Course: ME 657
Measurement of Refrigeration Effect on Single Stage Pulse Tube Cryocooler

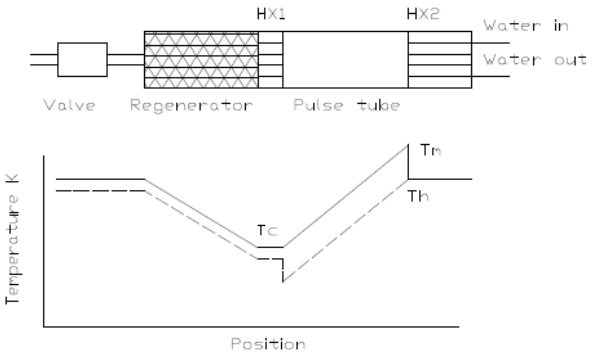
Name: **Roll No:**

Cryocooler: A Cryocooler is a device or ensemble of equipment for producing refrigeration effect at temperature less than 120 K.

Basic Principle of Pulse Tube Cryocooler: Pressurization and depressurization of any closed volume from a point on its periphery sets up temperature gradients in the volume.

Working of Pulse Tube Cryocooler:

During the pressure buildup, the high pressure gas admits through the Regenerator, where it is cooled to the cold end temperature T_c. As this gas enters the Pulse Tube through the heat exchanger, HX1, it compresses the gas that is already in the Tube nearly adiabatically, thus acting as 'Gas Piston', so that the temperature of this gas increases. At the hot end the temperature is maintained at room temperature by the circulation of water in the HX2, hence the gas looses certain amount of heat and temperature becomes equal to room temperature. During the expansion phase, the gas expands to lower temperature than the temperature while entering. This temperature difference gives rise to refrigeration effect.



Objectives of the Experiment:

1. To understand the working the Single Stage Pulse Tube Refrigeration System with the instrumentation like vacuum and temperature measurement.
2. To plot A) Cooldown curve and
   B) Refrigeration load V/s. Temperature.

List of components and accessories of Pulse Tube Refrigeration System:

Components:

1. Compressor
2. After-cooler
3. Regenerator
4. Cold End Heat Exchanger
5. Pulse Tube
6. Hot End Heat Exchanger
7. Inertance tube
8. Reservoir

Accessories:

1. Compressor Power Supply (Dimmerstat).
2. Vacuum System (Turbo Molecular Pump and Rotary Pump (RP) Unit / Diffusion Pump and Rotary Pump Unit)
3. Vacuum Gauges (Pirani Gauge, Penning Gauge)
4. Temperature Sensors and Indicators.
5. Heater with DC power Supply.

Accessories Details:

1. Rotary Pump: Atmospheric to 10^{-3}
2. Diffusion Pump: 10^{-3} to 10^{-6} mbar.
3. Turbo Molecular Pump: Operating Speed : 27067 to 27083 rpm for 10^{-6} mbar.
4. Vacuum Gauges: Pirani: Atmospheric to 10^{-3} Penning: 10^{-3} to 10^{-6} mbar.
5. Temperature Sensor: Silicon Diode: 4 K to 325 K.
6. Temperature Indicator: Lakeshore Model-340.

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Procedure:

1. Start the Vacuum system and obtain a vacuum in the jacket of the Pulse Tube unit of the order of 10^{-6} mbar (15 – 20 min.).
2. Switch on the Compressor power supply (Dimmerstat) and slowly increase the input power to 100 W.
3. Observe temperature at a time step of 5 min. till it reaches 125 K (approx. 25 min.).
4. Increase slowly the Compressor power to 200 W and observe temperature till 100 K will be attained (approx. 20 min.). Similarly, increase the power to 300 W and observe till temperature reaches to minimum value (approx. 40 min.)
5. Plot the Cooldown Curve.
6. After attaining min. temperature, apply Refrigeration load (DC Power Supply) for 80 K (i.e. apply the power till temperature becomes stable at 80 K; approx. 15 min.).
7. Repeat the procedure for 90 and 100 K (approx. 15 min. each).
8. Plot the curve for Refrigeration load V/s. Temperature.
9. Comment on the results and write your conclusion.
10. Viva.

Observations:

Charging Pressure (bar)		**Ambient Temperature (K)**	
Jacket Vacuum (mbar)			

Observation Table:

A) Cooldown Curve :

Compressor Input Power = 100 W		**Compressor Input Power = 200 W**		**Compressor Input Power = 300 W**	
Time (min)	***Temperature (K)***	***Time (min)***	***Temperature (K)***	***Time (min)***	***Temperature (K)***
5					
10					
15					
20					
	125		100		

B) ***Refrigeration Load:***

Temperature (K)	**Refrigeration Load (W) = V*I**
	0 (No Load)
80	
90	
100	

Conclusion: