

Comparison of Liquid Nitrogen, PSA Nitrogen Generation, and Cryogenic Air Separation			
Parameter	Liquid Nitrogen	PSA	Cryogenic Air Separation
600 Nm³/h			
Purity	99.999%	99.999%	99.999%
Separation Medium	None	Carbon Molecular Sieve	None
Oxygen Content	≤5 ppm	≤10 ppm	≤5 ppm; ppb level achievable with dedicated solutions
Flow Rate	600 Nm³/h	600 Nm³/h	600 Nm³/h
Air-to-Nitrogen Ratio	—	≈5–7:1	≈2.4–3.0:1
Dew Point	Typically depends on gas supply and vaporization conditions	≤-40 °C	≤-70 °C
Energy Consumption	—	480 kW	150 kW
Equipment Delivery Time	In stock / tanker supply	≈2 months	≈3 months
Floor Area	50–100 m² (incl. tank area, reference)	100–150 m² (reference)	200–300 m² (reference)
Service Life	Depends on continuous procurement	Design life ≈10–15 years; adsorbent, valves, etc. require maintenance/replacement	Main equipment design life can be considered ≥20 years
800 Nm³/h			
Purity	≥99.999%	≥99.999%	≥99.999%
Separation Medium	None	Carbon Molecular Sieve	None
Oxygen Content	≤5 ppm	≤10 ppm	≤5 ppm; ppb level achievable with dedicated solutions
Flow Rate	800 Nm³/h	800 Nm³/h	800 Nm³/h
Air-to-Nitrogen Ratio	—	≈5–7:1	≈2.4–2.7:1
Dew Point	Typically depends on gas supply and vaporization conditions	≤-40 °C	≤-70 °C
Energy Consumption	—	640 kW	200 kW
Equipment Delivery Time	In stock / tanker supply	≈2 months	≈3 months
Floor Area	70–120 m² (incl. tank area, reference)	130–200 m² (reference)	250–400 m² (reference)
Service Life	Depends on continuous procurement	Design life ≈10–15 years; adsorbent, valves, etc. require maintenance/replacement*	Main equipment design life can be considered ≥20 years
1000 Nm³/h			
Purity	≥99.999%	≥99.999%	≥99.999%
Separation Medium	None	Carbon Molecular Sieve	None
Oxygen Content	≤5 ppm*	≤10 ppm	≤5 ppm; ppb level achievable with dedicated solutions
Flow Rate	1000 Nm³/h	1000 Nm³/h	1000 Nm³/h
Air-to-Nitrogen Ratio	—	≈5–7:1	≈2.0–2.4:1
Dew Point	Typically depends on gas supply and vaporization conditions	≤-40 °C	≤-70 °C
Energy Consumption	—	800 kW	250 kW
Equipment Delivery Time	In stock / tanker supply	≈2 months	≈3 months
Floor Area	90–150 m² (incl. tank area, reference)	165–250 m² (reference)	315–500 m² (reference)
Service Life	Depends on continuous procurement	Design life ≈10–15 years; adsorbent, valves, etc. require maintenance/replacement*	Main equipment design life can be considered ≥20 years
Pros & Cons			
Item	External Tanker + Storage Tank Vaporization Gas Supply	On-Site Gas Generation	On-Site Gas Generation
	External tanker + storage tank vaporization gas supply 1. No on-site gas generation unit is required; gas can be supplied once the storage tank and vaporization system are installed. 2. High dependence on logistics and gas suppliers, with risks from transportation, weather, and supply fluctuations. 3. Long-term storage of liquid nitrogen incurs natural evaporation losses and requires continuous refilling. 4. Lower initial investment; suitable as a backup gas source or for low/fluctuating gas demand.	On-site gas generation 1. Continuous on-demand production reduces dependence on tanker transportation; operating costs are mainly driven by electricity and maintenance. 2. PSA supports fast start-up/shutdown and is suitable for continuous use at medium-to-low flow rates. 3. Higher purity generally means higher air consumption and energy consumption; the adsorbent and valves are consumable/maintenance parts. 4. Suitable for users sensitive to initial investment with medium gas demand that does not require very large-scale continuous supply.	On-site gas generation 1. Uses cryogenic distillation; suitable for large flow rates, long-term continuous operation, and high-purity nitrogen demand. 2. Modern modular small-scale cryogenic units can achieve relatively fast start-up, though the actual start-up time depends on hot/cold state and process design. 3. Initial investment and installation requirements are generally higher than PSA; the cold box, air compressor, and supporting facilities need to be considered. 4. Can achieve 99.999% or higher purity, and can be configured with by-products such as liquid nitrogen / backup capability depending on the process scheme. 5. Generally more advantageous for 24-hour continuous operation and long-term stable gas demand.