Reduction in variation in refrigeration temperature for a sorption compressor based J-T cooler

By

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Outline of the presentation

The presentation is divided into :

- Objective of work
- Why Sorption compressor?
- Operation of a sorption compressor based J-T cooler
- Development of experimental setup
- Results and discussion
- Conclusion and Future course of action

Objective

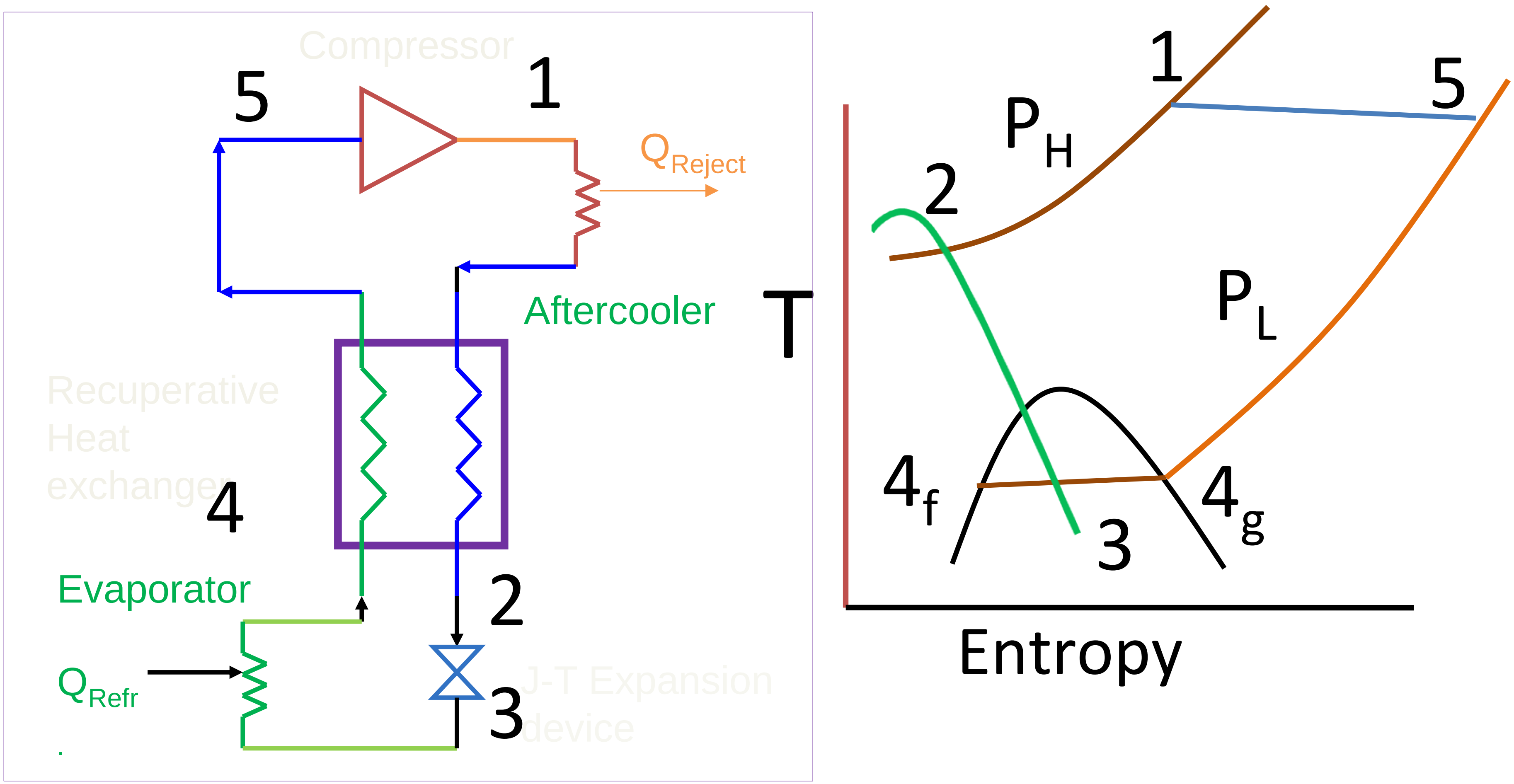
- The objective of the present work is to understand the reasons for the variations in the low temperature achieved using a sorption compressor type J-T cryocooler and the methods to control.

- A buffer chamber is connected on the adsorption side of the sorption compressor to control these variations.

Why Sorption type J-T cryocooler ?

- No moving parts. It is practically vibration free, so can be used in vibration sensitive instruments, such as Infra red (IR**),** Optical detectors.
- Efficiency of the cooler is fundamentally independent of size. Thus highest scope of application in Micro cooling of Electronic chips etc.
- No wear and very long life (>5 to 10 Yrs) is expected.
- Totally free of Electromagnetic Interference.

