Air Separation Unit

Priyam Nayak

Department of Chemical Engineering

Indian Institute of Technology Bombay, Mumbai

Email: nayak.priyam22@gmail.com

Background & Description:

Air Separation Process is an integration of separation columns and heat exchanger. The process is driven by compressing air at inlet of the unit. Compressed air is cooled and partially liquefied against leaving product streams. In the first column, nitrogen is separated at a pressure of 6 bar and then condensed against boiling oxygen at a pressure around 1.2 bar. In the high pressure column, liquid bottom product is rich in oxygen. The rich liquid is cooled using Joule-Thomson effect to run the condenser of a side rectifier that separates Argon from Oxygen. It is fed with vapour side draw from low pressure column. A part of air leaves the unit as waste stream due to the additional requirement of cooling which is obtained using Joule-Thomson effect in an expander , which feeds compressed air directly to the low pressure column. Gaseous Oxygen and Nitrogen, liquid Argon are obtained as products. Purity of Gaseous Oxygen ranges from 97.5 to 99.5 %.

Peng-Robinson Model was used to solve the flowsheet with binary interaction parameters as N_2/O_2 = -0.0133, N_2/Ar = -0.0026, O_2/Ar = 0.0089.

The liquid stream from the Argon Column is fed back to the low pressure column. This serves as tear stream for the flowsheet. Following heat integrations in the Air Separation Unit is shown: cooling of feed against products stream in main heat exchanger, Low Pressure condenser against High Pressure reboiler, condensation of Argon against evaporization of rich liquid.

In the flowsheet, the purity of liquid argon and gaseous oxygen obtained are less than what they normally are. This is due to limit in number of stages in the separation column used. If the Argon Column is equipped enough stages along with structured packings, it is possible to reduce the impurities to less than 1 ppm.

Results

	Gas N_2	Gas O_2	Waste Gases	S-26	Air
Temperature (C)	25	25	25	-184.2191	30
Pressure (bar)	1.1	1.1	1.1195652	1.2	1.01325
Mass Flow (kg/s)	13.718853	17.791249	68.114858	0.37334466	100
Molar Flow (kmol/h)	1762.9708	1994.1474	8640	33.644763	12431.006
Molar Fraction (Mixture) / Nitrogen	0.99999966	1.14E-16	0.91992284	2.16E-08	0.7812
Mass Flow (Mixture) / Nitrogen (kg/s)	13.718847	1.77E-15	61.849724	5.65E-09	75.56856
Molar Fraction (Mixture) / Oxygen	1.66E-08	0.985	0.07402818	7.00E-07	0.2095
Mass Flow (Mixture) / Oxygen (kg/s)	2.59E-07	17.459323	5.6851865	2.09E-07	23.148573
Molar Fraction (Mixture) / Argon	3.24E-07	0.015	0.006048979	0.99999928	0.0093
Mass Flow (Mixture) / Argon (kg/s)	6.34E-06	0.33192584	0.57994708	0.37334445	1.2828674

References

Flowsheet Source: www.chemsep.com/downloads/data/CScasebook_ASU.png