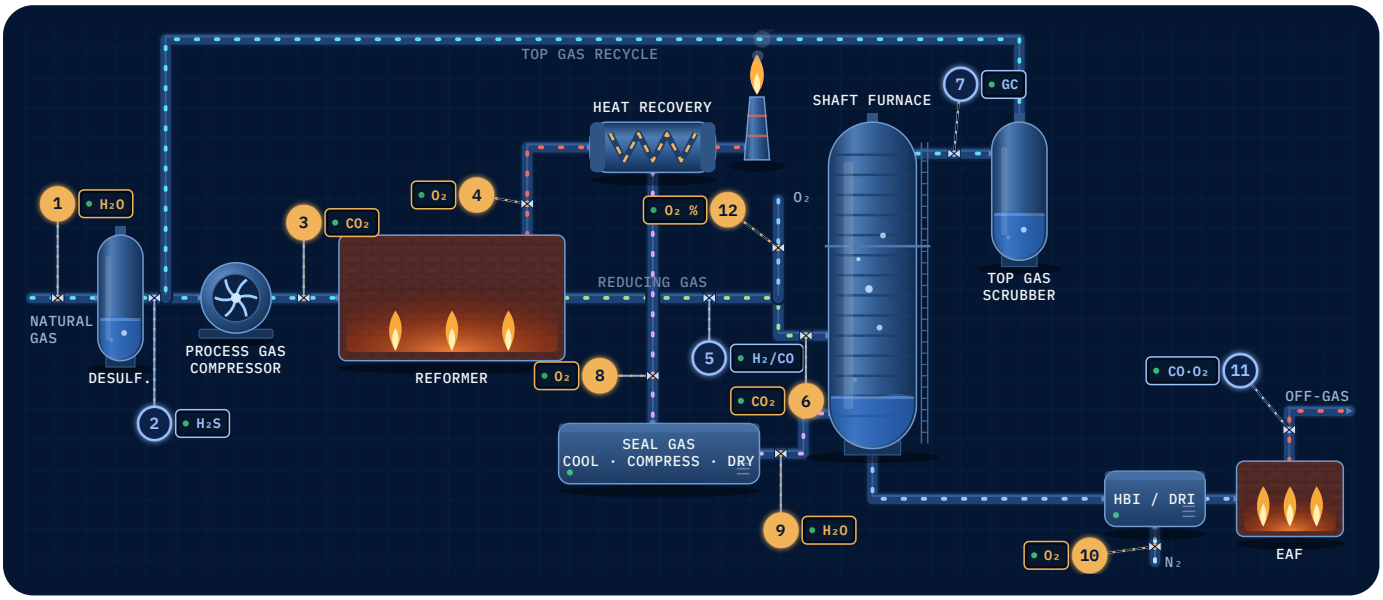
Direct reduced iron and EAF steel: where to measure moisture, O_2 and CO_2

Follow the gas from natural gas desulfurisation through the reformer and shaft furnace to the seal gas and the electric arc furnace. Each numbered point shows what is measured, the typical value, why it matters and the analyzer that fits.



● YORK instrument ○ Integrated system (supplied through YORK)

How the process works

A natural-gas direct reduction plant turns iron ore pellets into DRI or HBI with a hot H_2/CO gas, and the electric arc furnace melts it into steel. Gas quality decides metallisation and energy use at every step. In the GCC, EMSTEEL runs HYL/Energiron-type modules, Hadeed and Jindal Shadeed (Sohar) run MIDREX-type modules, and the Duqm project uses a hydrogen-ready HYL/Energiron-type plant.

1. **Desulfurisation.** Natural gas is cleaned to a narrow sulfur window: enough to stop carbon deposits in the reformer, not so much that the catalyst is poisoned.
2. **Reforming.** Recycled top gas and natural gas are compressed, preheated and reformed over nickel catalyst. CO_2 and H_2O in the feed are the oxidants. HYL/Energiron-type plants reform inside the shaft instead.
3. **Reduction.** Hot reducing gas, often boosted with oxygen injection, enters the shaft furnace at the bustle and reduces the iron ore.
4. **Top gas recycle.** Spent top gas is scrubbed, cooled and split into recycle process gas and reformer fuel. HYL/Energiron-type plants remove CO_2 with amine.
5. **Seal gas and inerting.** Dried flue gas or nitrogen seals the furnace and protects hot DRI and HBI from re-oxidation.
6. **Electric arc furnace.** DRI or HBI is melted. Off-gas analysis controls post-combustion and detects water leaks.

