WHEN TRUST MATTERS

Experimental results on impurity reaction kinetics in CO2 streams

CO_2RE

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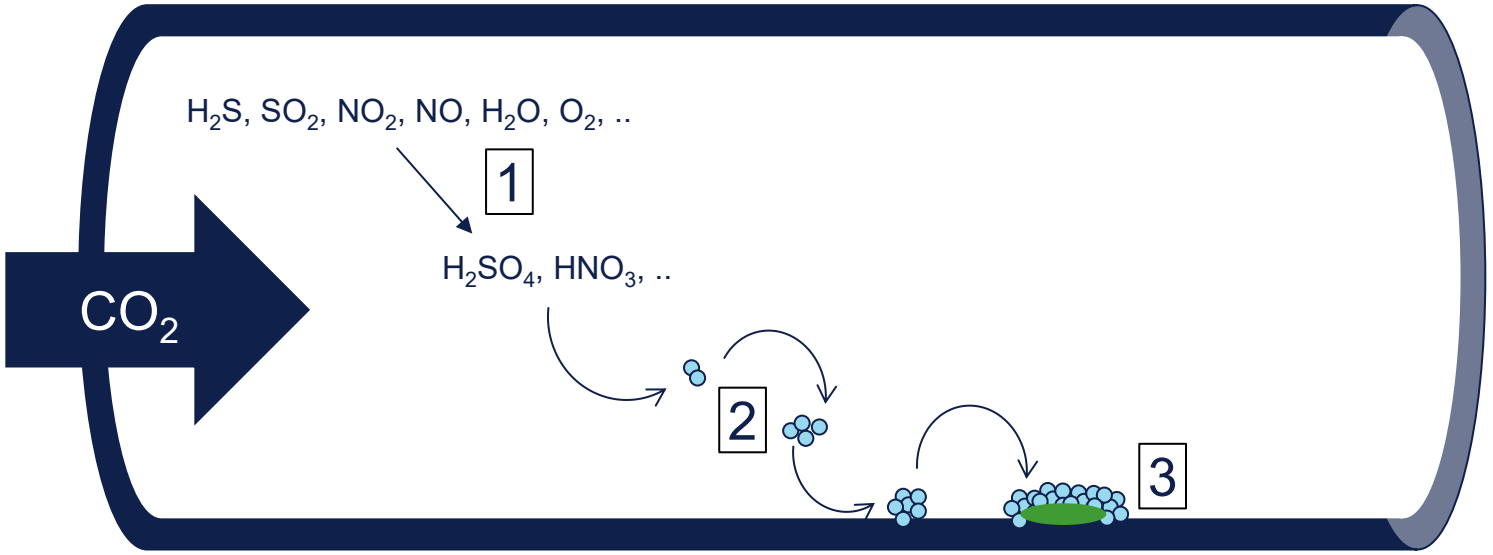
05 November 2026

The CO2RE project

- The CO_2RE project is a two-year research programme initiated by Gasunie and EBN with DNV Technology Centre Groningen as research contractor.
- The project focuses on understanding how different amounts and combinations of impurities react under realistic CO_2 transport conditions in the gas and dense phase.



Focus for CO2RE



1. Determine the **kinetics** of reactions in the bulk phase that could lead to acid formation

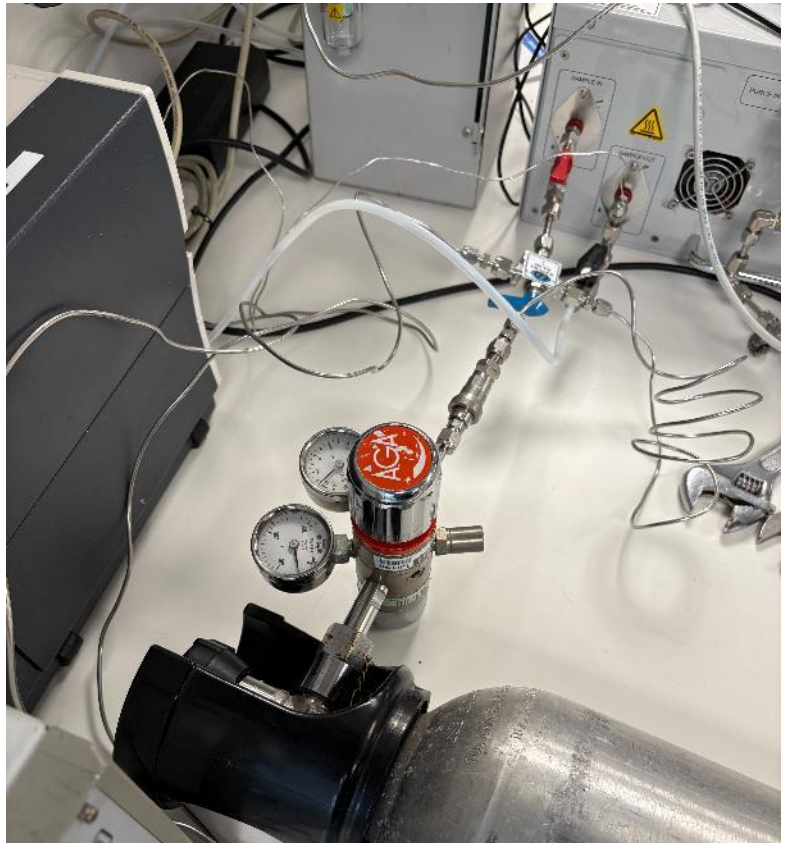
   Focus on NO_2, NO, H_2S, SO_2, H_2O, O_2