Joule – Thomson Cryocooler



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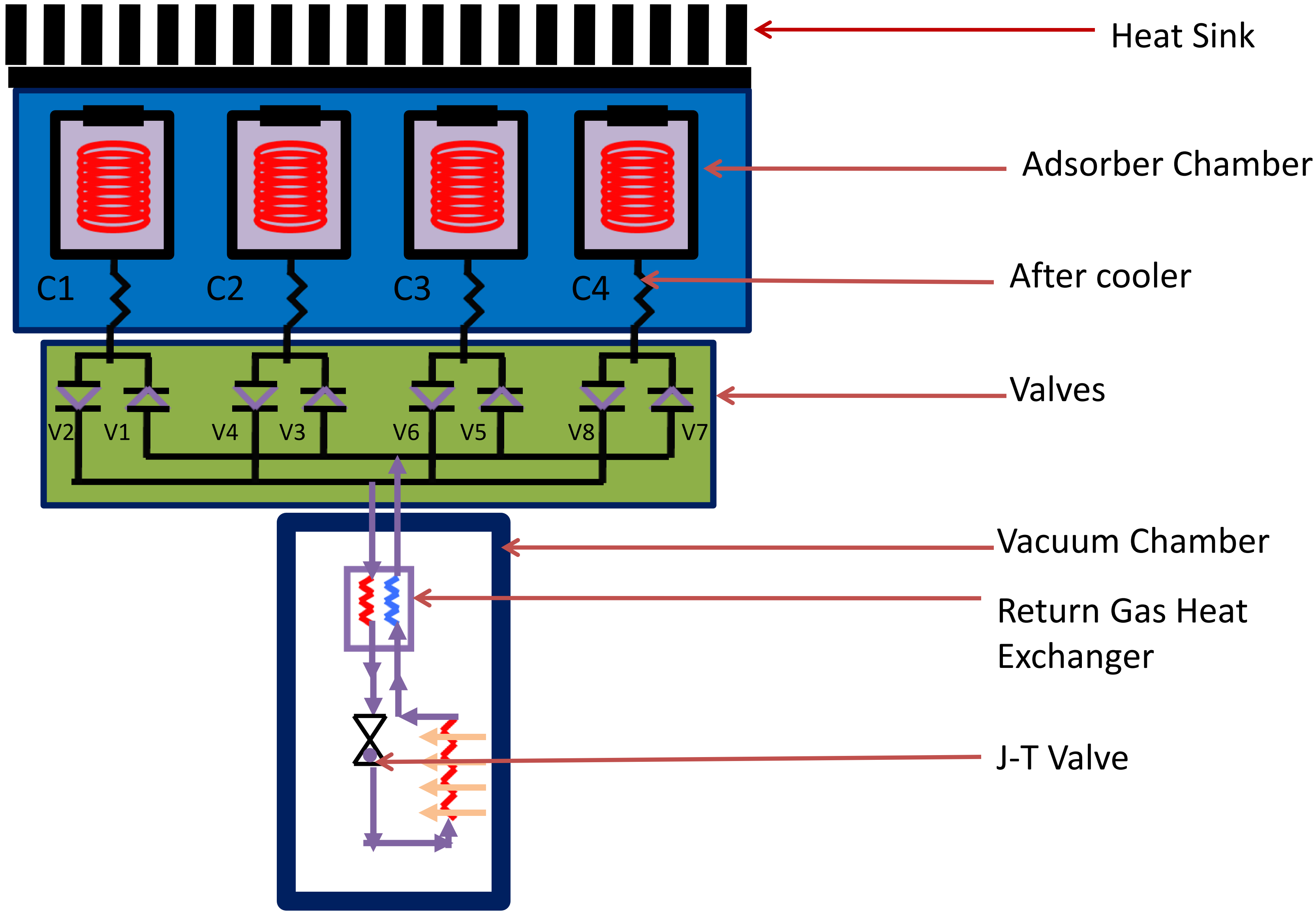
Layout of a Sorption Compressor type J-T Cryocooler



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Operating Sequence of Sorption Compressor

Sr. No	Part of the Cycle	Cell No.C1		Cell No.C2		Cell No.C3		Cell No.C4	
	Valve	V1 Suction	V2 Discharge	V3 Suction	V4 Discharge	V5 Suction	V6 Discharge	V7 Suction	V8 Discharge
1	1^{st} Quarter cycle	Open and cooling			Open and Heating	Cooling		Heating	
2	Half Cycle	Heating		Cooling		Open and cooling			Open and Heating
3	3^{rd} Quarter		Open and Heating	Open and cooling		Heating		Cooling	
4	One cycle	Cooling		Heating			Open and Heating	Open and cooling	

