

CO_2 Quality Standardisation and Corrosion Testing

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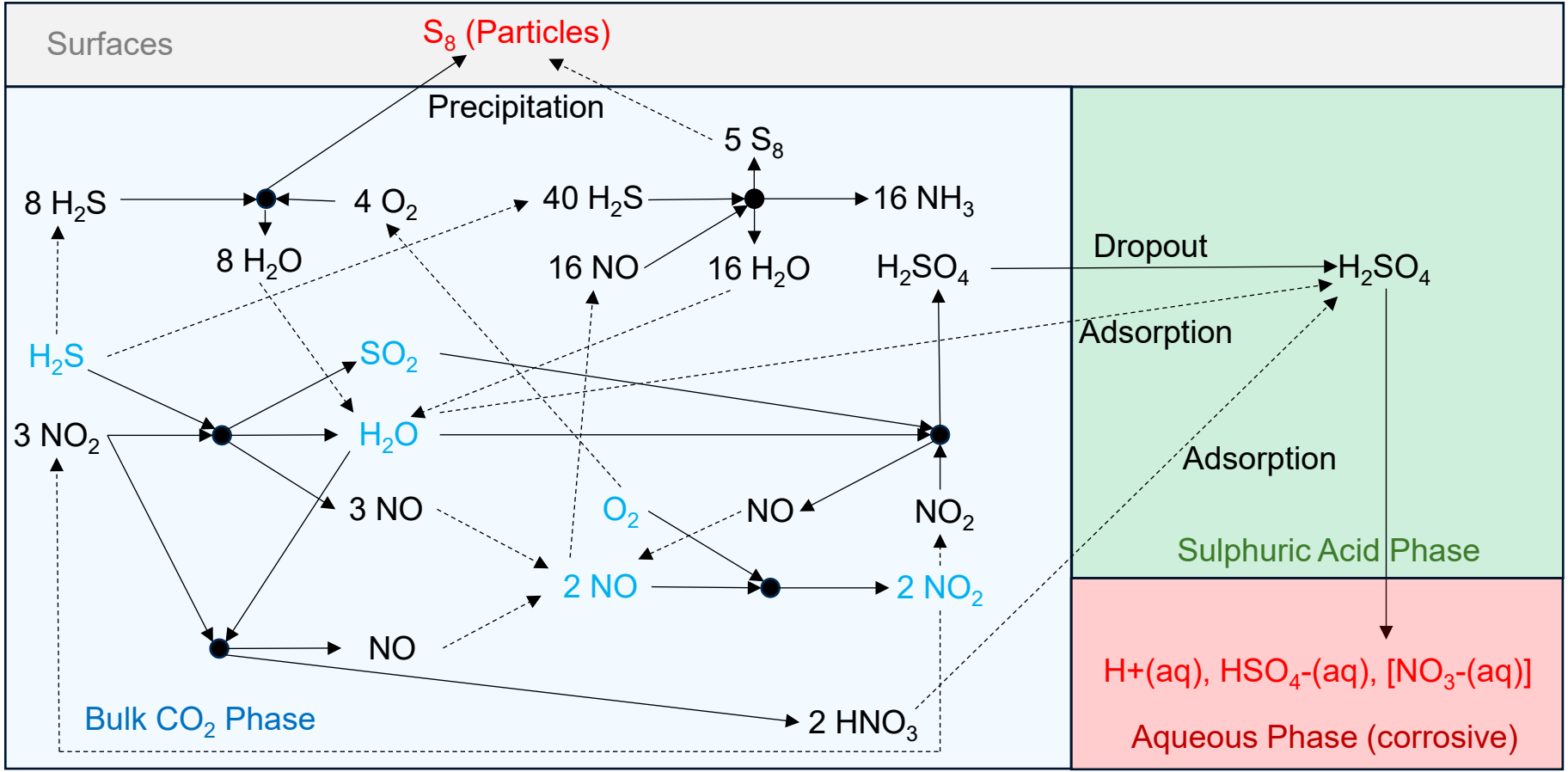
ENTSOG Gas Quality Workshop