2. Investigate droplet formation under **flow conditions**

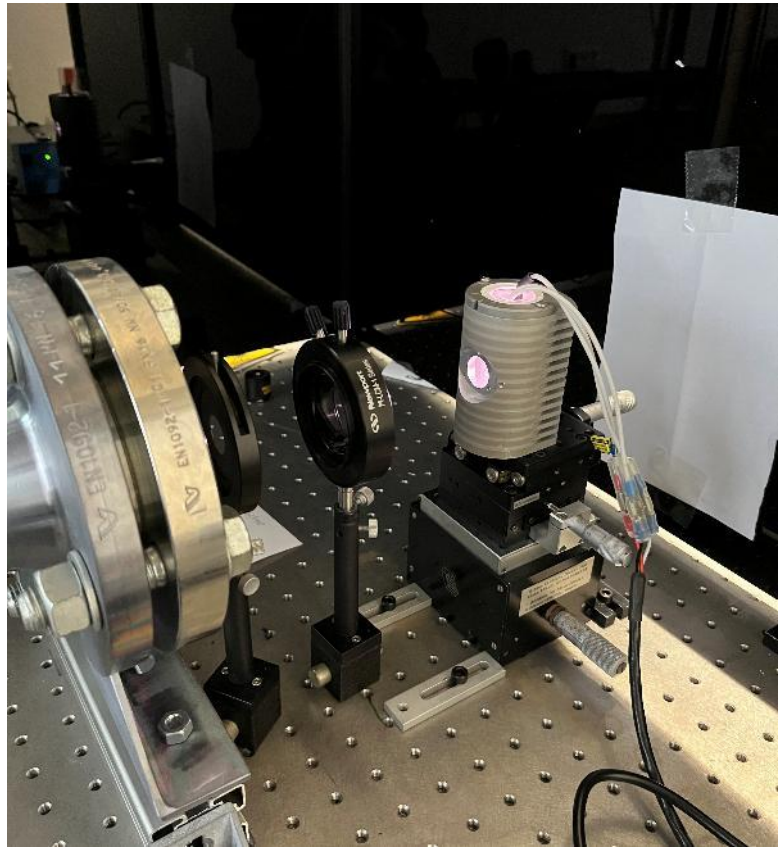
(3. Corrosion)

Three types of test setups

Batch reactors



Test cell with “**in situ** composition” measurement capabilities



Flow loop



Two sets of gas phase experiments

NO_2 + H_2S

- Reaction 1: $H_2S + 3\ NO_2 \leftrightharpoons SO_2 + H_2O + 3\ NO$
- When excess of NO_2:
- Reaction 2: $SO_2 + H_2O + NO_2 \leftrightharpoons H_2SO_4 + NO$

