[CEC2017: C2PoK-05]

Liquid nitrogen cooling test with linear driven Stirling cryocooler

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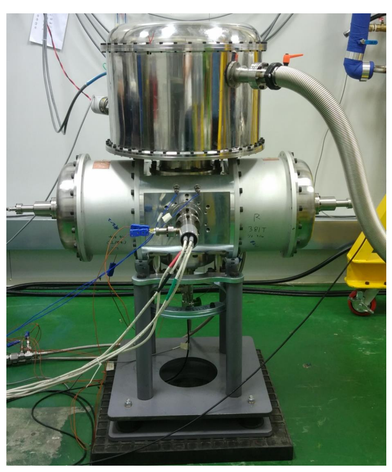
◆ Introduction



[Stirling cryocooler module (KIMM)]

Background & Objective

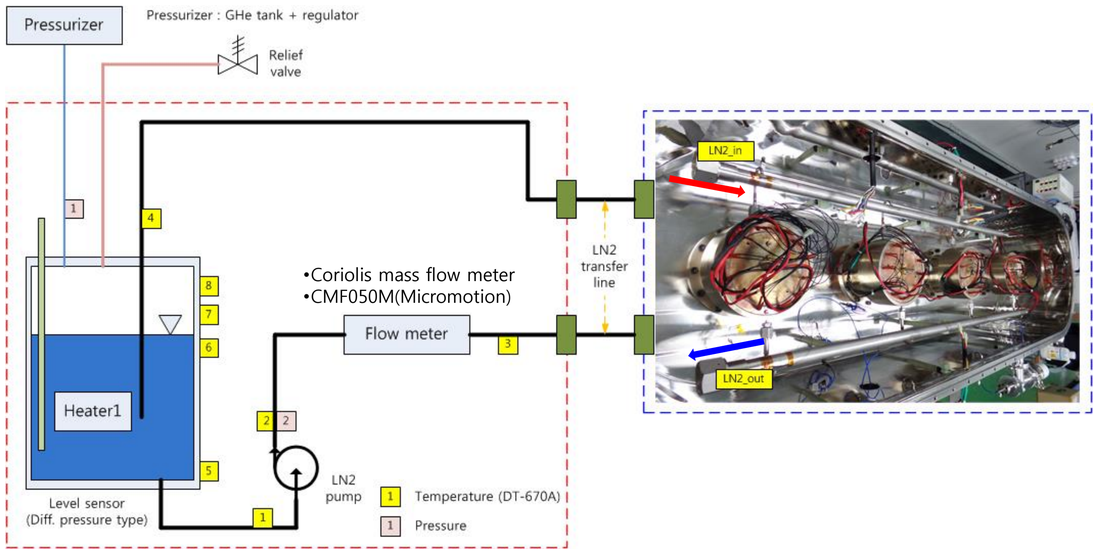
- ✓ Reliable and efficient large cooling capacity cryocooler is required for cryogenic cooling system of HTS applications.
- ✓ Crank-driven Stirling cryocooler is widely used at present.
- ✓ Issued problems of vibration absorption, oil removal and frequent maintenance in crank-driven Stirling cryocooler
- ✓ Gamma-type Stirling cryocooler with linear compressor is suggested.
- ✓ **Development of 2 kW (at 77 K) Stirling cryocooler driven by linear compressor & LN2 cooling test**

Previous work(presented at CEC 2015, ICC19)