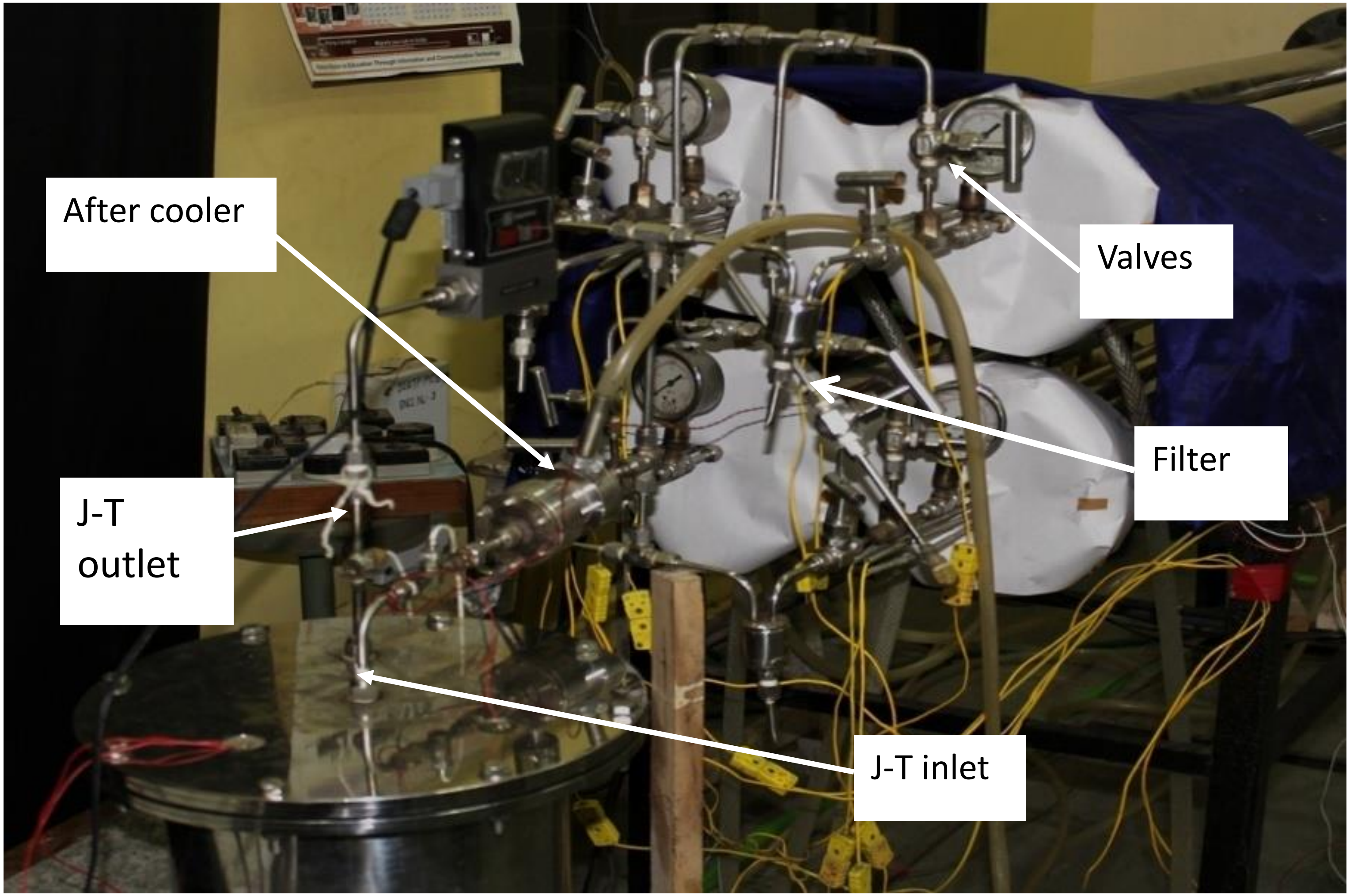
Open — Indicates valve is in open closed position

Indicates valve is in closed position

Cyclic operating Sequence of Sorption Compressor

Time (sec)	Heating	Discharge	Cooling	Adsorption
0 to 1500	C4	C2	C3	C1
1500 to 3000	C1	C4	C2	C3
3000 to 4500	C3	C1	C4	C2
4500 to 6000	C2	C3	C1	C4

Four Cell Sorption Compressor type J-T Cryocooler Experimental Setup



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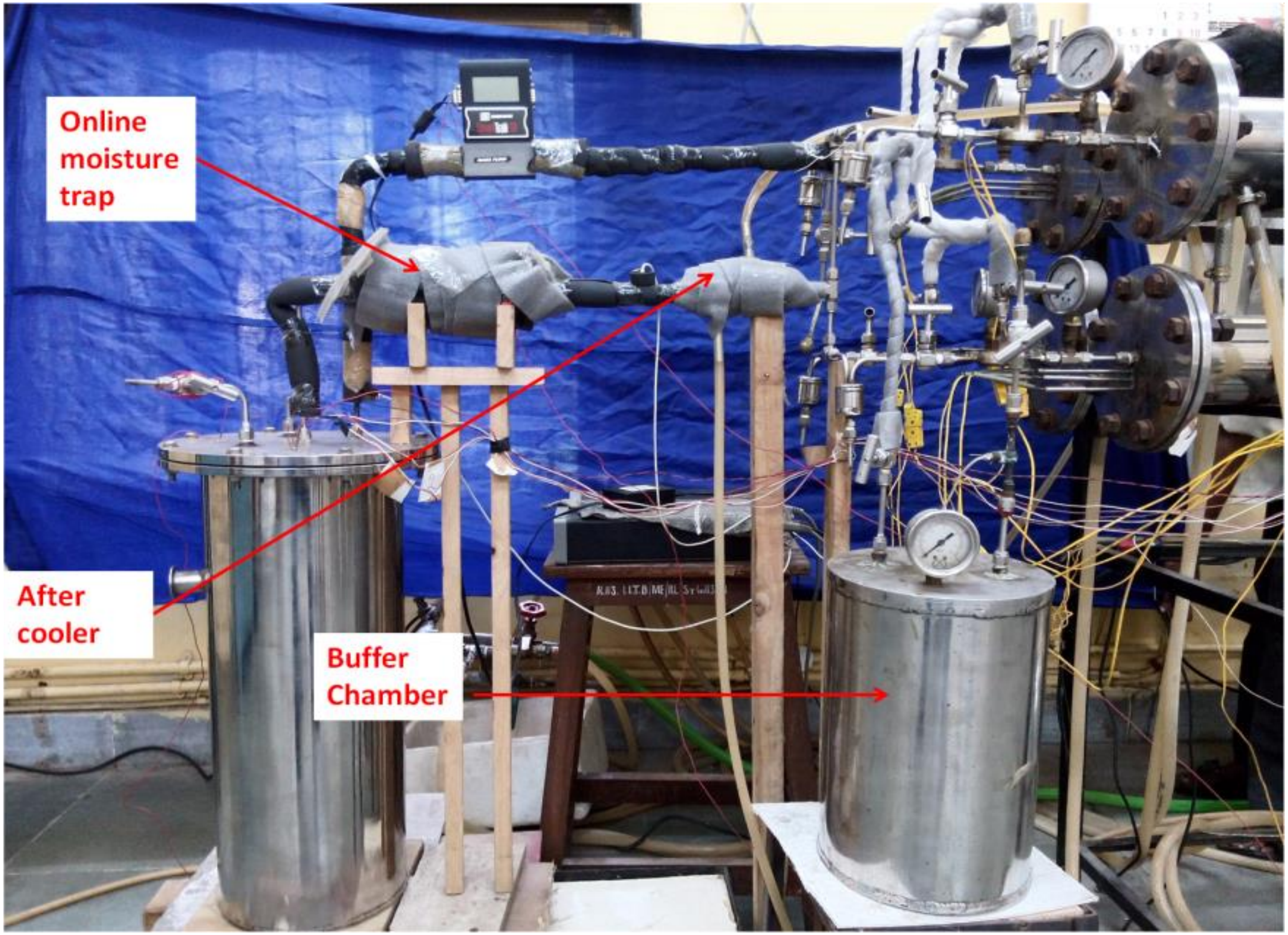