NO_2 + SO_2 + H_2O

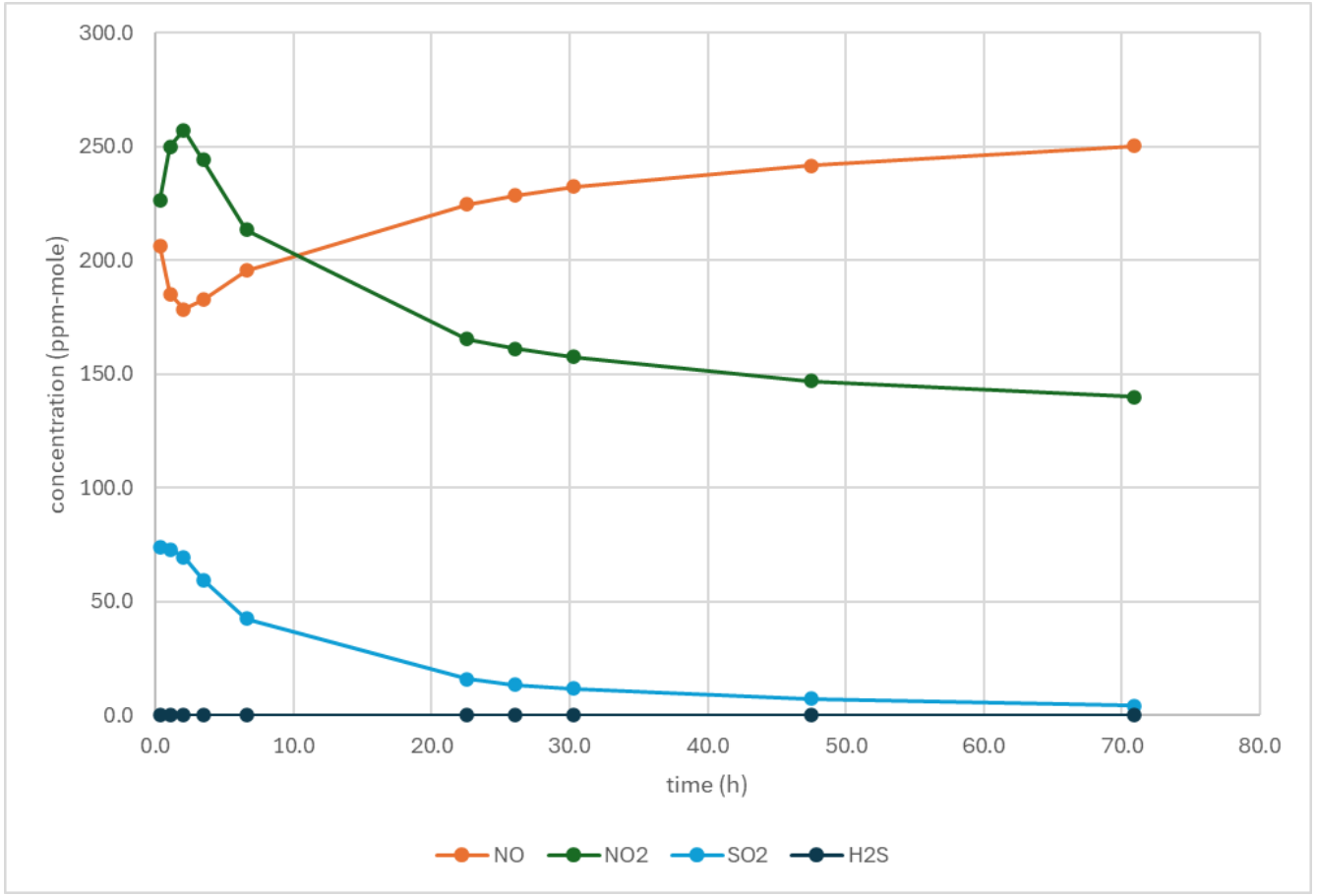
- Reaction 2: $SO_2 + H_2O + NO_2 \leftrightharpoons H_2SO_4 + NO$

Mainly in N_2 environments, ambient temperature

$H_2S + NO_2$

- 485 ppm NO_2 + 92 ppm H_2S @ 30 bar N_2
- Excess of NO_2: Reaction 1 and 2
- All H_2S consumed between preparation and first measurement (0.3h)
- Formation and consumption of SO_2