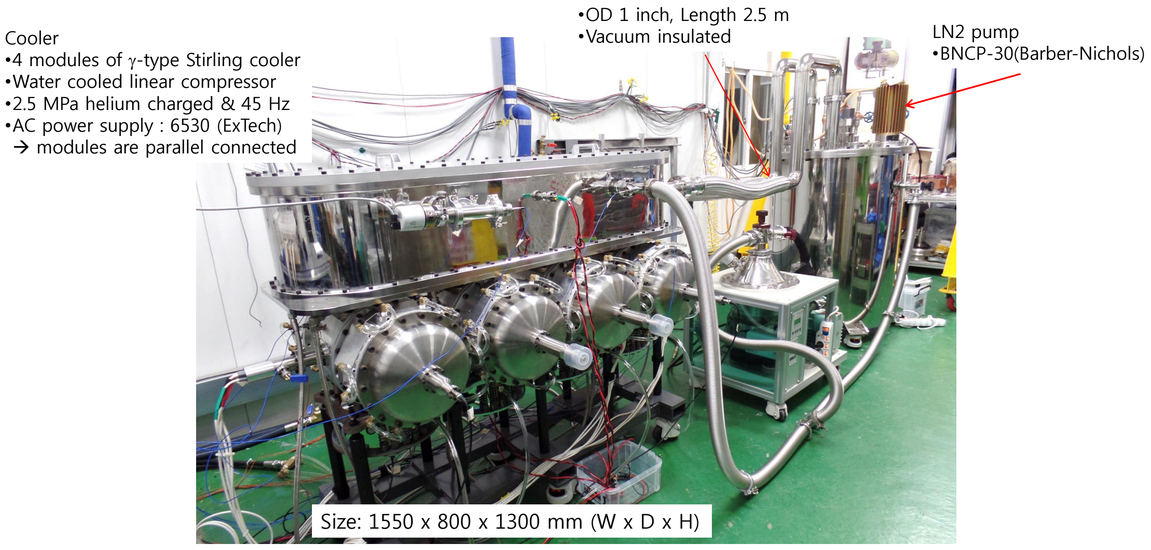
- ✓ 1st & 2nd prototype(module) was fabricated and tested

	No-load temperature, K	Cooling capacity, W	Input power, kW	% Carnot COP
1st (CEC 2015)	47.8	440	6.45	19.4
2nd (ICC 19)	43.3	650	8.76	21.6

◆ Experimental setup



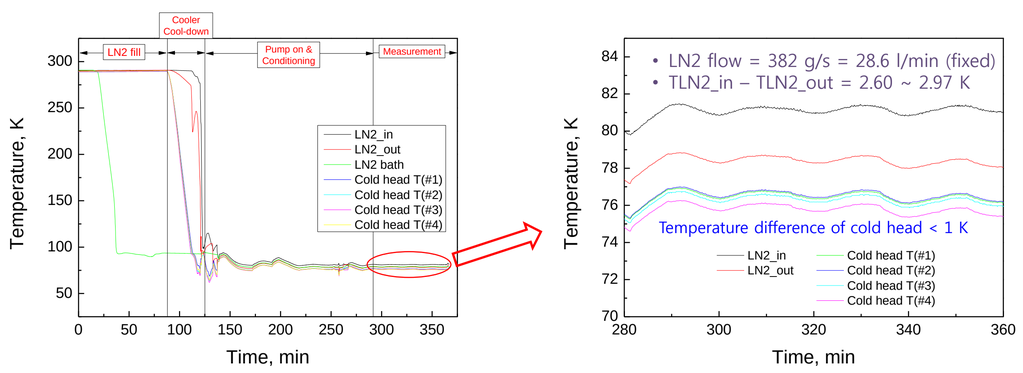
[Schematic diagram of LN2 circulation test setup]



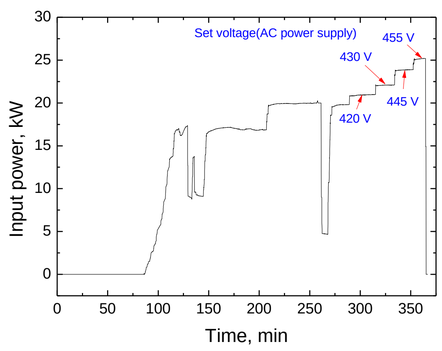
[Photo of experimental setup]