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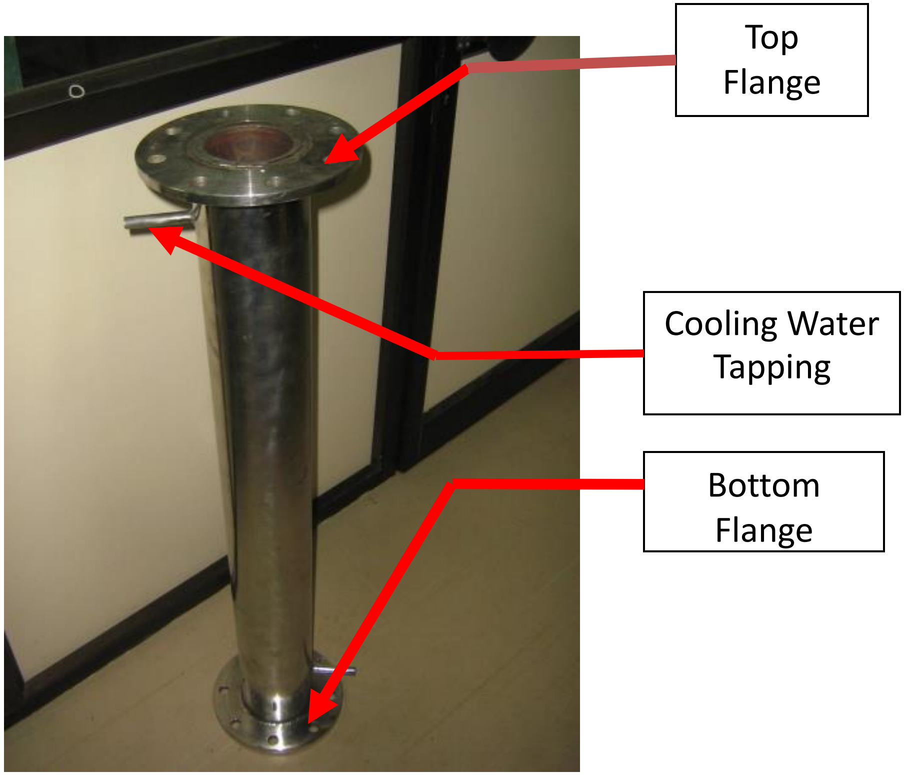
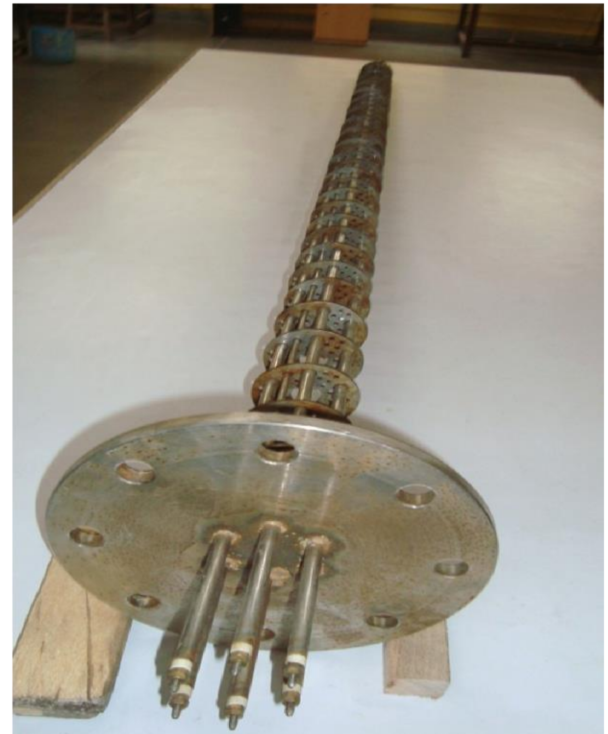
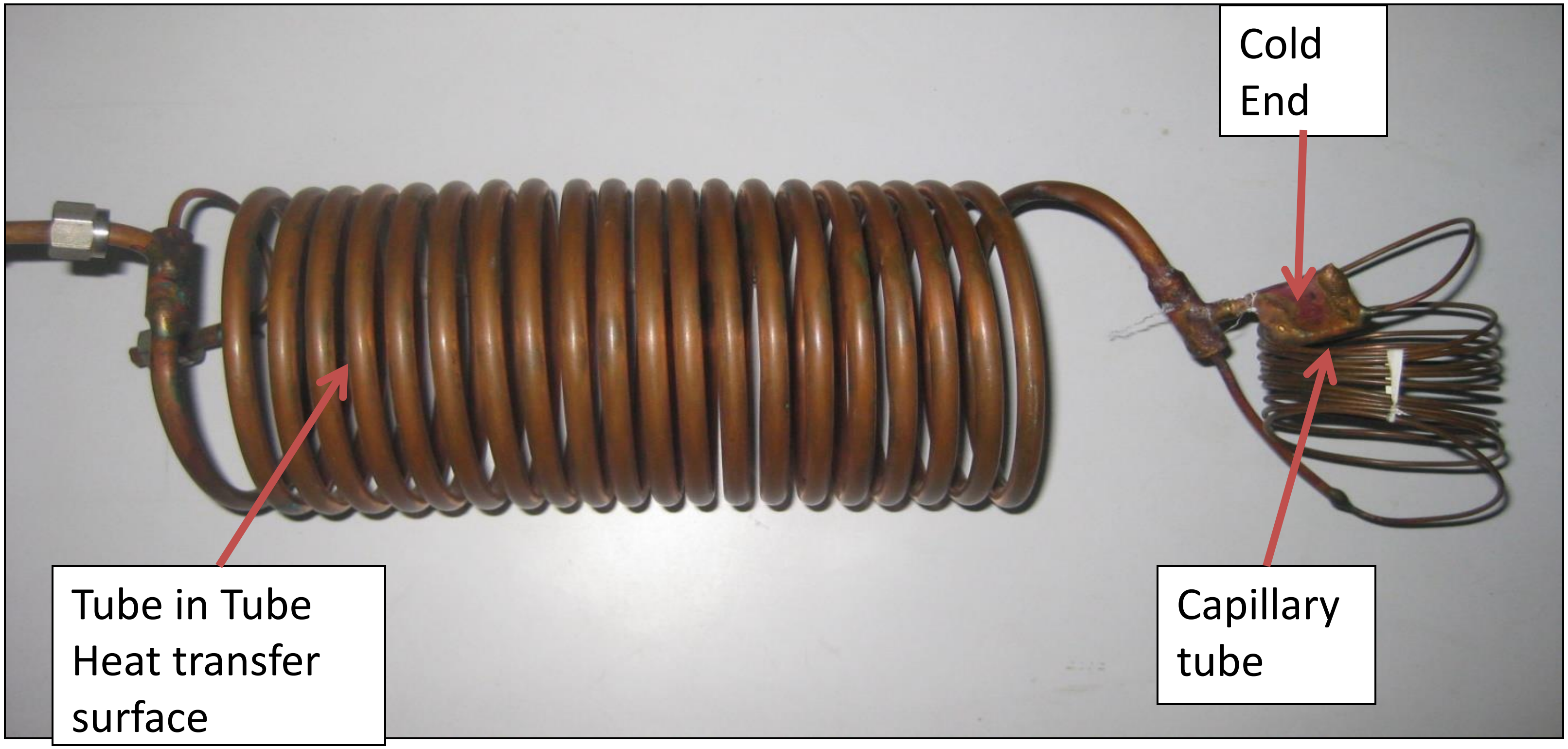