- Experiments repeated at low pressure: slows down reaction 1 significantly



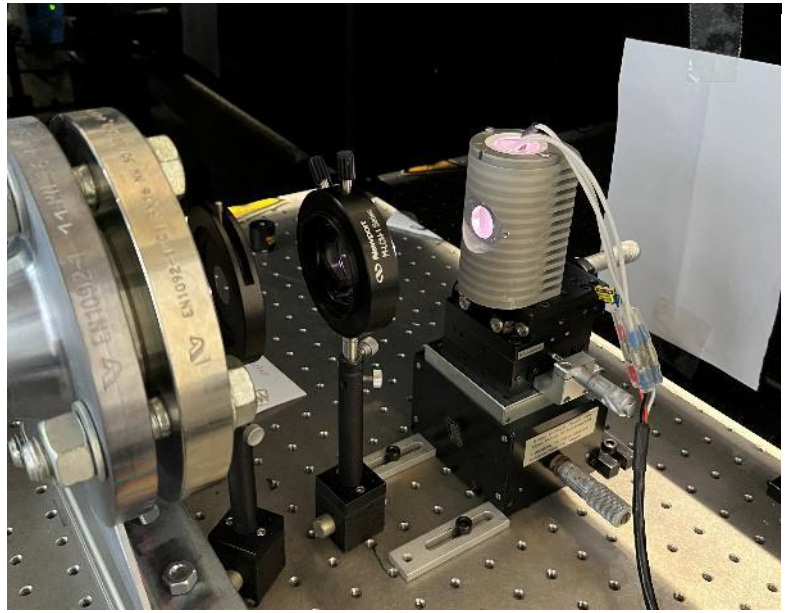
Proof of concept for in-situ

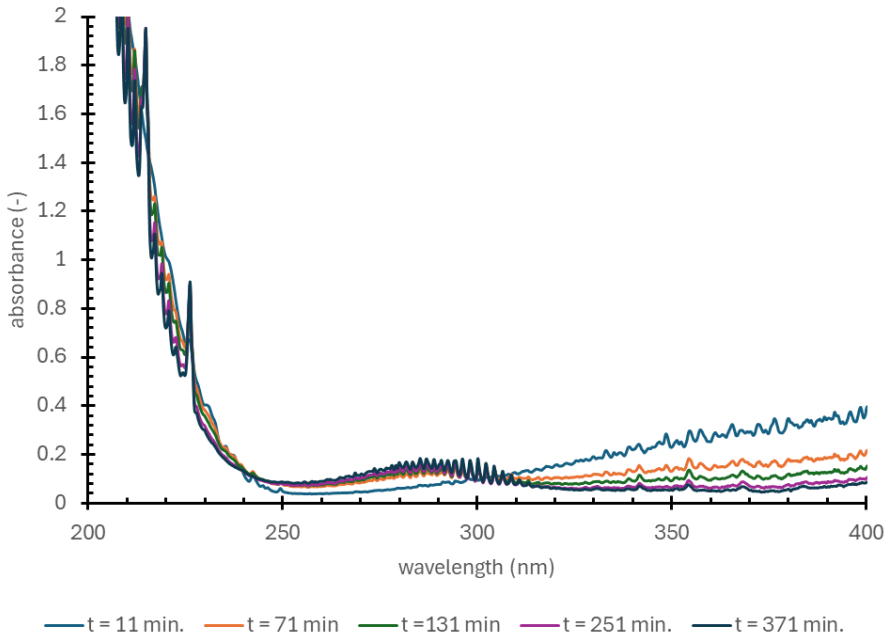
Test cell with “**in situ** composition” measurement capabilities

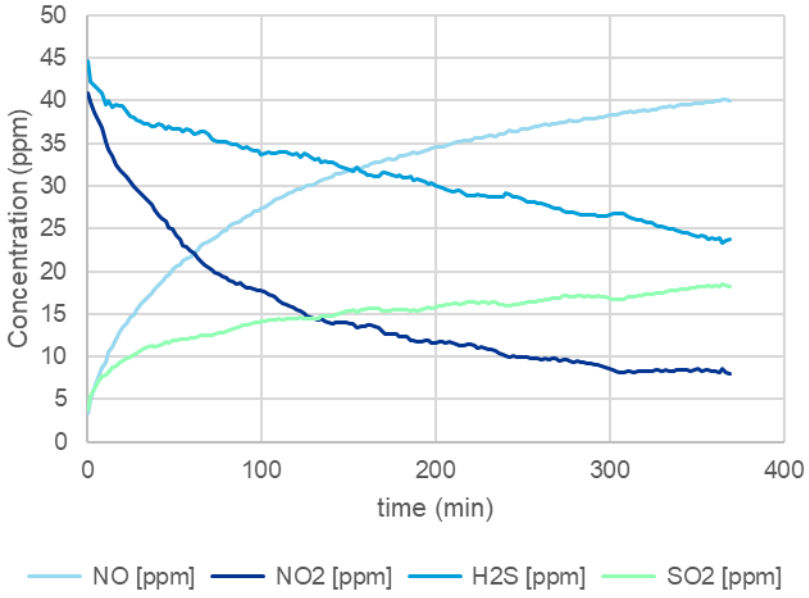
- Light absorption measurement or other in situ technologies

Measure absorption in UV-spectrum and relate to concentrations

- $H_2S + 3NO_2 \rightarrow SO_2 + 3NO + H_2O$
- Monitor concentrations under realistic conditions
  - Experiment below is at room temperature and 5 bar