◆ Experimental Results

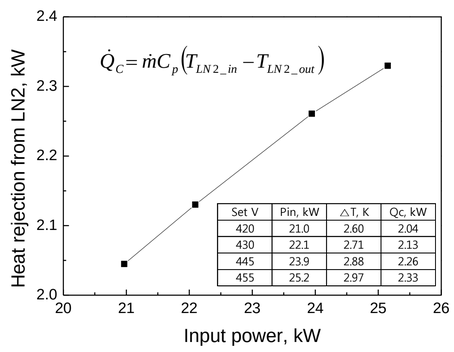
Cooling performance



[Temperature profile during experiment]

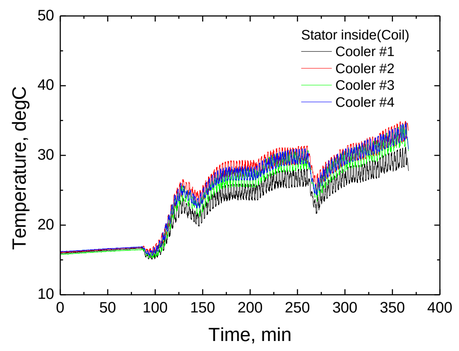


[Total input power]

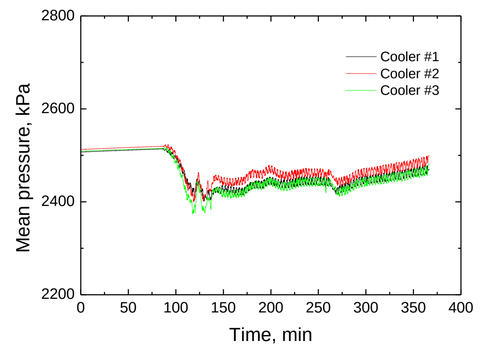


[Cooling performance as input power]

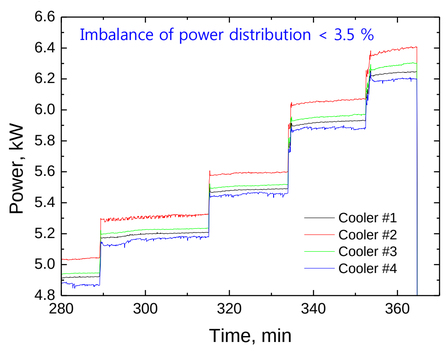
System monitoring



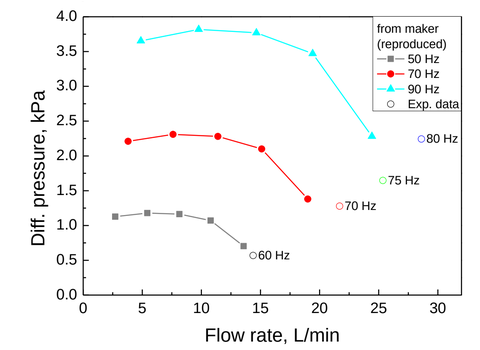
[Temperature at coil inside linear motor]



[Mean pressure of each cooler module]



[Power input to each module]



[LN2 pump performance]

◆ Summary

- ➢ Four linear compressor driven Stirling cryocoolers are integrated into the single cooling system to produce 2 kW of cooling capacity.
- ➢ LN2 cooling test are performed to simulate the cooling system of HTS cable
- ➢ From LN2 cooling performance test,
  - The amount of heat rejection is estimated from the measured enthalpy difference of LN2 flow
  - With the fixed mass flow rate of LN2, temperature difference between in/out is 2.60 ~ 2.97 K and it corresponds to 2.04 ~ 2.33 kW of heat rejection.
  - The results of system monitoring show the stable operation of the developed 2 kW Stirling cryocooler.
  - LN2 pump shows the better performance than the predicted data at high speed. It might be due to low flow resistance of test loop.

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