05.11.2026

OGE

Acid corrosion: chemical reactions

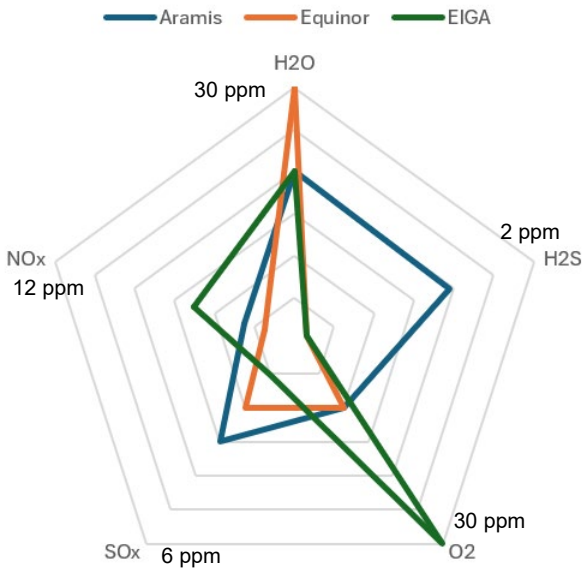


European Standardisation of CO_2 Quality

- The draft of EN 18397 („Properties of carbon dioxide streams in carbon steel pipelines“) has been published for Enquiry until November 5, 2026.
- In the draft no limits for the five molecules known to be involved in the formation of strong acids will be given.
  - Instead the state of the art will be discussed in an informal annex.
  - The consensus in the WG is that the purpose of the document is not to adopt the known specifications from e.g. the food industry, but ensure in the long term that CCS systems can be operated not only safely, but also at minimum costs.
- Experts are called upon to join a new project at CEN/TC 474 on Medium Pressure Tank Transport.

Known non-corrosive CO_2 streams

Source	H_2O ppm	H_2S ppm	O_2 ppm	SO_x ppm	NO_x ppm	T_{min} °C	Phase	Notes
EIGA, Doc 70/17, 2017, Appendix A	20	0,1	30	1 (as SO_2)	2,5+ 2,5	≈ -30	liquid/ gas	Principle unclear. ISBT beverage grade, long established for tanks.
Aramis/IFE, EuroCorr 2025	20	1,3	10	3	2,5	4	dense	Avoids acid formation. Single test, to be verified.
Equinor, CO_2 Highway Europe, 2026	30	0,1	10	2 (as S_{tot})	1,5	2	dense, gas	Avoids acid dropout. Conservative according to Equinor.

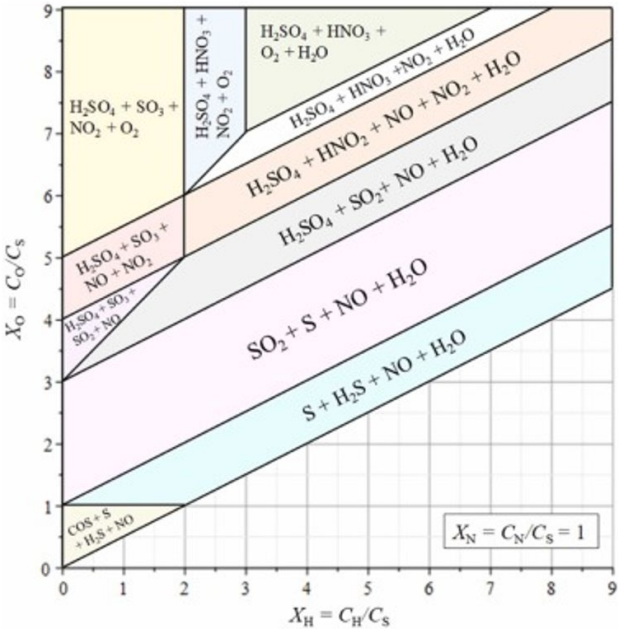


— Research is currently limited by experimental capacities.