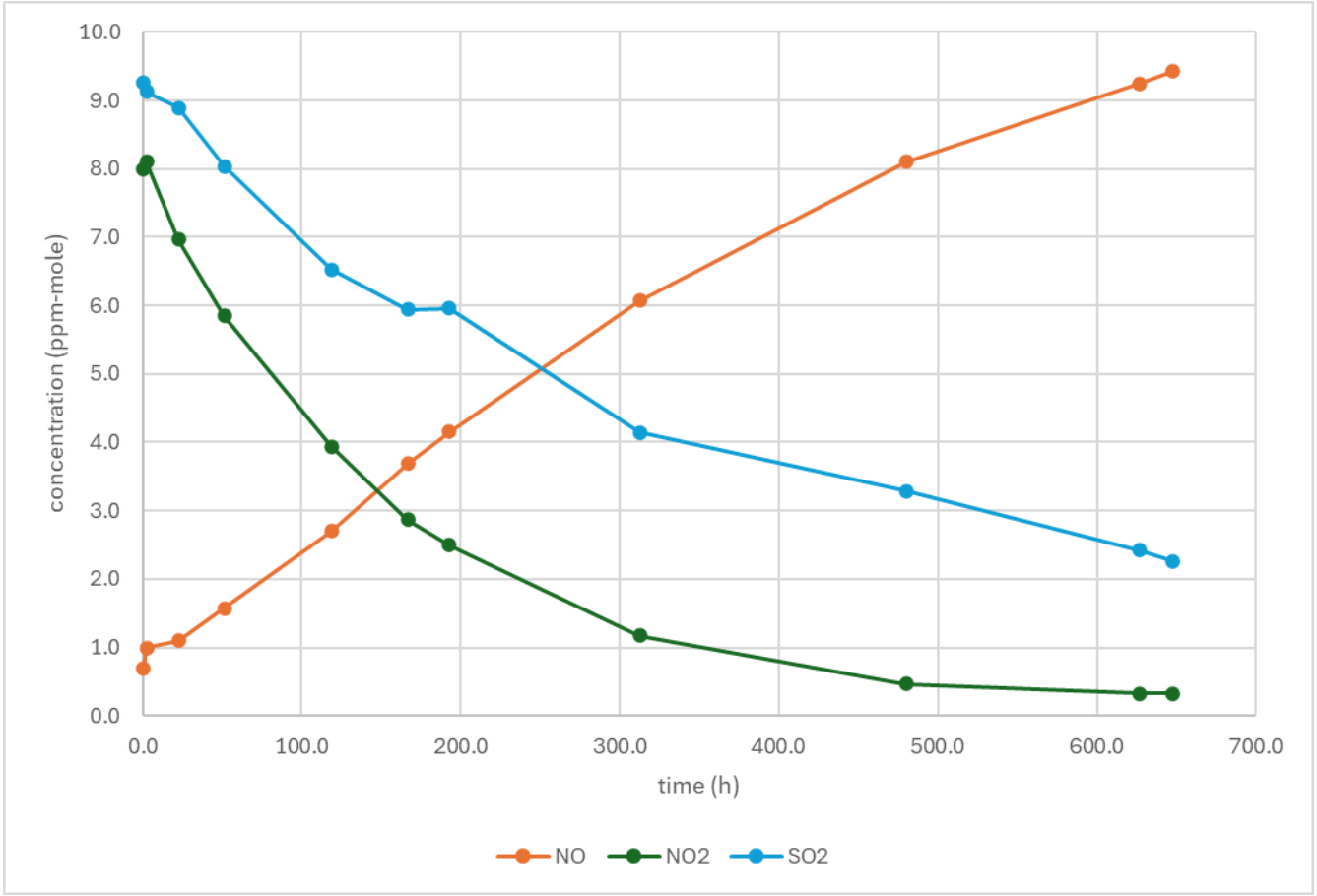






$NO_2 + SO_2 + H_2O$

- Start concentrations 10 ppm and 40 bar
- Very slow decrease of NO_2 and SO_2 up to 600 hours
- Formation of NO and H_2SO_4
  - Additional experiments show that dropout is formed with low pH (~1) that contains sulphate.
- Experiments repeated with different components in excess. Difficult to built a consistent kinetic model.
- Kinetics is influenced by the reduction of pressure in the cylinders, due to sampling



Summary CO2RE

- 2 year program
- Results will be publicly available: www.dnv.com/co2re
- Open for knowledge exchange

Thanks

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