DE-OXYGENATION AS COUNTERMEASURE FOR THE REDUCTION OF OXIDATIVE DEGRADATION OF CO2 CAPTURE SOLVENTS

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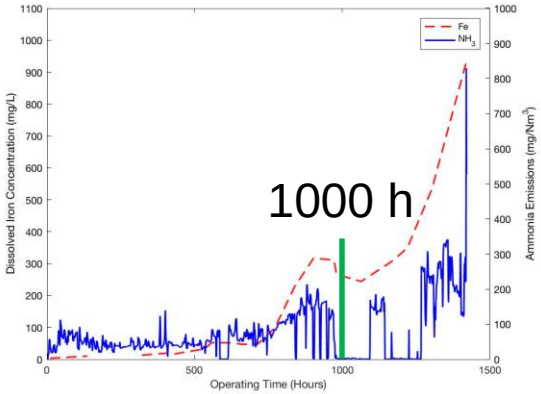
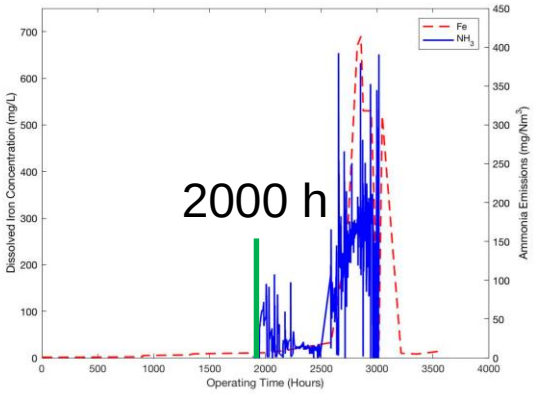
ghgt-14

