

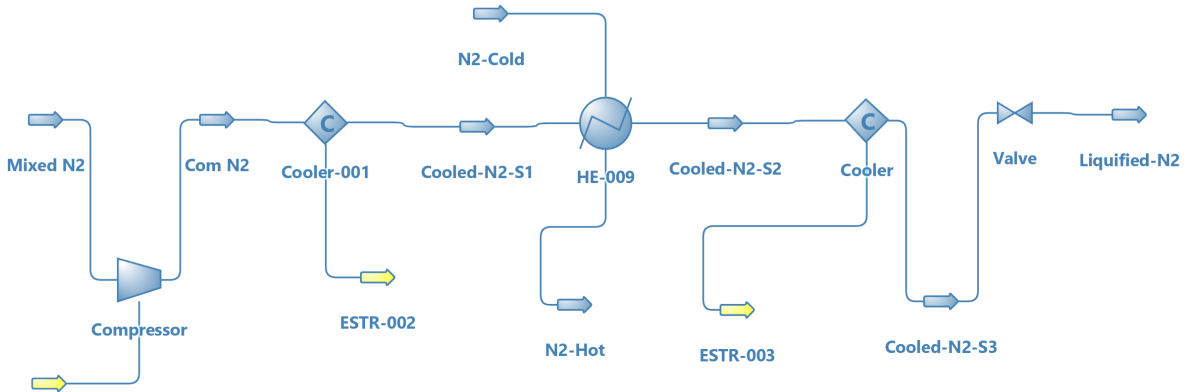
# Nitrogen Liquifaction Using Linde Cycle

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A process for gas liquefaction, particularly nitrogen liquefaction, which combines the use of a nitrogen auto-refrigeration cooling cycle with one or more closed-loop refrigeration cycles using two or more refrigerant components. The closed-loop refrigeration cycle provide refrigeration in a temperature range having a lowest temperature between about -125°F. and about -250°F. A nitrogen expander cycle provides additional refrigeration, a portion of which is provided at temperatures below the lowest temperature of the closed-loop or recirculating refrigeration cycle or cycles. The lowest temperature of the nitrogen expander cycle refrigeration range is between about -220°F. and about -320°F. The combined use of the two different refrigerant systems allows each system to operate most efficiently in the optimum temperature range, thereby reducing the power consumption required for liquefaction.

Gaseous nitrogen at 80°F, 1 atm is compressed to 25 atm pressure. Adiabatic compressor is employed for this purpose with 50% efficiency which also results in increasing the temperature of  $N_2$  stream to 1577°F. The stream is further cooled to -306°F with the help of a series of cooler and heat exchanger. Cooled  $N_2$  is further expanded by reducing the pressure to 1 atm using an isenthalpic valve to obtain liquefied  $N_2$ .

**Nitrogen Liquifaction Flowsheet using Linde Cycle**



Object	N2-Hot	N2-Cold	Mixed N2	Liquified-N2	
Temperature	229.000009	77.354723	300.000000	77.354722	K
Pressure	1.000000	1.000000	1.000000	1.000000	atm
Mass Flow	810.000000	810.000000	1,000.000000	1,000.000000	kg/h
Molar low	28.914114	28.914114	35.696437	35.696437	kmol/h
Volumetric Flow	9,039.506245	2,933.487221	14,638.558044	317.457296	L/min
Vapor Phase Molar Enthalpy	-2,026.180673	-6,491.084701	46.205128	-6,491.084717	kJ/kmol
Mass Flow (Vapor Phase) / Nitrogen	810.000000	810.000000	1,000.000000	82.385093	Kg/h
Mass Flow (Liquid Phase 1) / Nitrogen	0.000000	0.000000	0.000000	917.614907	Kg/h
Object	Cooled-N2-S3	Cooled-N2-S2	Cooled-N2-S1	Com N2	
Temperature	85.000000	185.421934	300.000000	1,131.982017	K
Pressure	25.000000	25.000000	25.000000	25.000000	atm
Mass Flow	1,000.000000	1,000.000000	1,000.000000	1,000.000000	kg/h
Molar Flow	35.696437	35.696437	35.696437	35.696437	kmol/h
Volumetric Flow	21.548744	330.795696	580.618715	2,224.492556	L/min
Vapor Phase Molar Enthalpy	0.000000	-3,747.282874	-130.711665	25,876.051649	kJ/kmol
Mass Flow (Vapor Phase) / Nitrogen	0.000000	1,000.000000	1,000.000000	1,000.000000	Kg/h
Mass Flow (Liquid Phase 1) / Nitrogen	1,000.000000	0.000000	0.000000	0.000000	Kg/h

Table 1: Streamwise Results for the Nitrogen Liquifaction Flowsheet