

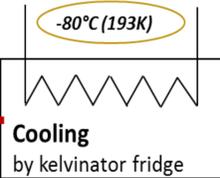
Prototype of Oxygen liquefaction



LR25B Laboratory refrigerator
 Compress about 2 to 15 bar
 Suction line 5/16" (0.79375 cm)
 Discharge line 1/4" (0.635 cm)

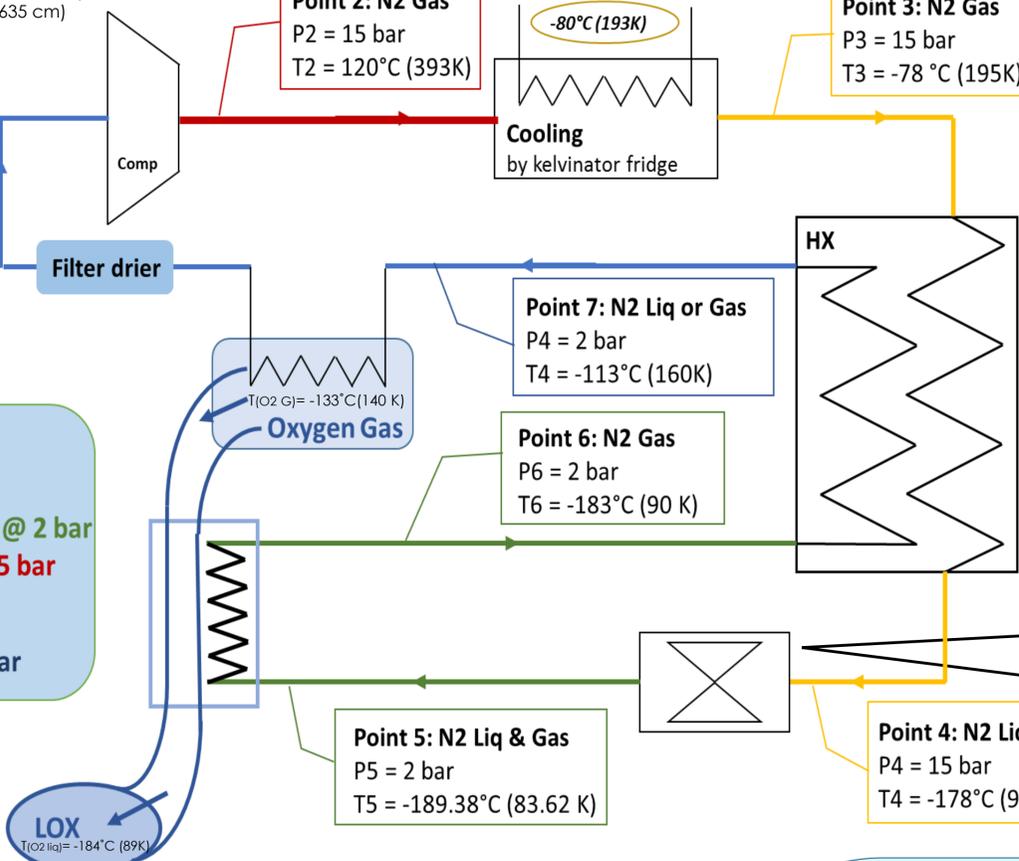


Point 2: N2 Gas
 P2 = 15 bar
 T2 = 120°C (393K)



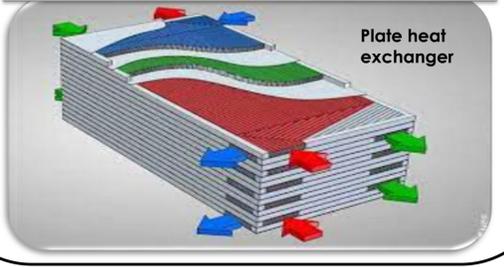
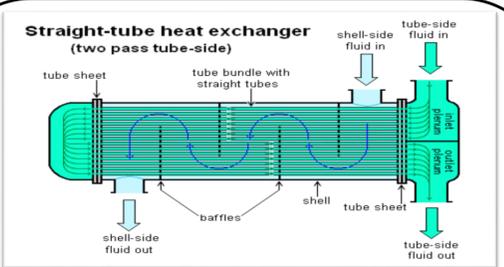
Point 3: N2 Gas
 P3 = 15 bar
 T3 = -78 °C (195K)