Adsorber Chamber

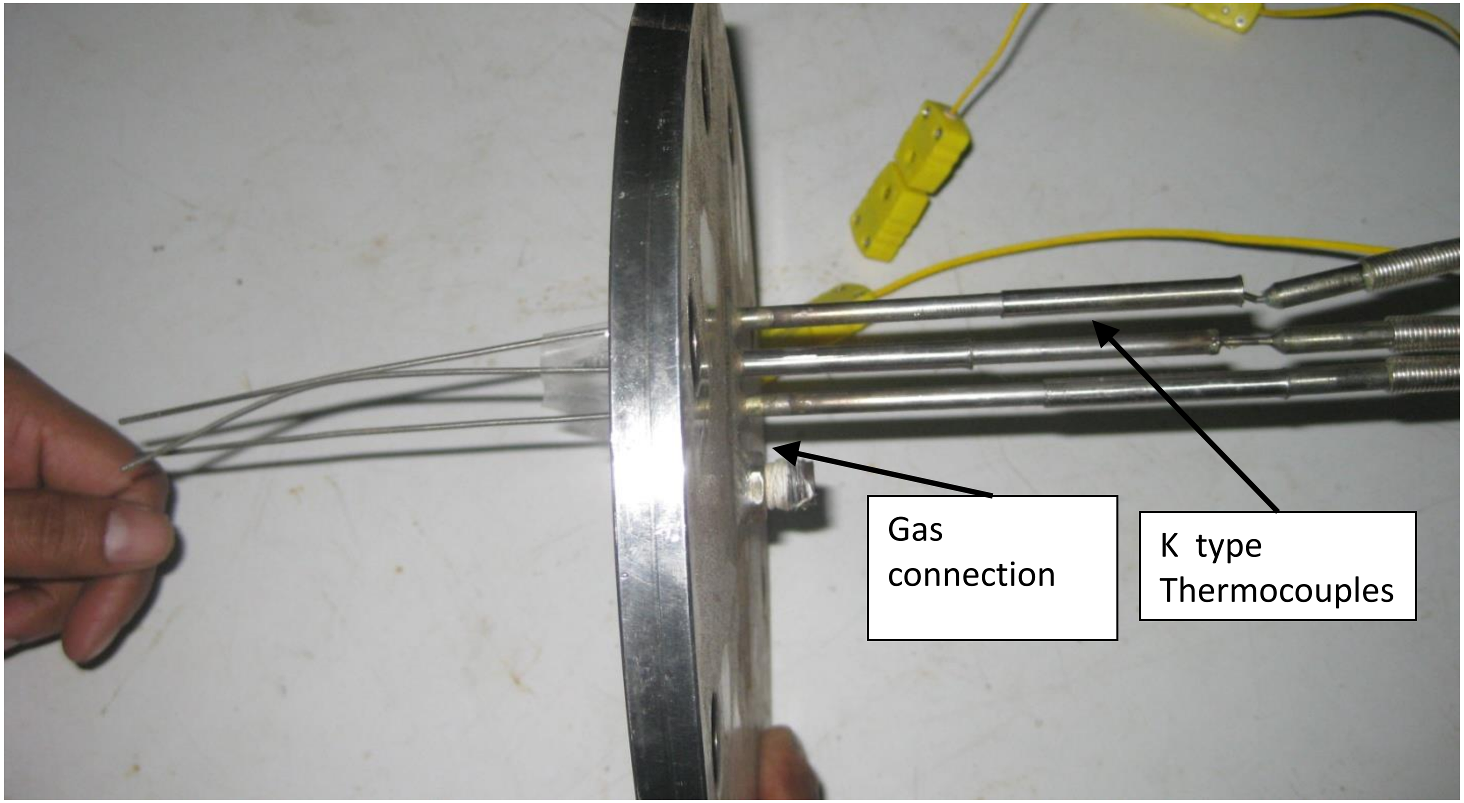


Heaters

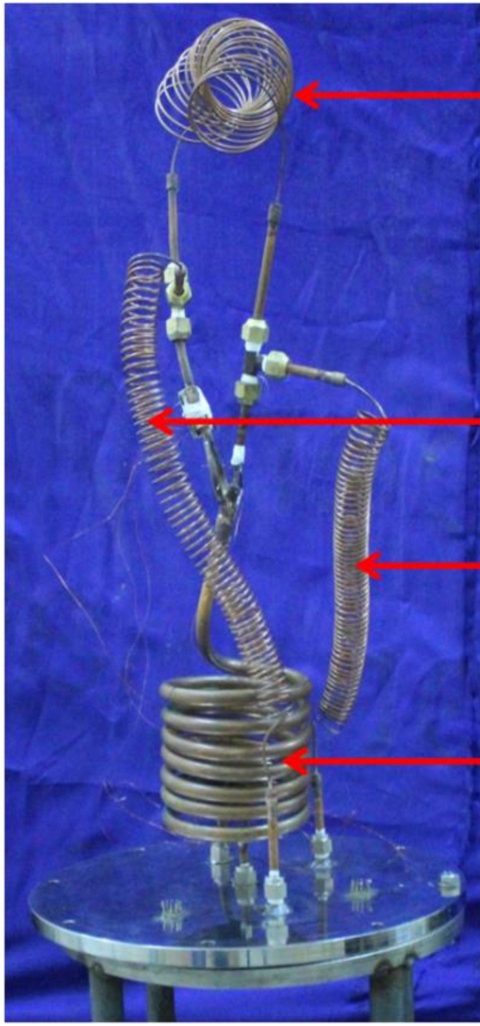
Return gas Heat Exchanger



Adsorber Chamber Top Flange