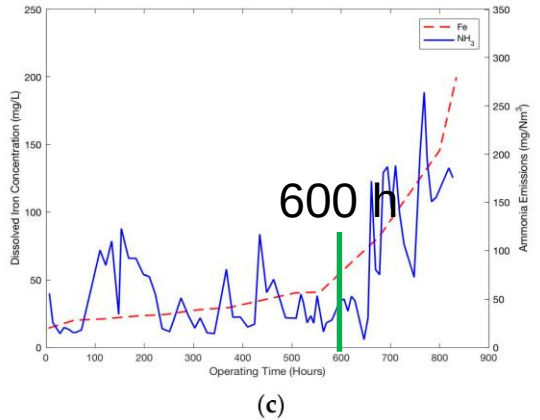
October, 2018

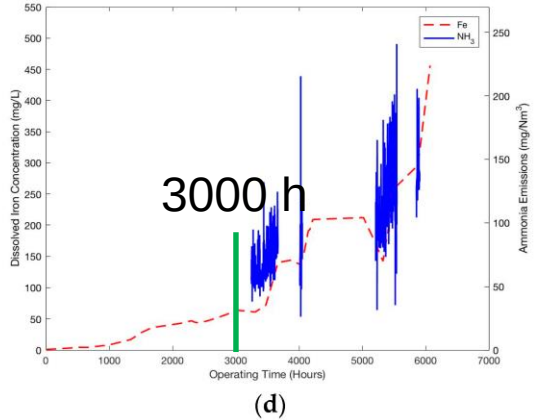
RELEVANCE

- Dissolved oxygen leads to oxidative degradation of amines



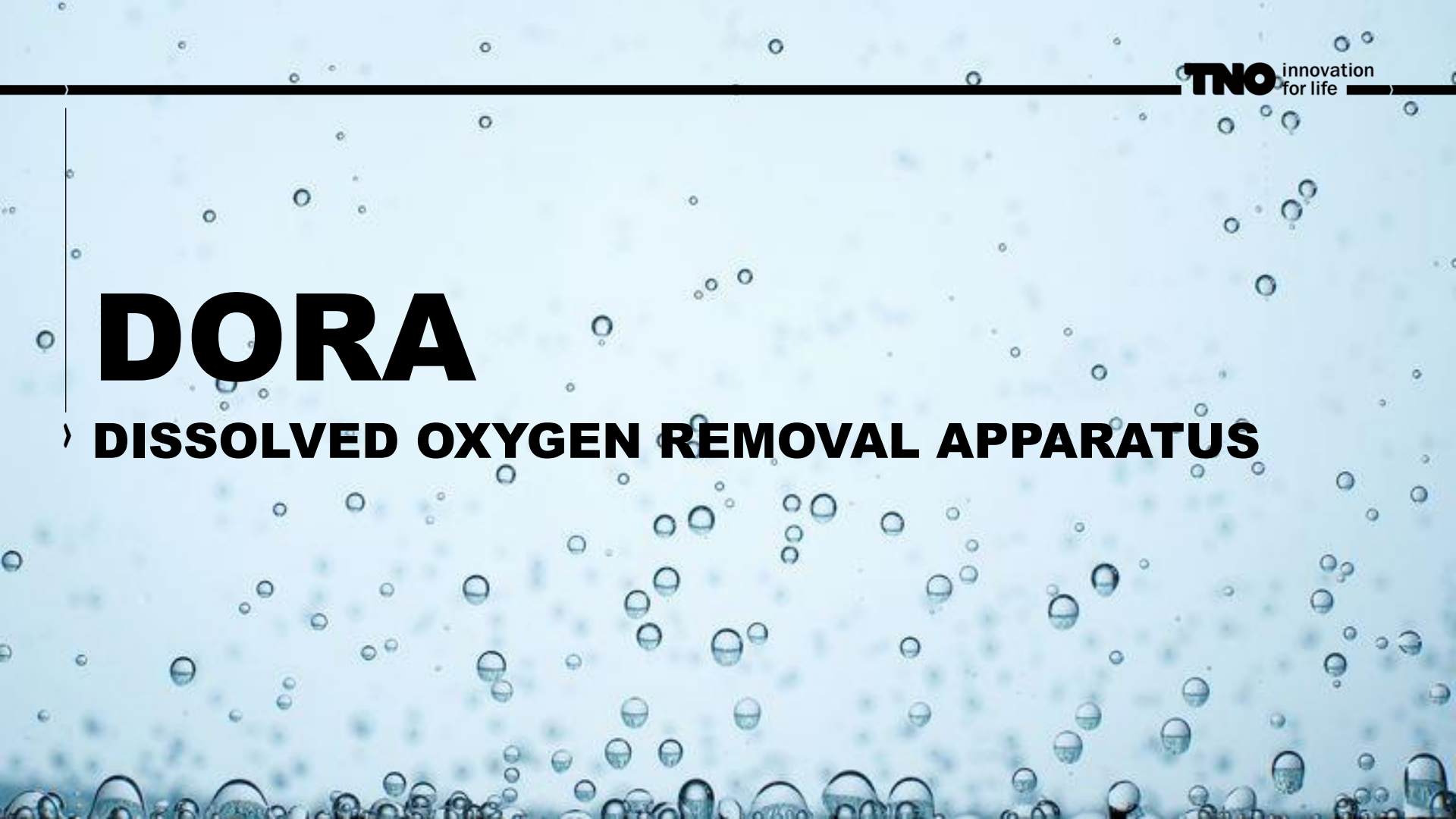






(a) EnBW's pilot campaign;
(b) TNO's pilot campaign;
(c) CSIRO's Loy Yang Campaign; and
(d) Esbjerg pilot campaign

S. Dhingra *et al.*, "Understanding and Modelling the Effect of Dissolved Metals on Solvent Degradation in Post Combustion CO2 Capture Based on Pilot Plant Experience," *Energies*, vol. 10, no. 5, p. 629, May 2017.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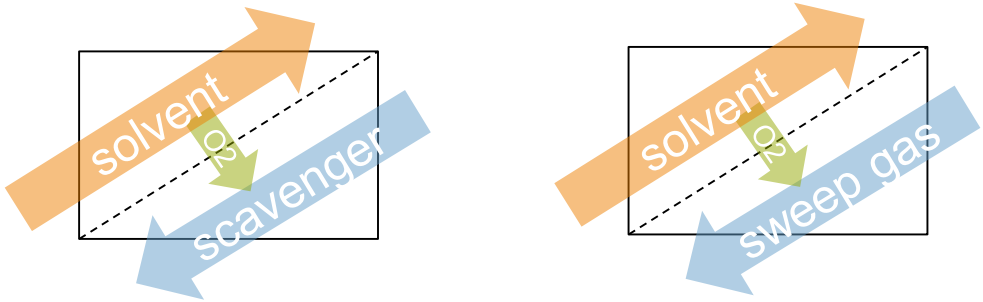
DORA
DISSOLVED OXYGEN REMOVAL APPARATUS