Point 1: N2 Gas
 P1 = 2 bar
 T1 = 7°C (280K)



Boiling point :

- Nitrogen N2**
 - 189.38°C (83.62K) @ 2 bar
 - 163°C (110K) @ 15 bar
- Oxygen O2**
 - 183°C (90K) @ 1 bar



Gas flow rate of compressor : 25 Kg/hr = 6.9 g/s in condition of:
 Condensing temperature: 55°C
 Evaporating temperature: 7°C

Prototype Heat exchanger (HX - N₂/N₂)

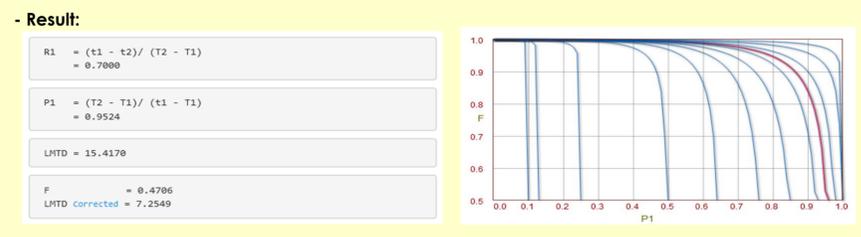
LMTD Correction Factor Charts
 Calculates Logarithmic Mean Temperature Difference (LMTD) Correction factor for different configuration of exchangers.

- Data:

Exchanger Type
 4 Shell 8 Tube Tema E

Stream 1
 Temperature In (T1): 195
 Temperature Out (T2): 95

Stream 2
 Temperature In (t1): 90
 Temperature Out (t2): 160



Shortcut Heat Exchanger Sizing
 Estimates LMTD (Log Mean Temperature Difference), Exchanger surface area, number of tubes, shell diameter and number of shell in series.

- Data:

Heat Duty: 350 W
 U Value: 500 W/m²·K

Hot Side
 Temperature In: 195 °K
 Temperature Out: 95 °K

Cold Side
 Temperature In: 90 °K
 Temperature Out: 130 °K

- Result:

Tube Pitch: 21.3500 mm
 LMTD: 23.39 °K
 Correction Factor (F): 0.8381
 LMTD (Corrected): 19.61 °K
 Shell in Series: 3
 Total Area: 0.04 m²
 Area per Shell: 0.01 m²
 Tubes per Shell: 0
 Shell ID (Estimate): 88.31 mm

Prototype Heat exchanger (HX - N₂/O₂)

LMTD Correction Factor Charts

- Data:

Exchanger Type
 1 Shell 2 Tube Tema E

Model Number: 00402-01 (17 Series Sanitary HX, 4 Inch Tube Bundle)

Tube Side (product): Oxygen
 Flow Rate: 0.4 kg/hr
 Inlet Temperature: 140 K
 Inlet Pressure: 100 kPa

Shell Side (working): Nitrogen
 Flow Rate: 25 kg/hr
 Inlet Temperature: 83 K
 Inlet Pressure: 200 kPa

- Result:

R1 = $(t1 - t2) / (T2 - T1)$ = 0.0769
 P1 = $(T2 - T1) / (t1 - T1)$ = 0.9381
 LMTD = 31.0186
 F = 0.7999
 LMTD Corrected = 24.8123

Metric Units		
Heat Exchanger Model	00402-01	
	Tube Side	Shell Side
Fluid	Oxygen	Nitrogen
Temperature In	-133.15	-190.15
Temperature Out	-184.29	-189.43
Mass Flow	0.11	6.95 g/sec
Volumetric Flow	N/A	N/A lpm
Pressure Drop	0.01	11.04 kPa
Heat Transfer	5	Watts
Effectiveness	0.897	

* The oxygen flow should be 0.4 Kg/hr or less

Shortcut Heat Exchanger Sizing

- Data:

Heat Duty: 5 W
 U Value: 150 W/m²·K

Hot Side
 Temperature In: 140.00 °K
 Temperature Out: 89.00 °K

Cold Side
 Temperature In: 83.00 °K
 Temperature Out: 90.00 °K

- Result:

Tube Pitch: 21.3500 mm
 LMTD: 20.75 °K
 Correction Factor (F): 0.9623
 LMTD (Corrected): 19.97 °K
 Shell in Series: 2
 Total Area: 0.00 m²
 Area per Shell: 0.00 m²
 Tubes per Shell: 0
 Shell ID (Estimate): 79.41 mm