Return gas heat exchanger



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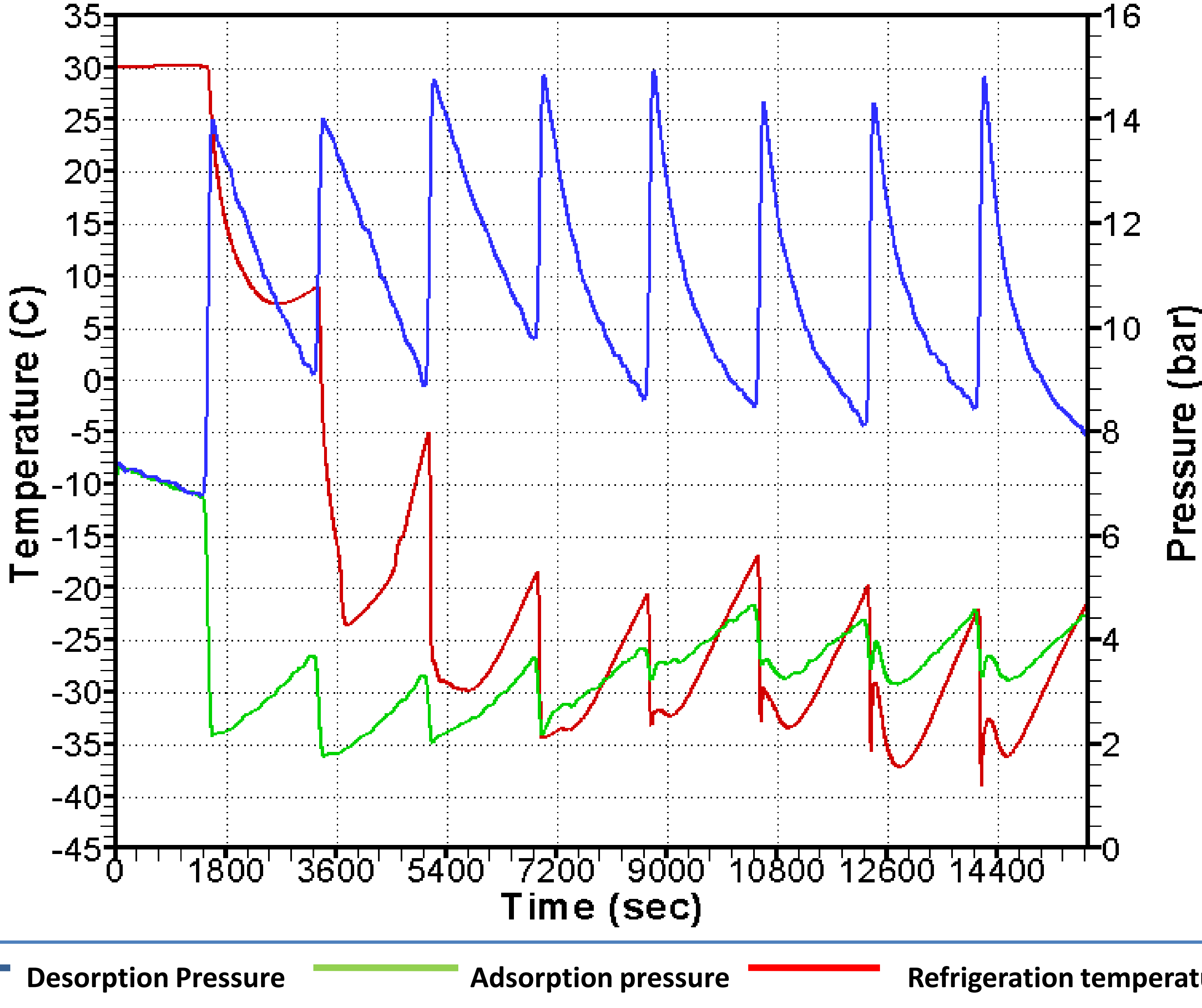
Design Methodology

