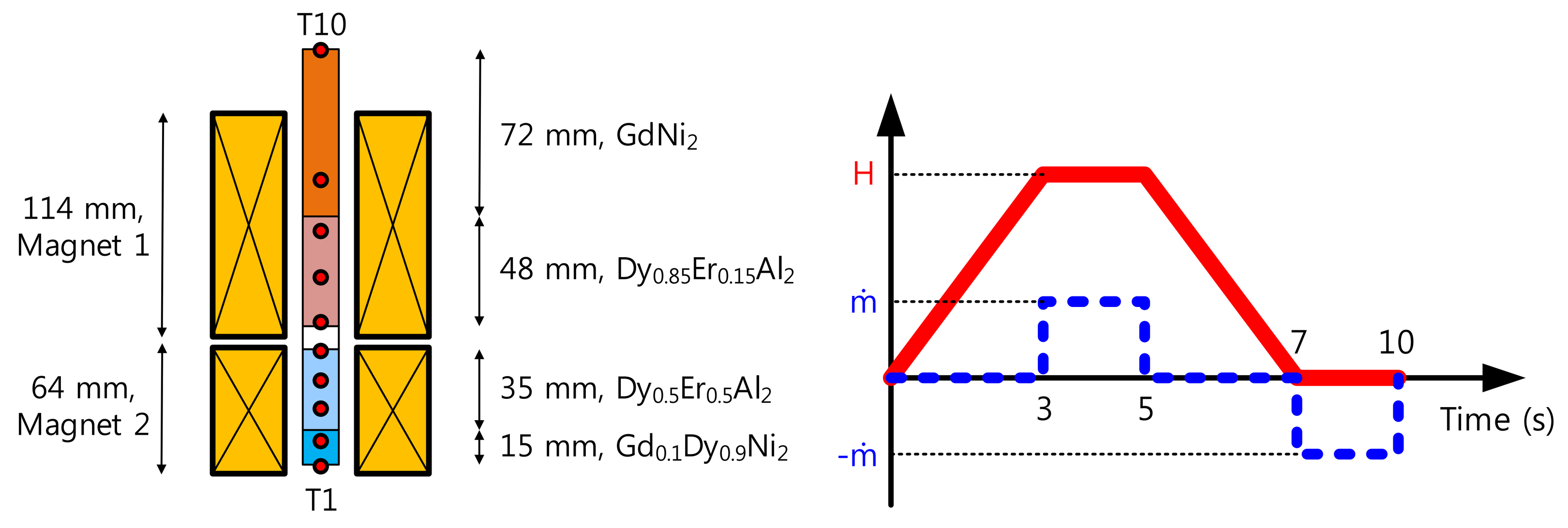
Experimental procedure

1. Filling liquid nitrogen in liquid nitrogen chamber
2. Pre-cooling of the AMR with liquid nitrogen by one way-circulating flow of the helium gas
3. Pre-cooling of the LTS magnet with liquid nitrogen
4. Cool-down of the LTS magnet with liquid helium
5. Test operation of the LTS magnet
6. Synchronizing the phase of the mass flow rate and the AC operation of the LTS magnet
7. Changing the experimental conditions

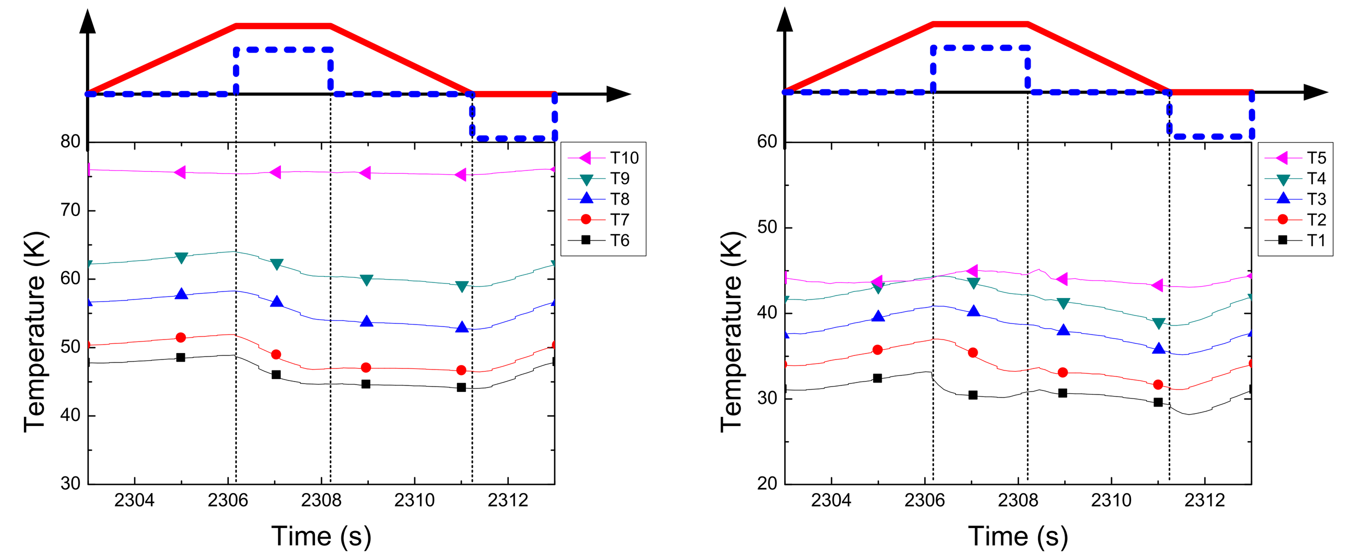
Experimental results

Case 1: $m_{He,\,AMR1}$ = 0.15 g/s, $m_{He,\,AMR2}$ = 0.07 g/s

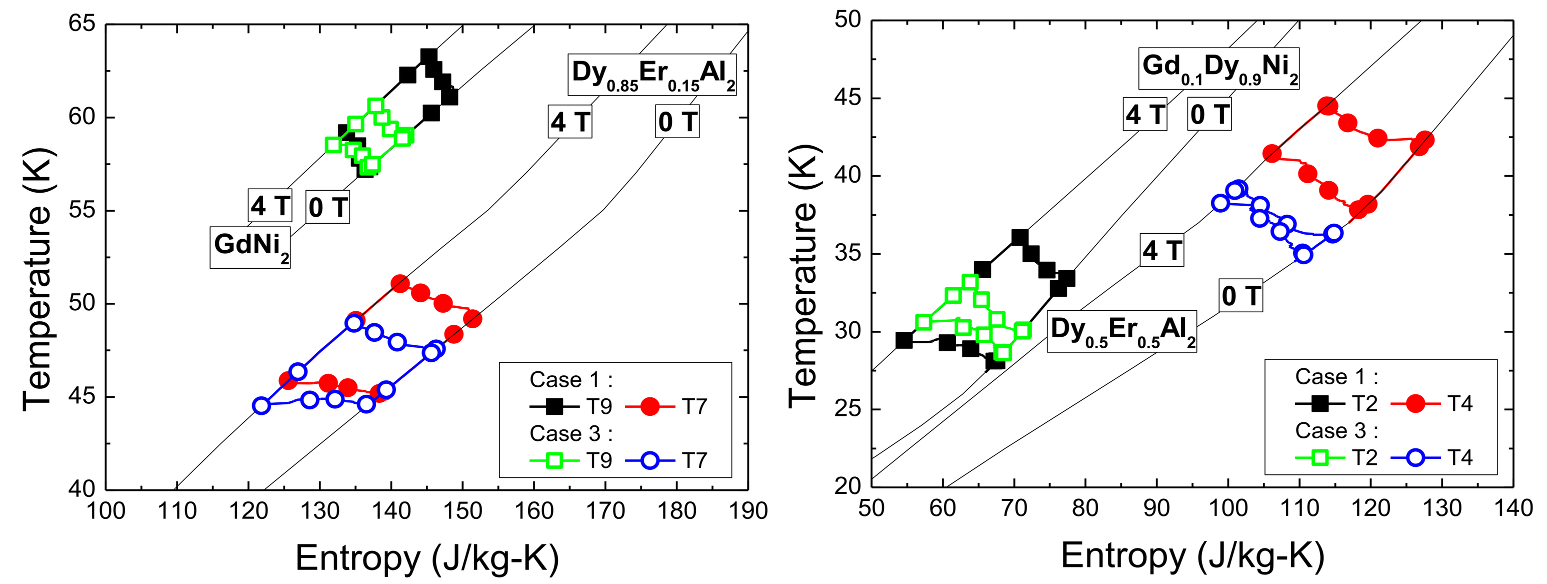




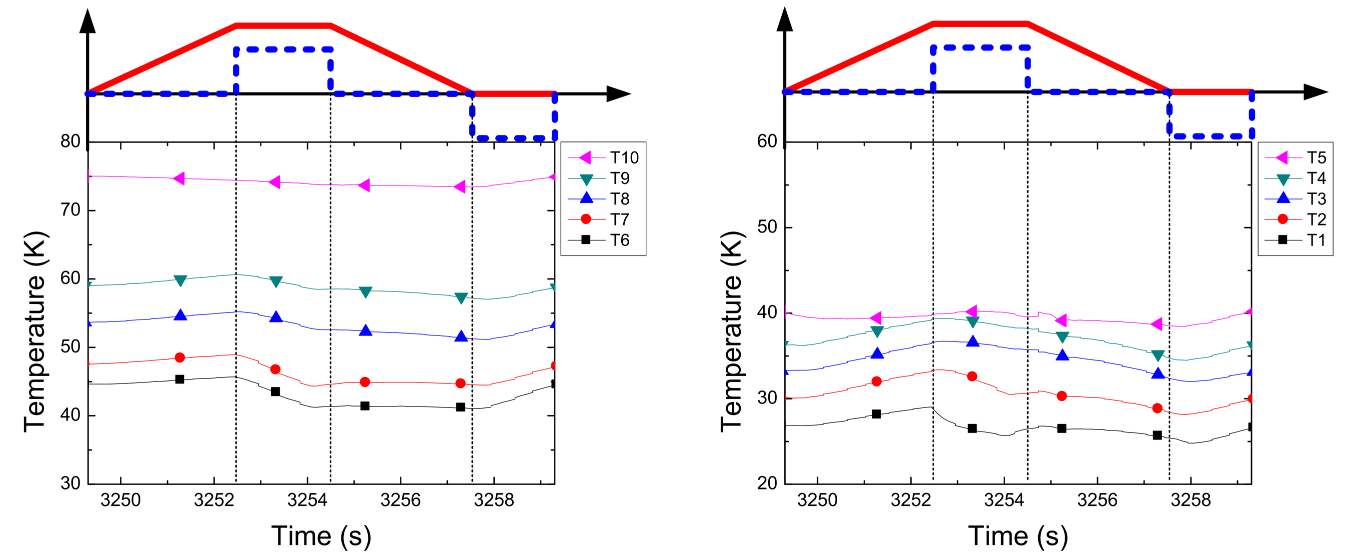
Case 2: $m_{He,\,AMR1}$ = 0.12 g/s, $m_{He,\,AMR2}$ = 0.05 g/s



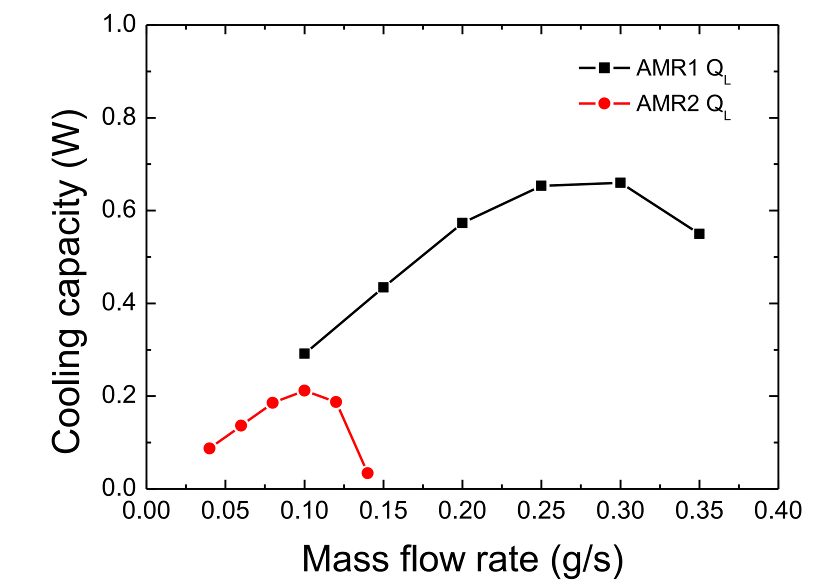
T-s diagram of the case 1 and the case 3



Case 3: $m_{He,\,AMR1}$ = 0.07 g/s, $m_{He,\,AMR2}$ = 0.03 g/s



Calculated cooling capacity of the AMR system



Conclusion

✓ The two-stage AMRR system proposed for the operation between 77 K and 20 K has been tested.
✓ The modified AMR system reached the lowest no-load temperature of 25 K without gas expansion effect.
✓ The performance of the AMR is also influenced by shuttle heat transfer and the environmental liquid helium.
✓ Each effect of shuttle mass or liquid helium on the overall cooling performance has not been decoupled from the original MCE.

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