— Models are still at an early stage and mostly confined to equilibrium calculations. Research on kinetics has started.

How to navigate a five-dimensional space?

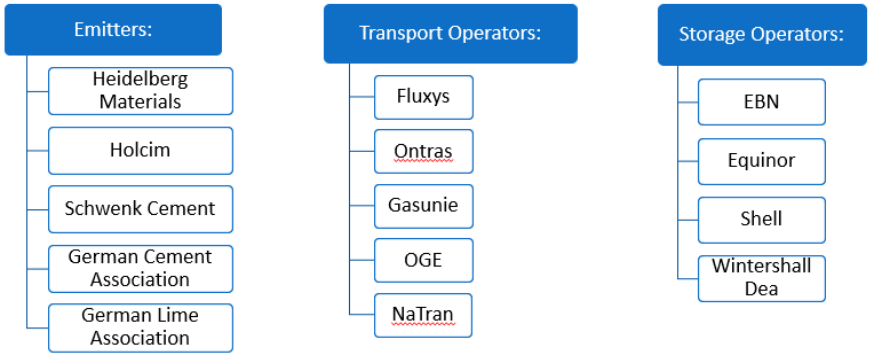
- „Corrosion Map“ approach:
  - Reduce to four dimensions by considering the elements S, N, O, H instead of molecules.
  - Assume dilute limit, use three ratios normalized by S.
  - Keep the N/S ratio constant.
  - Plot a two-dimensional corrosion map for the chemical equilibrium at the given conditions.
- Alternatively:
  - Vary only two parameters at a time, compare the results to the equilibria.



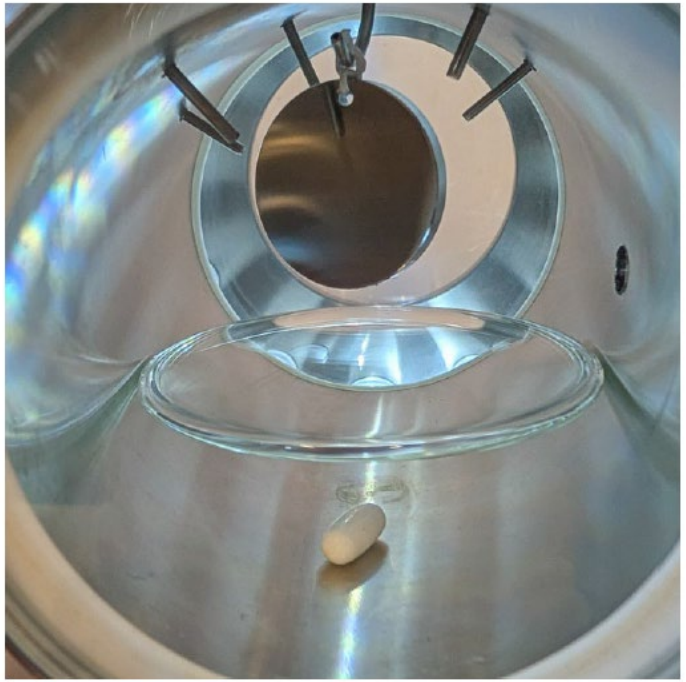
Source: Slavchov et al. 2024

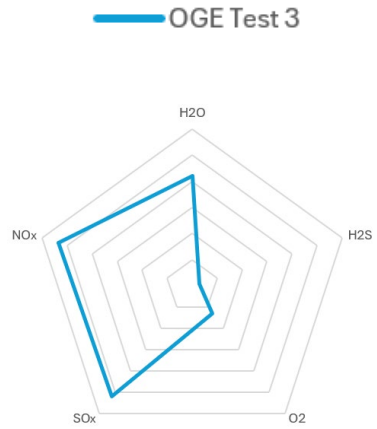
Recent research

- OGE contracted a series of tests at IFE (Norway), funding is provided by 14 partners in total.
- The results will be freely available.
- The tests are focussing on variations of O_2 and H_2S at constant levels of H_2O, SO_2 and NO_2 that can be achieved in cement and lime plants.