The Methodology adopted for the design of sorption compressor type J-T cryocooler is as follows :

1. Characterization of the adsorbent for equilibrium capacity for various gases and their mixtures
2. Design of heating system for effective desorption of the adsorbed gas
3. Design of gas distribution system for effective utilization of the adsorption capacity of the adsorbent
4. Design of After cooler
5. Design of Return gas heat exchanger
6. Selection of J-T Expansion device
7. Decision on the composition of the working substance

Continuous operation without buffer chamber



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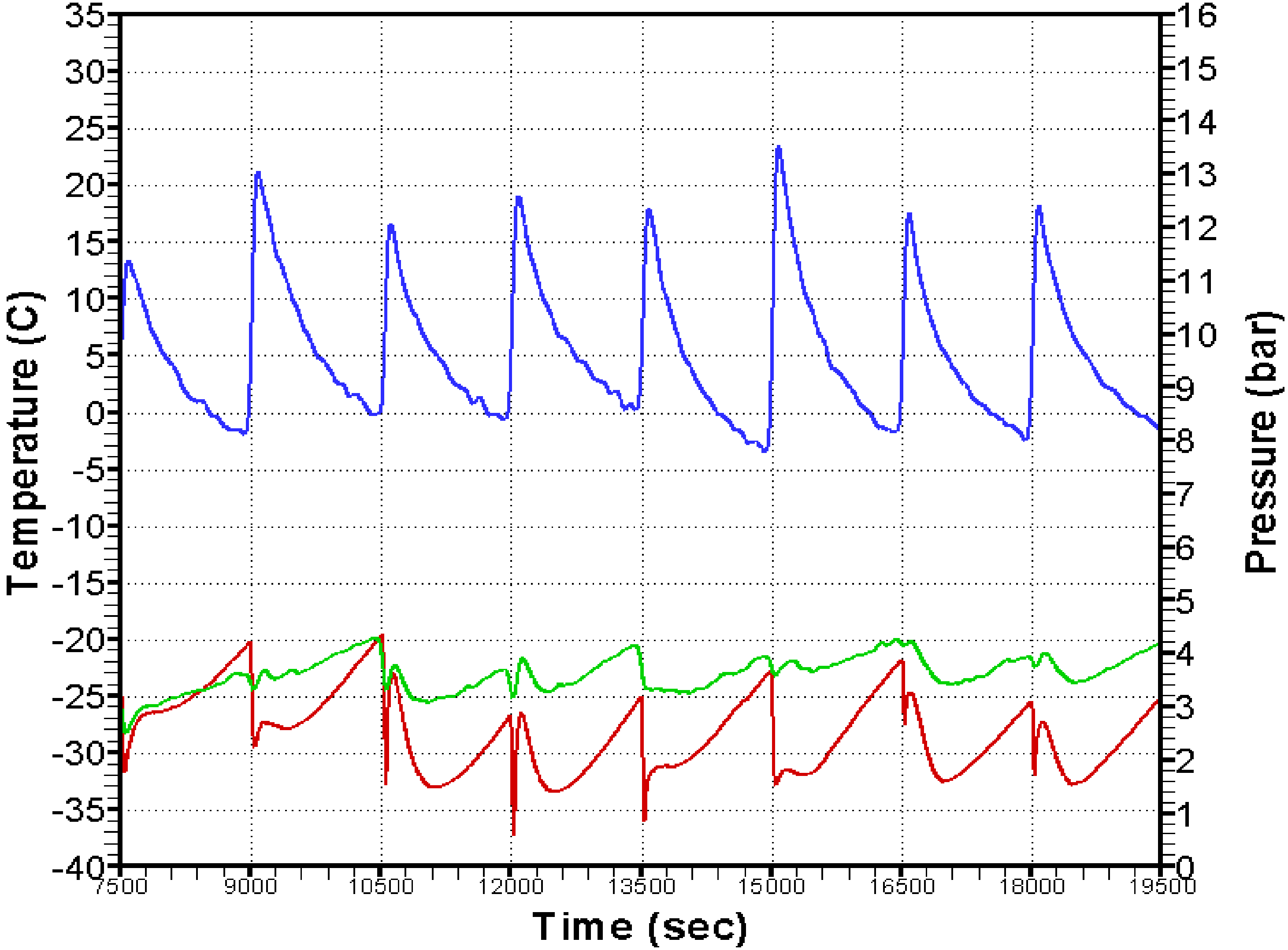
Continuous operation with buffer chamber