Interactive version with animation:
https://www.yorkinstrument.ae/guides/dri-steel-measurement-points/

Measurement points

#	POINT	MEASURES	TYPICAL VALUE / LIMIT	RECOMMENDED SOLUTION
1	Natural gas at the plant battery limit	Water dew point at line pressure	Per the gas supply contract (no published limit for GCC plant supplies)	DPT990-EX
2	Desulfurised gas to the reformer	H_2S / total sulfur (ppmv)	Window of 2–5 ppmv in reformer feed (MIDREX-type). Raw associated gas has run 350–600 ppmv at one plant	Integrated system: ppm-level H_2S / total sulfur analyzer (GC with sulfur detector or UV)
3	Reformer feed gas (top gas + natural gas)	CO_2 (%)	About 15 % CO_2 (with ~13 % H_2O) in typical MIDREX-type feed gas	DPSS-61XX; Integrated system: NDIR CO_2 analyzer in a purged analyzer shelter
4	Reformer flue gas	Excess O_2 (%)	1–2 % O_2; flue gas is roughly N_2 60–65 %, CO_2 15–18 %, H_2O 20–22 %	POA3500, DPSS-61XX, POA300, PGA530
5	Reformed (bustle) gas	H_2, CO, CO_2, H_2O, CH_4 and quality ratio	Quality $(H_2+CO)/(H_2O+CO_2) \geq 9.5$; typical H_2 55 %, CO 35 % (MIDREX-type). HYL/Energiron-type gas runs H_2/CO 3–5	Integrated system: process gas chromatograph or mass spectrometer
6	Bustle gas to the shaft furnace	CO_2 (%)	About 2 % in typical reformed gas; 2.8 % reported at one plant	DPSS-61XX; Integrated system: NDIR CO_2 analyzer with a low-percent range, in a purged analyzer shelter
7	Top gas leaving the furnace	H_2, CO, CO_2, CH_4	Measured at one plant: H_2 37 %, CO 19 %, CO_2 14 %, H_2O 21 %	Integrated system: process gas chromatograph or mass spectrometer
8	Seal (inert) gas from reformer flue gas	O_2 (%)	Source flue gas below 2 % O_2; seal-gas specification set by the licensor	POA3500, POA300, PGA530, PGA500-EX
9	Dry seal gas after the dryer	Dew point	Set by the licensor's seal-gas specification	DPT810, DPT830
10	Nitrogen header for inerting (HYL/Energiron-type)	O_2 and dew point	N_2 use of about 12 (cold DRI) to 19 Nm^3/t (HBI); purity per plant specification	PGA500, POA200, DPT830
11	EAF off-gas after the elbow	CO, CO_2, O_2, H_2 (H_2O for water leaks)	One control scheme keeps the CO/O_2 ratio between 0.40 and 0.75	Integrated system: water-cooled extractive probe with NDIR / paramagnetic / thermal-conductivity analyzers, or in-situ laser (TDLAS)
12	Oxygen for bustle-gas injection and EAF lancing	O_2 purity (%)	> 99.5 % from cryogenic air separation; < 95 % from VPSA	POA3500

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. ENERGIRON technology: DRI-EAF production route using natural gas or H_2 — European Commission, Innovation Centre for Industrial Transformation
2. Quatravaux et al., Adaptation of the Rist operating diagram for the direct reduction shaft, Metals 11 (2021) 1953 — MDPI
3. MIDREX Process — Kobelco Technology Review No. 29
4. Krassnig et al., EAF post-combustion control by on-line laser-based off-gas measurement — Archives of Metallurgy and Materials 53(2), 2008