First results





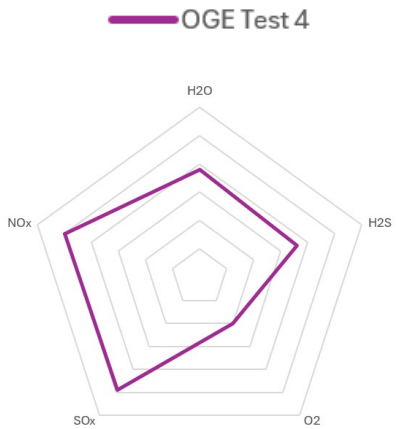
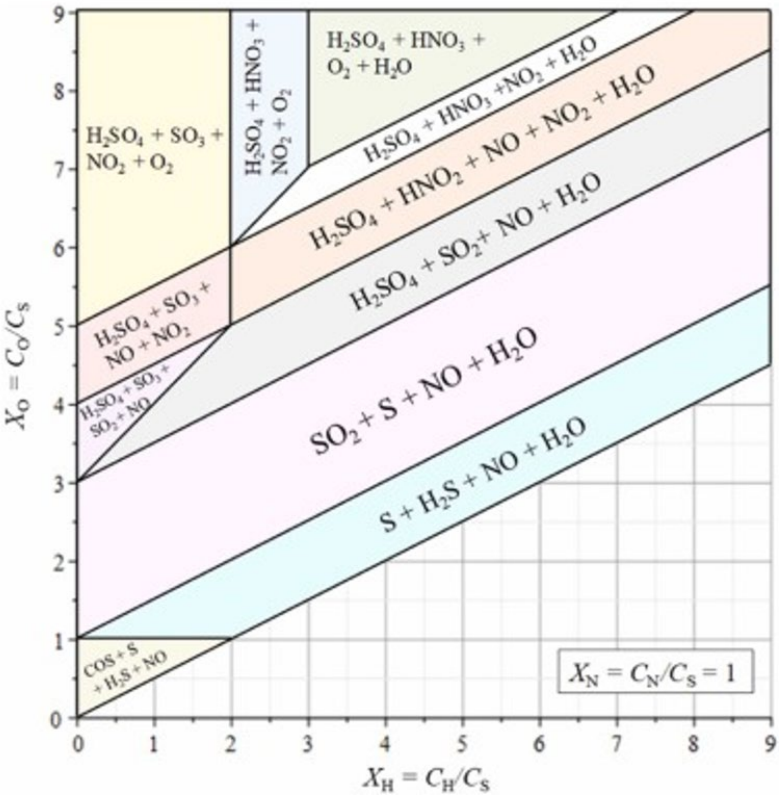
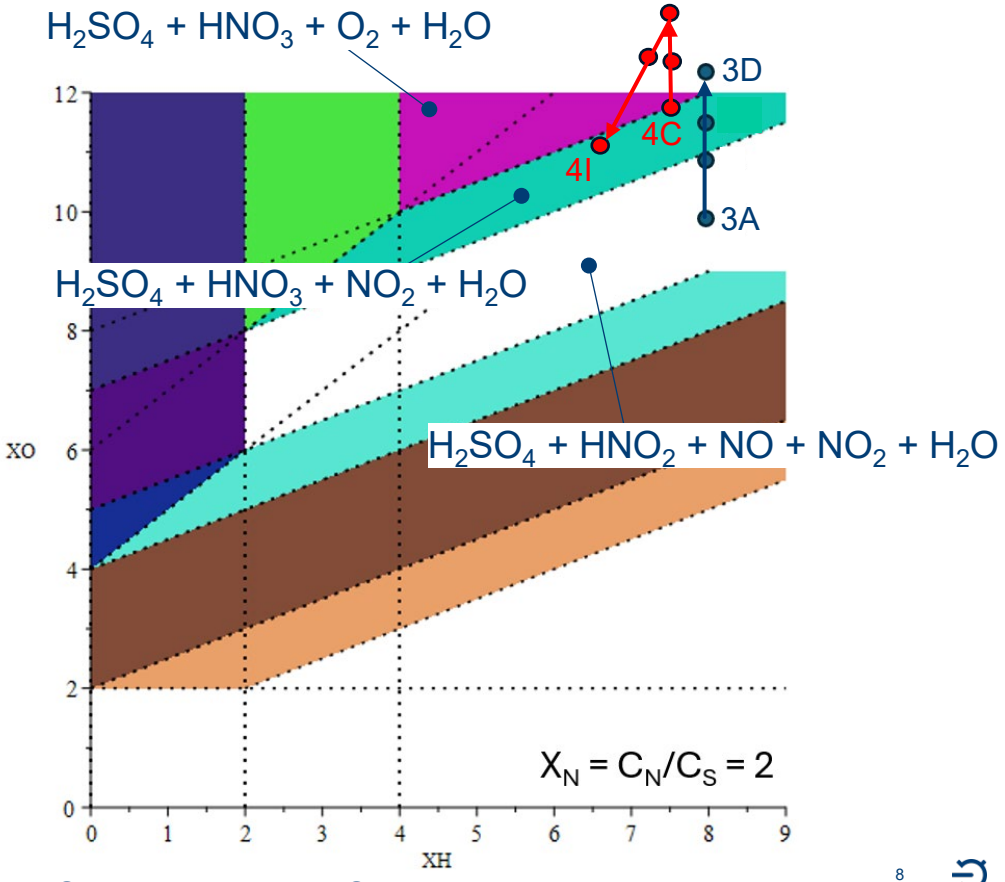