Desorption Pressure **Adsorption pressure** **Refrigeration temperature**

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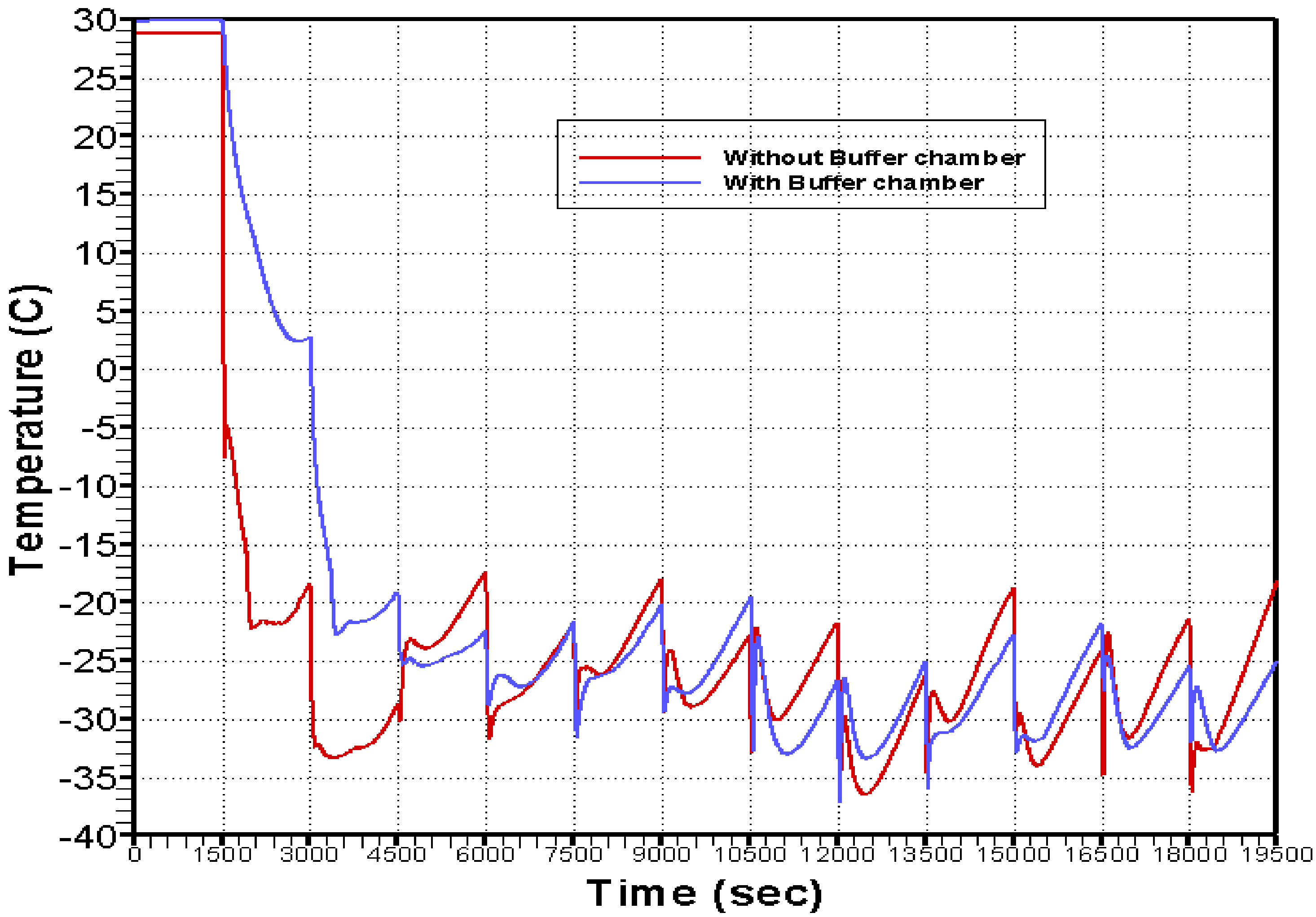
Low temperature with and without buffer chamber



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Conclusions

- Experimental investigations are performed on a four-Cell sorption compressor using a mixed gas consisting of four component Nitrogen, Ethane, Propane and R134a with a molar concentration of 18.25:23.75:25:33 respectively.
- A desorption pressure of (high pressure)14 bar and adsorption pressure of 3.5 bar is attained.
- A lowest temperature of -37^{o} C is achieved with a variation of +12^{o} C. This variations are on account of fluctuations in the discharge/desorption and suction/adsorption pressures. A buffer chamber is fitted on the adsorption line of the compressor. The variations are reduced by 2.5^{o} C by fitting a buffer chamber in the suction line.


JAI HIND