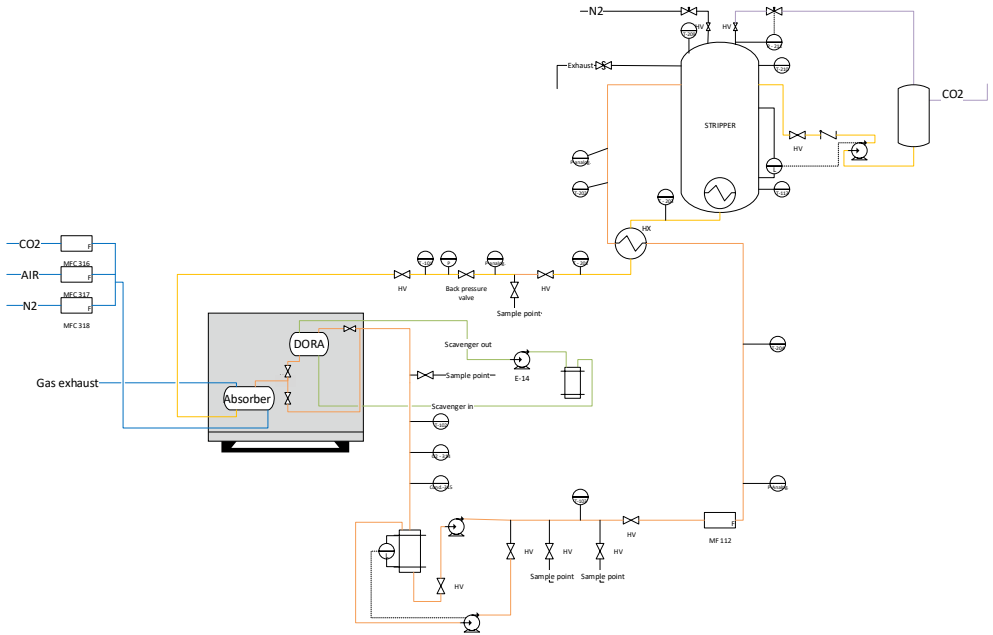
DORA CONCEPT

- Remove DO from the rich solvent, before the absorber sump

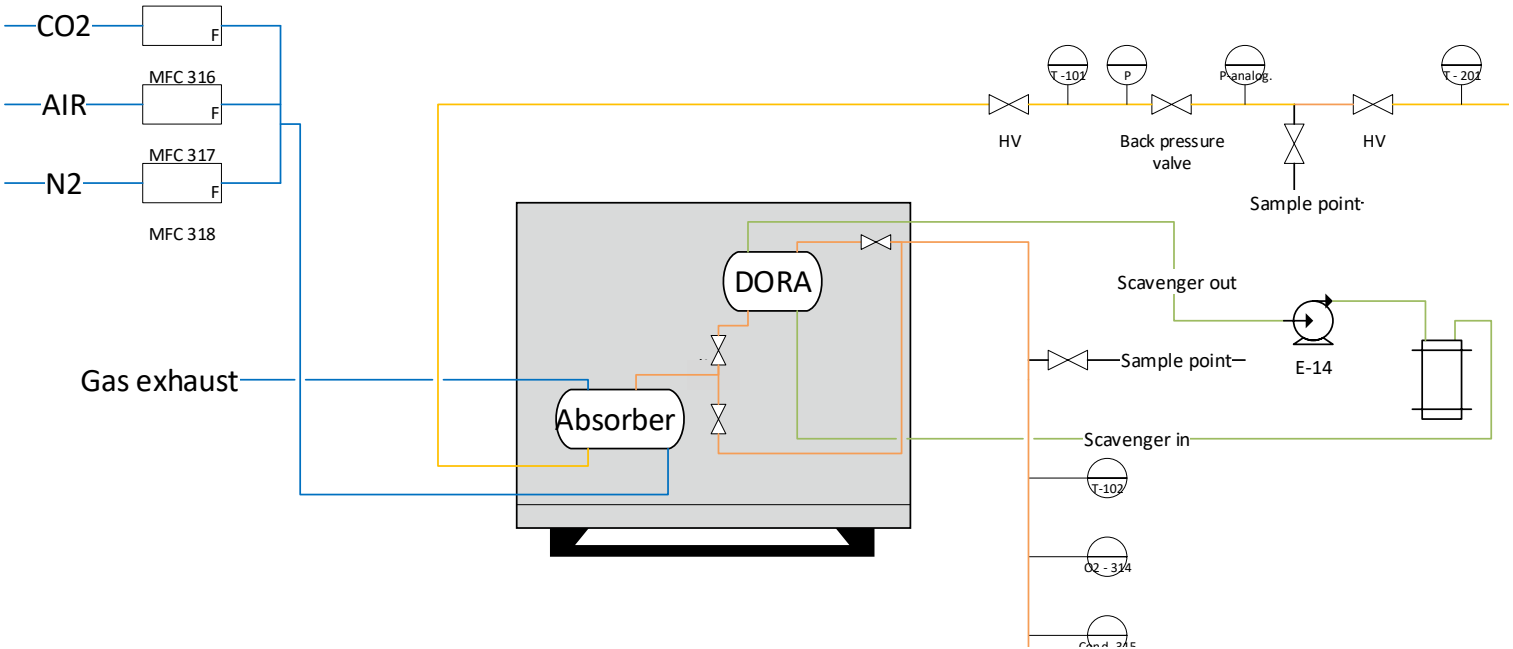


DORA LAB TESTS (TRL4)

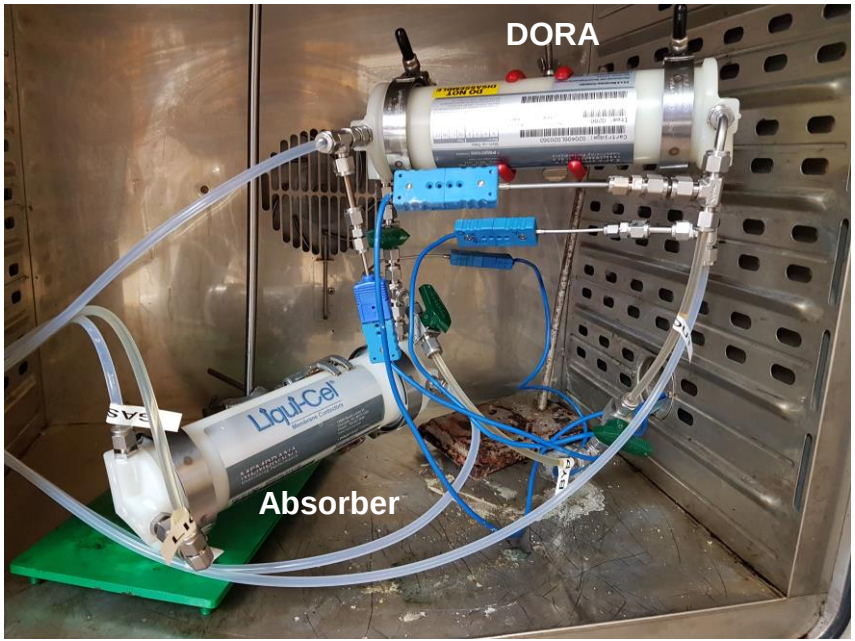
50g CO_2/h



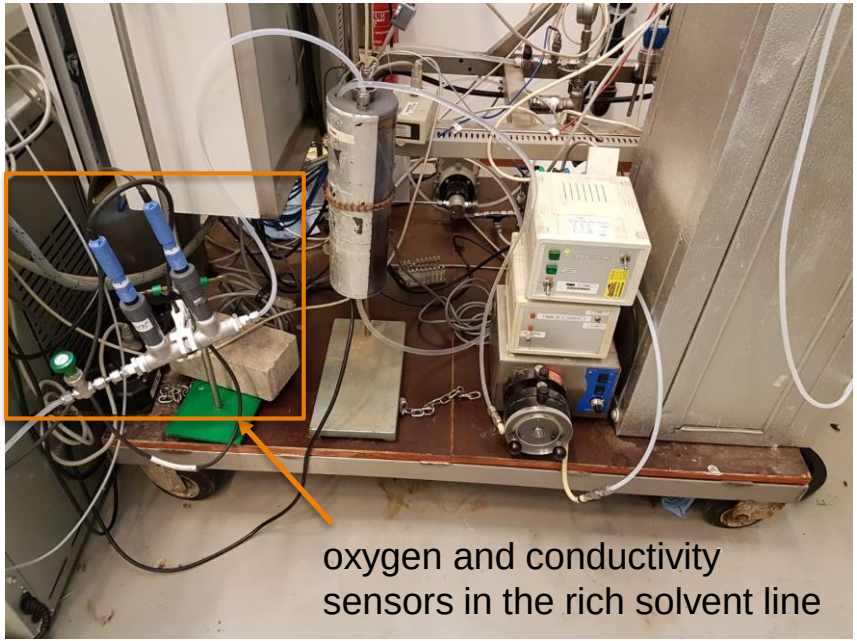
DORA LAB TESTS (TRL4)



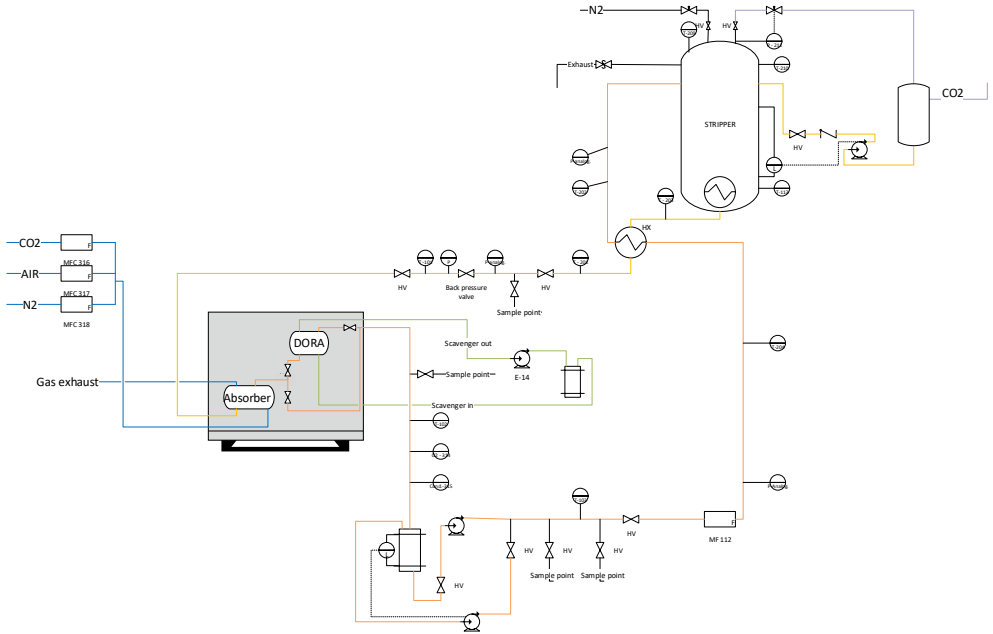
DETAIL OF THE DORA SYSTEM



DETAIL OF OXYGEN MEASUREMENT SYSTEM



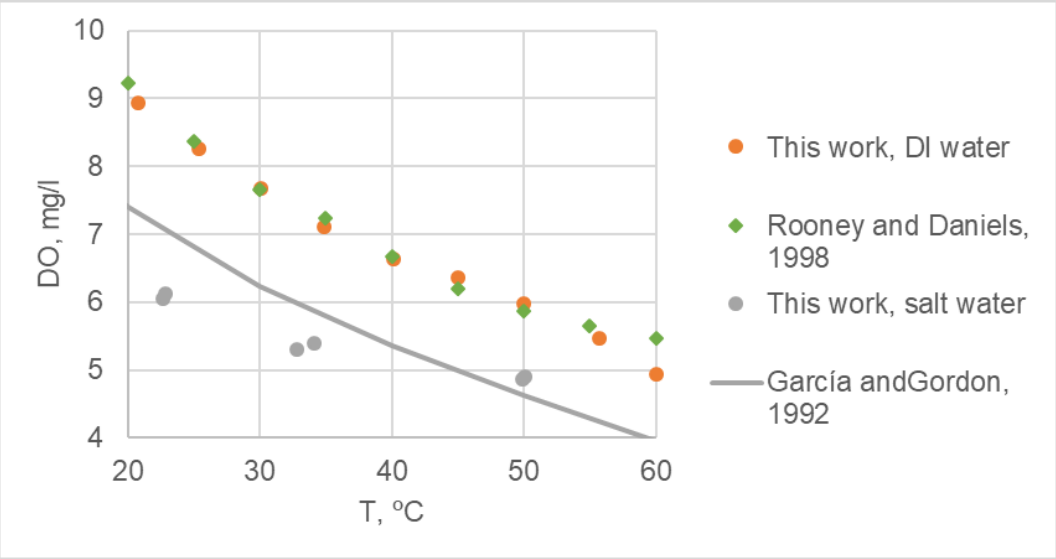
DORA LAB TESTS (TRL4)



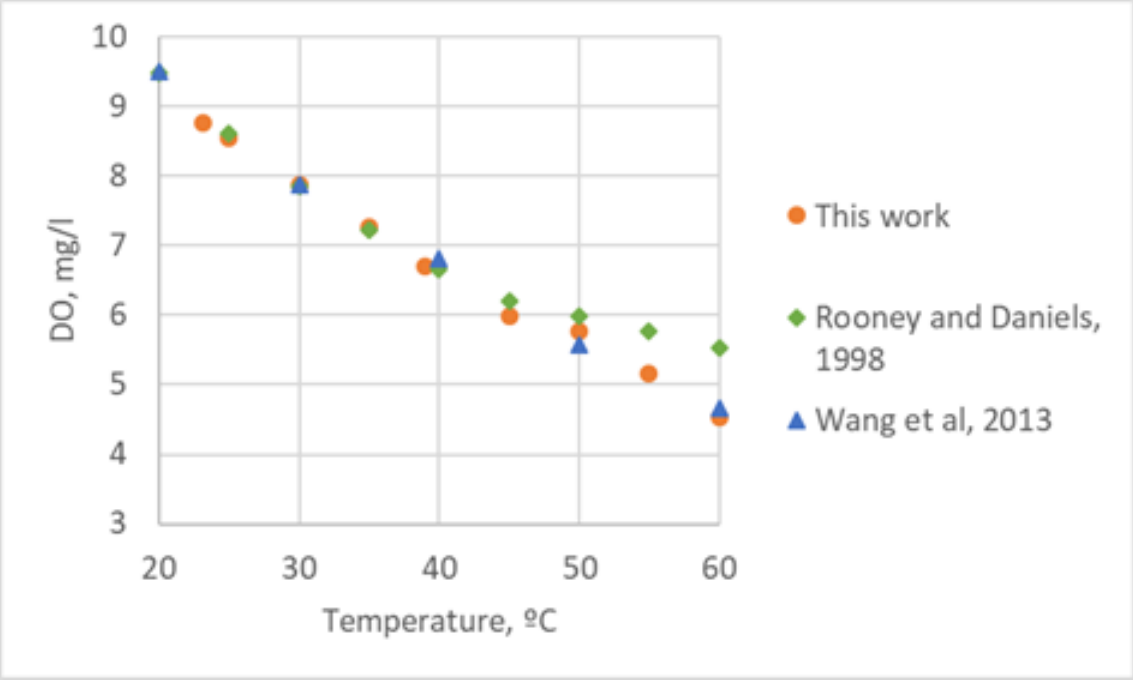

CAN WE MEASURE DO?

DO MEASUREMENTS – WATER

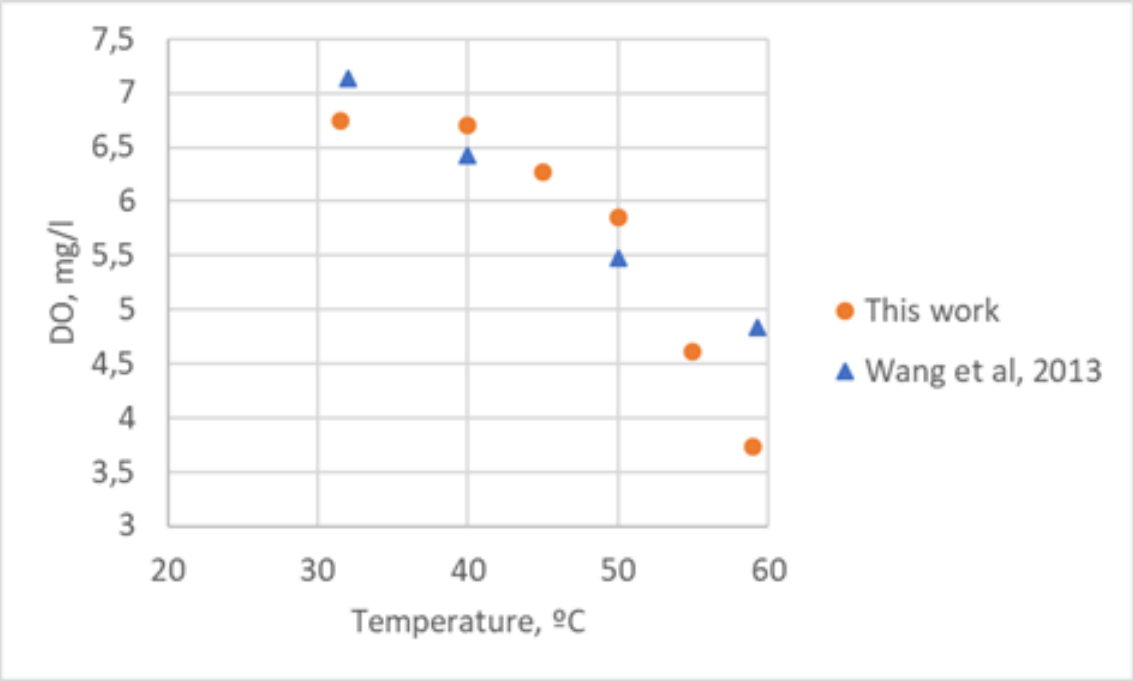
- de-ionized water and salt water S = 35 mg/kg



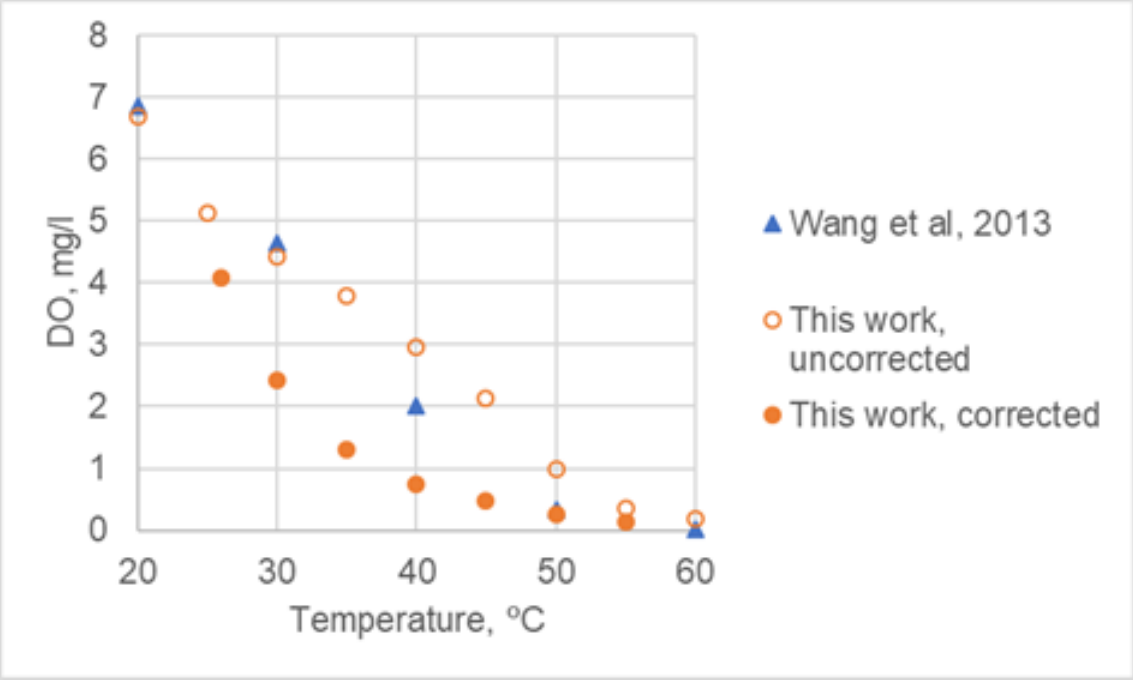
DO MEASUREMENTS – 20 WT% MEA



DO MEASUREMENTS – 50 WT% MEA



30% MEA, LOADING = 0,4 MOL/MOL

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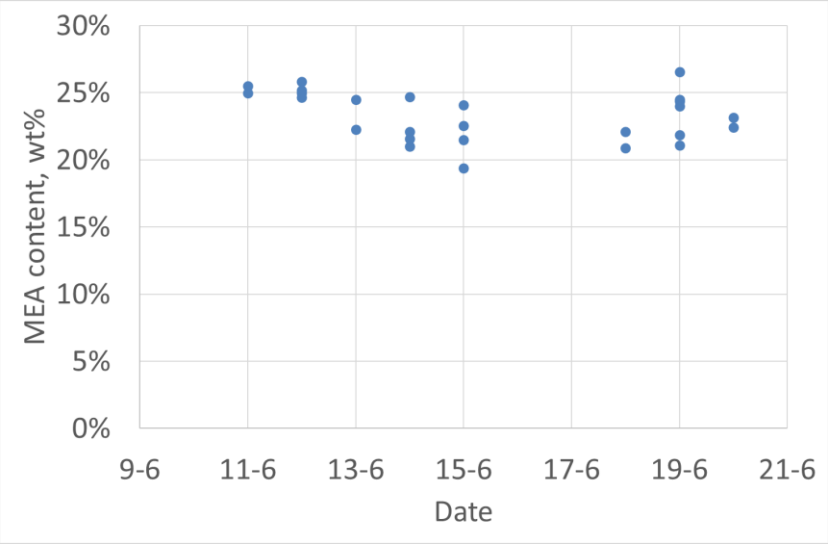
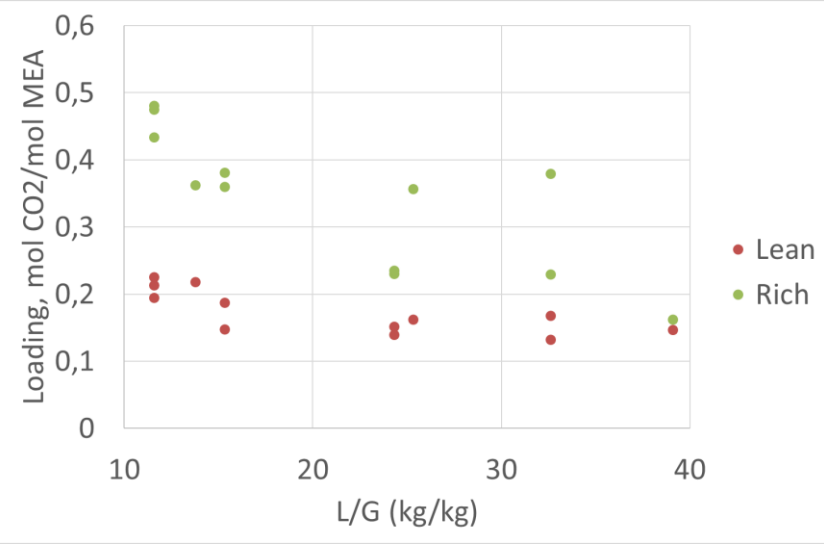
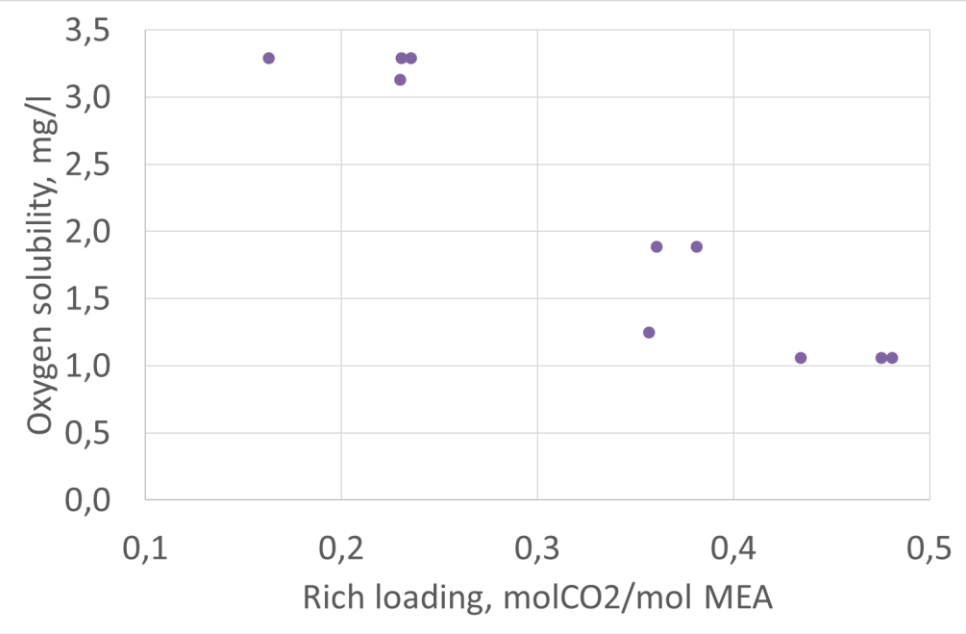
RESULTS