Table 10: Summary of results.

Experiment and step	Press. (bar)	Temp. (°C)	Impurity dosing (ppm-mol)					Observation
			H_2O	H_2S	SO_2	NO_2	O_2	
3A	100	+4	21	0.1	5.3	10.7		Chemical reactions. No corrosion or precipitation.
3B	100	+4	21	0.1	5.2	10.7	2.8	
3C	100	+4	21	0.1	5.2	10.7	4.5	
3D	100	+4	21	0.1	5.2	10.7	6.5	
3E	99	+2	21	0.1	5.3	10.7	6.5	
4C	100	+2	19	0.2	4.9	10	6	Chemical reactions. No corrosion or precipitation.
4D	100	+2	19	0.2	4.9	10	8	
4E	100	+2	19	0.2	4.9	10	10	
4H	100	+2	19	0.5	4.9	10	10	
4I	100	+2	19	1.2	4.9	10	10	

Corrosion maps for chemical equilibrium

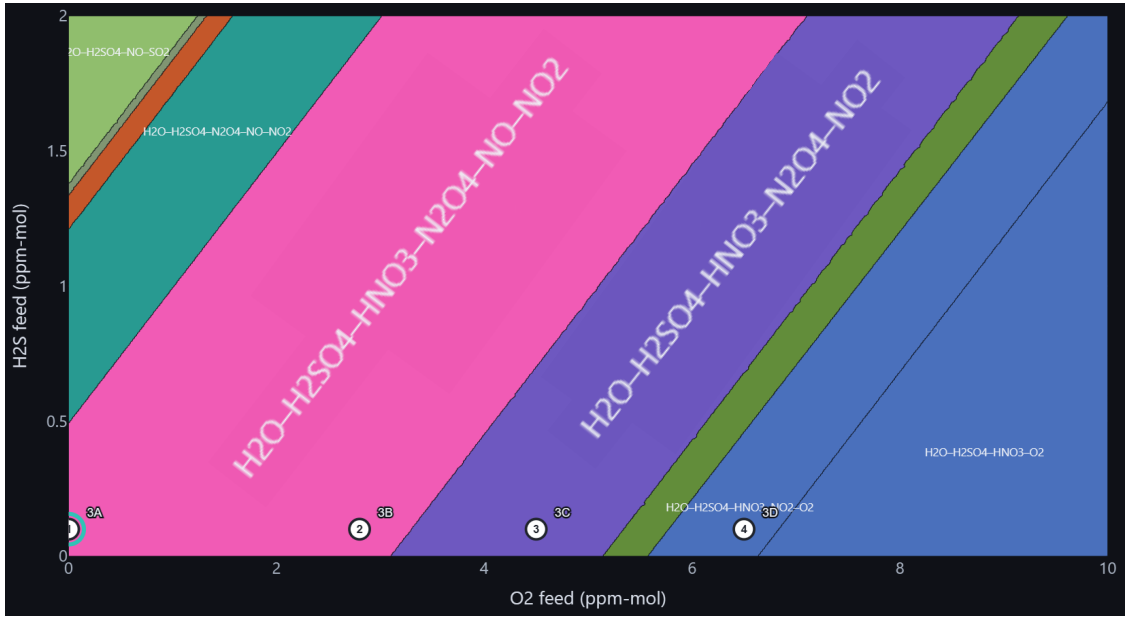




Source: Radomir Slavchov

Equilibria in the O_2-H_2S plane

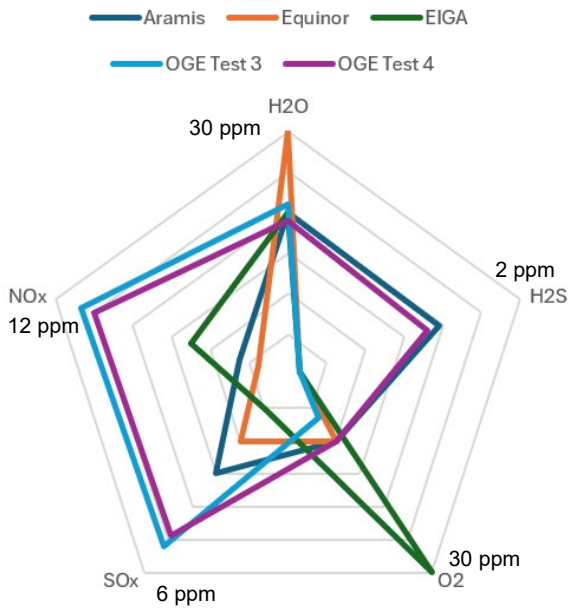
- An alternative modelling approach for equilibria confirms that H_2SO_4 should be formed in all stages of Test 3.
- It is known that the reaction of SO_2 to H_2SO_4 can be slow, in the hundreds of hours.
- While Tests 3 and 4 took more than 600 hrs each, the residence time in the autoclave was about 7 hrs.
- This residence time was sufficient for H_2SO_4 formation in many previous tests, however.



Source: Allan Leal, Reaktoro

Summary of ongoing OGE tests

Source	H_2O ppm	H_2S ppm	O_2 ppm	SO_x ppm	NO_x ppm	T_{min} °C	Phase	Notes
OGE und 13 partners, IFE, 2026	21	0,1	6,5	5,2 (as SO_2)	10,7	2	Dense	Slows acid formation. To be investigated further.
OGE und 13 partners, IFE, 2026	19	1,2	10	4,9 (as SO_2)	10	2	Dense	Slows acid formation. To be investigated further.



Summary

— No set of limits on acid-forming impurities in EN 18397 yet, to avoid expensive lock-ins. But updates will likely be forthcoming before the next regular revision.

— Experimental capacity remains scarce, although several stakeholders besides IFE are developing their own facilities.

— Recent testing was successful during the given residence times. If confirmed to be safe under operating conditions, some limits could become more lenient than in ongoing projects.

— Modelling is so far limited to chemical equilibria, new test results underline the importance of kinetics for interpretation.

We bring the energy.