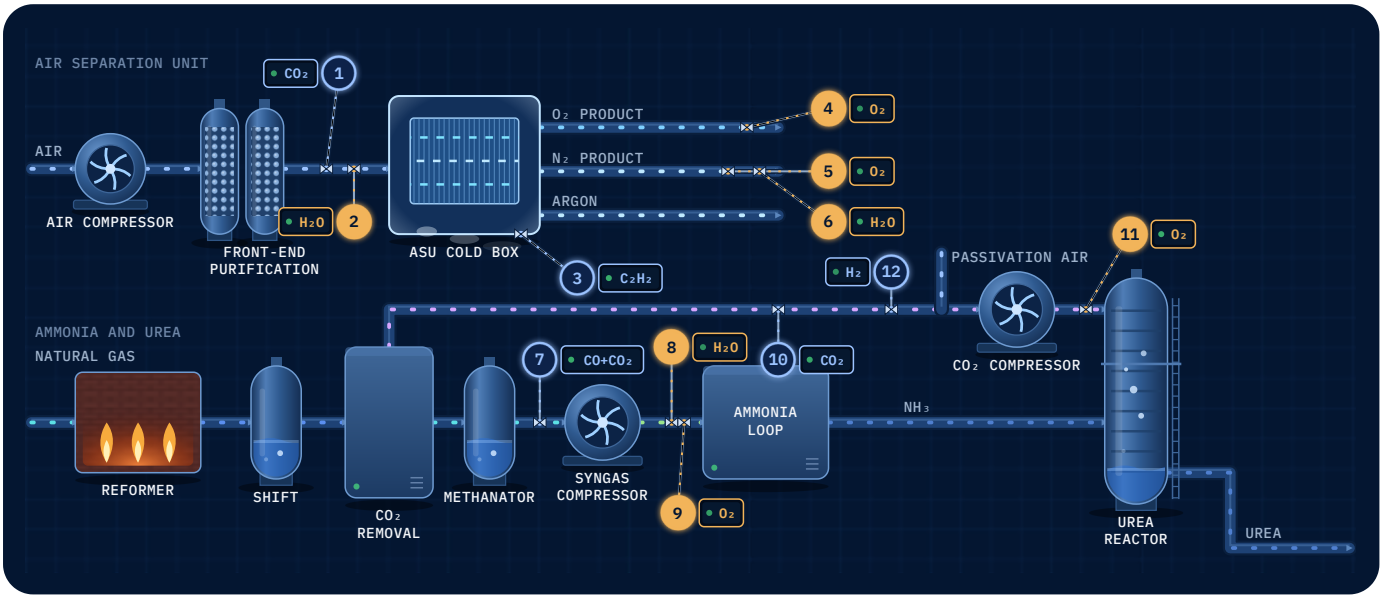
Ammonia, urea and air separation: where to measure moisture, O_2 and CO_2

Follow air through the air separation unit, and natural gas through the ammonia line to the urea reactor. Each numbered point shows what is measured, the typical limit and the analyzer that fits.



● YORK instrument ○ Integrated system (supplied through YORK)

How the process works

Gulf fertilizer complexes make ammonia from natural gas and turn most of it into urea with the CO_2 removed from the synthesis gas. Air separation units on the same sites supply oxygen and nitrogen. In both, catalysts and cryogenic equipment fail if trace water, CO_2 or oxygen gets through, so each purification step has an analyzer behind it.

1. **Air compression and front-end purification.** Molecular-sieve adsorbers remove water and CO_2 from compressed air before it enters the cold box.
2. **Cryogenic separation.** The cold box distils air into oxygen, nitrogen and argon. The reboiler sump is watched for hydrocarbons that could concentrate in liquid oxygen.
3. **Reforming and shift.** Natural gas and steam are reformed to hydrogen and carbon monoxide; the shift converter turns most CO into CO_2 and more hydrogen.
4. **CO_2 removal and methanation.** A solvent removes CO_2, which goes on to urea. The methanator converts the remaining CO and CO_2 to methane, because both poison the ammonia catalyst.
5. **Compression and ammonia synthesis.** The hydrogen–nitrogen make-up gas is compressed into the synthesis loop, where it must be free of water and oxygen.
6. **Urea synthesis.** CO_2, dosed with a little passivation air, is compressed and reacted with ammonia in the urea reactor.

Interactive version with animation:
https://www.yorkinstrument.ae/guides/ammonia-urea-air-separation-measurement-points/

Measurement points

#	POINT	MEASURES	TYPICAL VALUE / LIMIT	RECOMMENDED SOLUTION
1	Front-end purification outlet	Trace CO_2 (ppmv)	Alarm typically at 1 ppmv; high-high ≤ 5 ppmv; shutdown at 10 ppmv	Integrated system: trace CO_2 NDIR analyzer
2	Front-end purification outlet	Water dew point	Detects adsorber breakthrough; −40 to −60 °C confirms the cold box is dry after deriming	DPT830, DPT810, DM9800, DM9900
3	Main condenser / reboiler sump	Acetylene, N_2O and total hydrocarbons	Sump limits: C_2H_2 0.5 ppmv; total hydrocarbons 500 ppmv as CH_4	Integrated system: process gas chromatograph with flame-ionisation detector
4	Oxygen product	O_2 purity (%)	About 95 % for gasification; higher purity for chemical and merchant grades	POA3500, POA300, PGA530
5	Nitrogen product	Trace O_2 (ppm)	Pure / high-purity / ultra-pure N_2: < 50 / < 3 / < 0.1 ppm (GB/T 8979-2025)	POA200, PGA500
6	Nitrogen product	Trace water	< 15 / < 3 / < 0.5 ppm by grade (≈ −57 / −69 / −80 °C frost point)	DPT830, DM9900
7	Methanator inlet and outlet	CO and CO_2	Inlet typically about 0.2 % CO and 0.1 % CO_2; outlet < 5 ppmv each by design	Integrated system: NDIR CO/CO_2 analyzer at the inlet; gas chromatograph with methanizer-FID for ppm CO + CO_2 at the outlet
8	Synthesis make-up gas	Trace water	Water is a synthesis-catalyst poison; take the limit from the catalyst specification	DPT830, DPT990-EX
9	Synthesis make-up gas	Trace oxygen	Normally near zero; any oxygen forms water over the catalyst	PGA500-EX
10	Urea CO_2 feed	CO_2 purity (%)	> 98 %	Integrated system: CO_2 purity analyzer with a narrow high-percent range
11	Urea CO_2 feed after passivation air	Oxygen (vol %)	≈ 0.6 vol % with conventional stainless steels; can be cut to ≈ 0.04 vol % with a special duplex stainless steel	POA3500; Integrated system: laser O_2 analyzer qualified for CO_2 service
12	Urea CO_2 feed	Hydrogen in CO_2	Historically close to 1 %; many plants now remove it	Integrated system: thermal-conductivity H_2 analyzer

Typical values from published standards, regulations and technical literature. Your contract, licensor or plant specification always governs. Integrated systems are supplied by YORK through its partner integration factory.

Key references

1. AIGA 035/20 Safe Operation of Reboilers/Condensers in Air Separation Units — Asia Industrial Gases Association
2. Gasifipedia: Commercial Oxygen — US DOE NETL
3. GB/T 8979-2025 Pure nitrogen, high-purity nitrogen and ultra-pure nitrogen (table preview) — chinesestandard.net
4. Can passivation air in urea plants be minimized? IFA Technical Conference 2002 — International Fertilizer Association