26 DATA POINTS

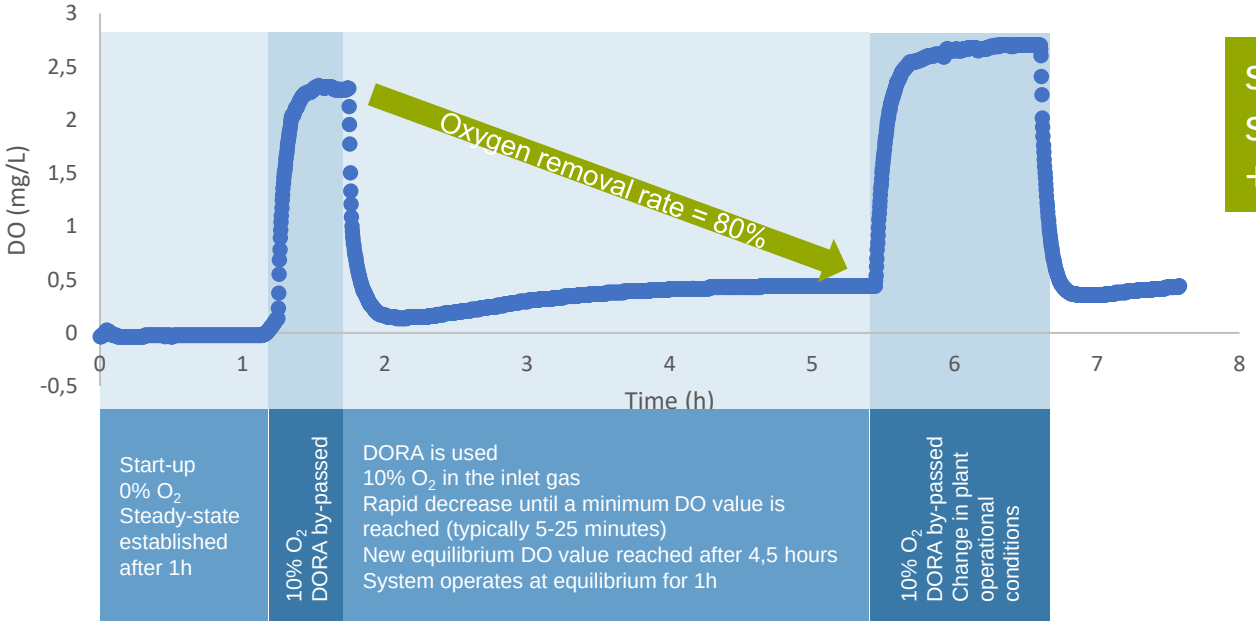




DISSOLVED OXYGEN

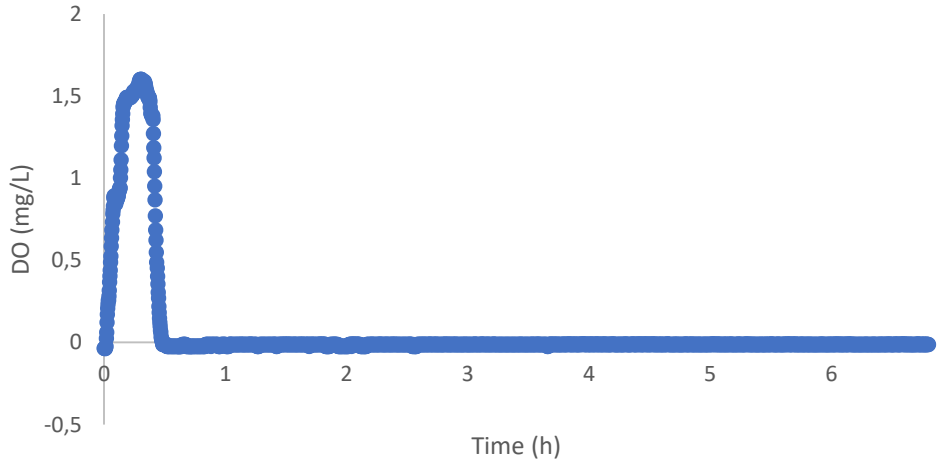


OXYGEN REMOVAL BY DORA: SCAVENGER MODE



scavenger: aqueous sodium sulphite solution + copper catalyst

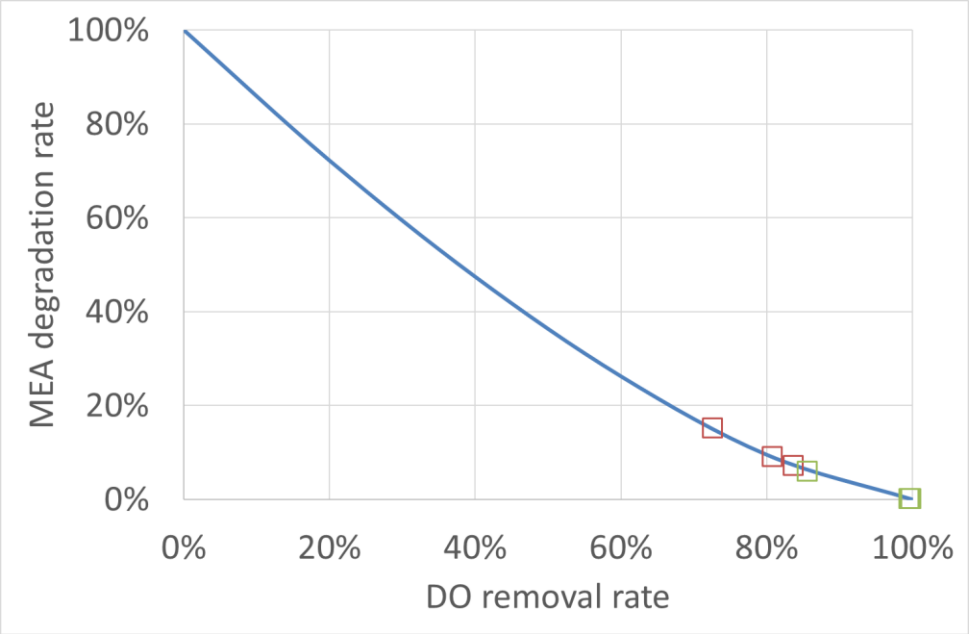
OXYGEN REMOVAL BY DORA: GAS SWEEPING MODE



Sweep gas: CO_2

Detection limit = 4 µg/l

MEA DEGRADATION RATE



$$-r_{MEA} \propto [O_2]^{1,46}$$

Leonard, G.; Toye, D.; Heyen, G. Expermiental study and kinetic model of monoethanolamine oxidative and thermal degradation for post combustion CO2 capture. Int. J. Greenh. Gas Control 2014, 30, 171–178.

CONCLUSIONS AND NEXT STEPS

CONCLUSIONS

- DO measurement in loaded solutions is challenging, but we seem to get the order of magnitude and trends right
- DORA was successfully operated at both scavenger and sweep gas modes at our lab microplant
- Oxygen removal rates obtained varied from 70% to 100%

NEXT STEPS

- Microplant campaigns (Nov-Dec 2018):
  - Testing membrane materials
  - Optimizing operational parameters (e.g., scavenger flow and composition)
  - Run with degraded solvent from RWE pilot plant

- Next step: Plant1 campaign (from Mar 2019) → TRL 6-7
  - 1500 m^3/h of flue gas, 250 kg/h CO_2
  - Realistic conditions, industrial flue gas
  - Monitor solvent degradation reduction

ACKNOWLEDGEMENTS

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THE PROBE

- Memosens COS81D from optode Endress+Hauser
- Oxygen-sensitive molecules (markers) integrated into an optically active layer (fluorescence layer)
- Temperatures range: 0 to 60ºC
- Pressure range: 0,02 to 13 bar
- DO range is from 4 µg/l to 30 mg/l