NTNU

Norwegian University of Science and Technology

The progress in solvent-based CO_2 capture in the last decade

Piloting and demonstration

Electricity and heat production

- Hard coal
- Biomass
- Lignite
- Natural gas

Synthetic gas / propane

Industrial

- Cement Kiln
- Steeel/Blast furnace
- Silicon production

Waste-to-Energy

Piloting and demonstration

- Measurement of process performance (SRD)
- Operability and long-term performance

International Journal of Greenhouse Gas Control
Volume 126, June 2023, 103894

Conclusions from 3 years of continuous capture plant operation without exchange of the AMP/PZ-based solvent at Niederaussem – insights into solvent degradation management

Peter Moser [a], Georg Wiechers [a], Roberta Veronezi Figueiredo [b], Eirini Sk
Juliana Garcia Moretz-Sohn Monteiro [b]

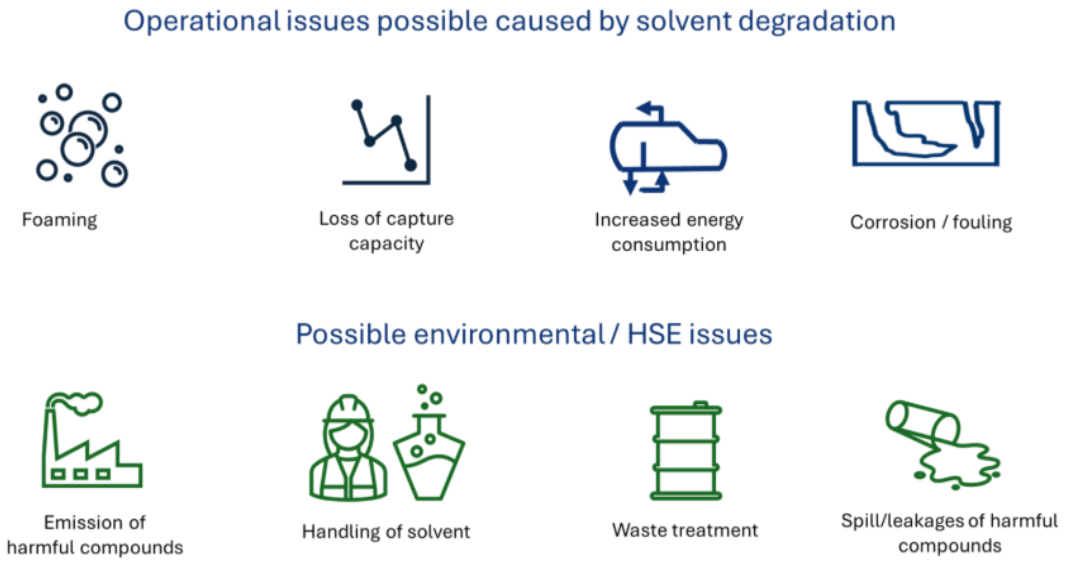
International Journal of Greenhouse Gas Control
Volume 95, April 2020, 102945

Results of the 18-month test with MEA at the post-combustion capture pilot plant at Niederaussem – new impetus to solvent management, emissions and dynamic behaviour

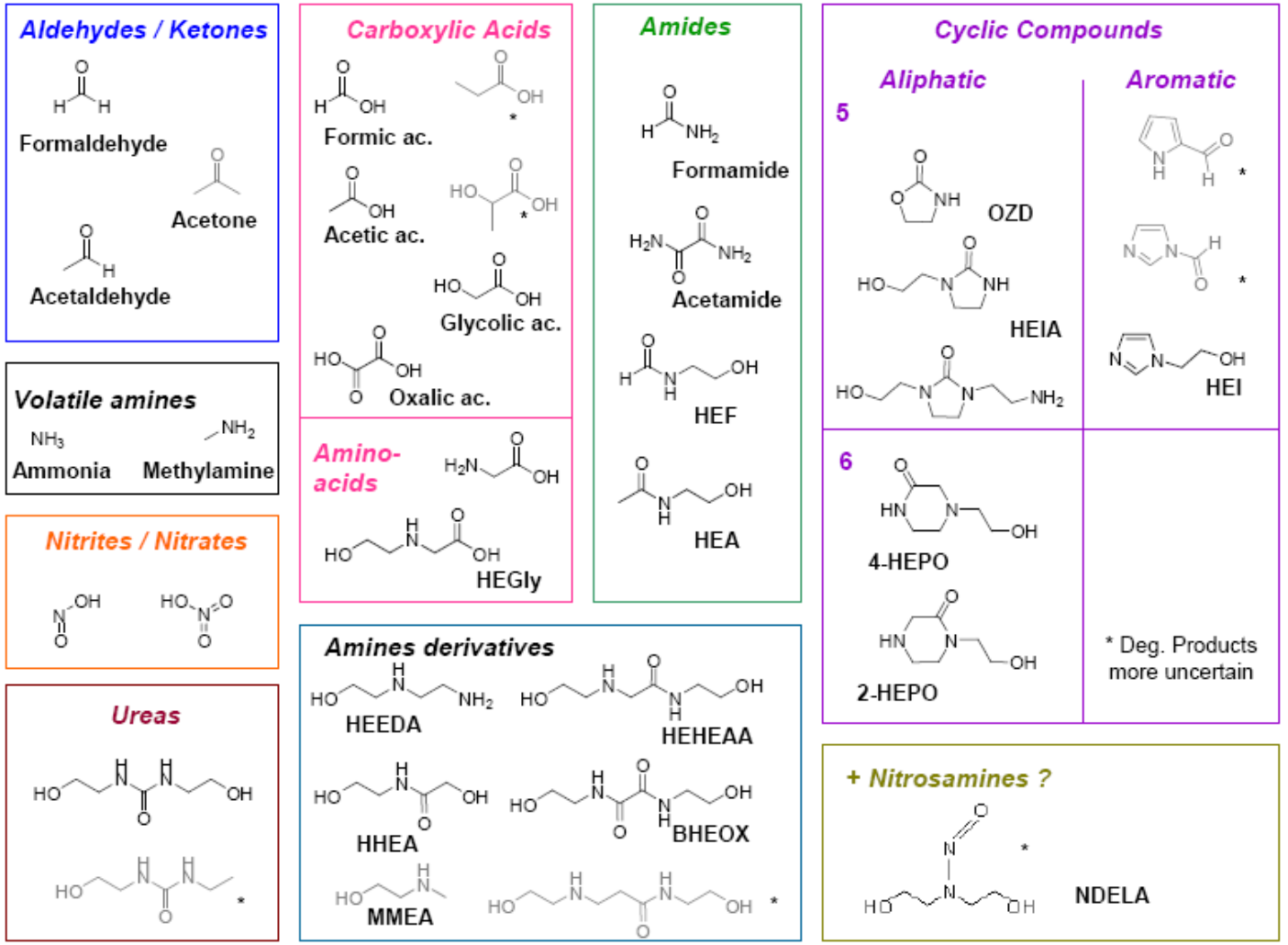
Peter Moser [a], Georg Wiechers [a], Sandra Schmidt [a], Juliana Garcia Moretz-Sohn Monteiro [b], Charithea Charalambous [c], Susana Garcia [c], Eva Sanchez Fernandez [c]

Piloting and demonstration

- Measurement of process performance (SRD)
- Operability and long-term performance
- Solvent management studies



Closing the nitrogen balance



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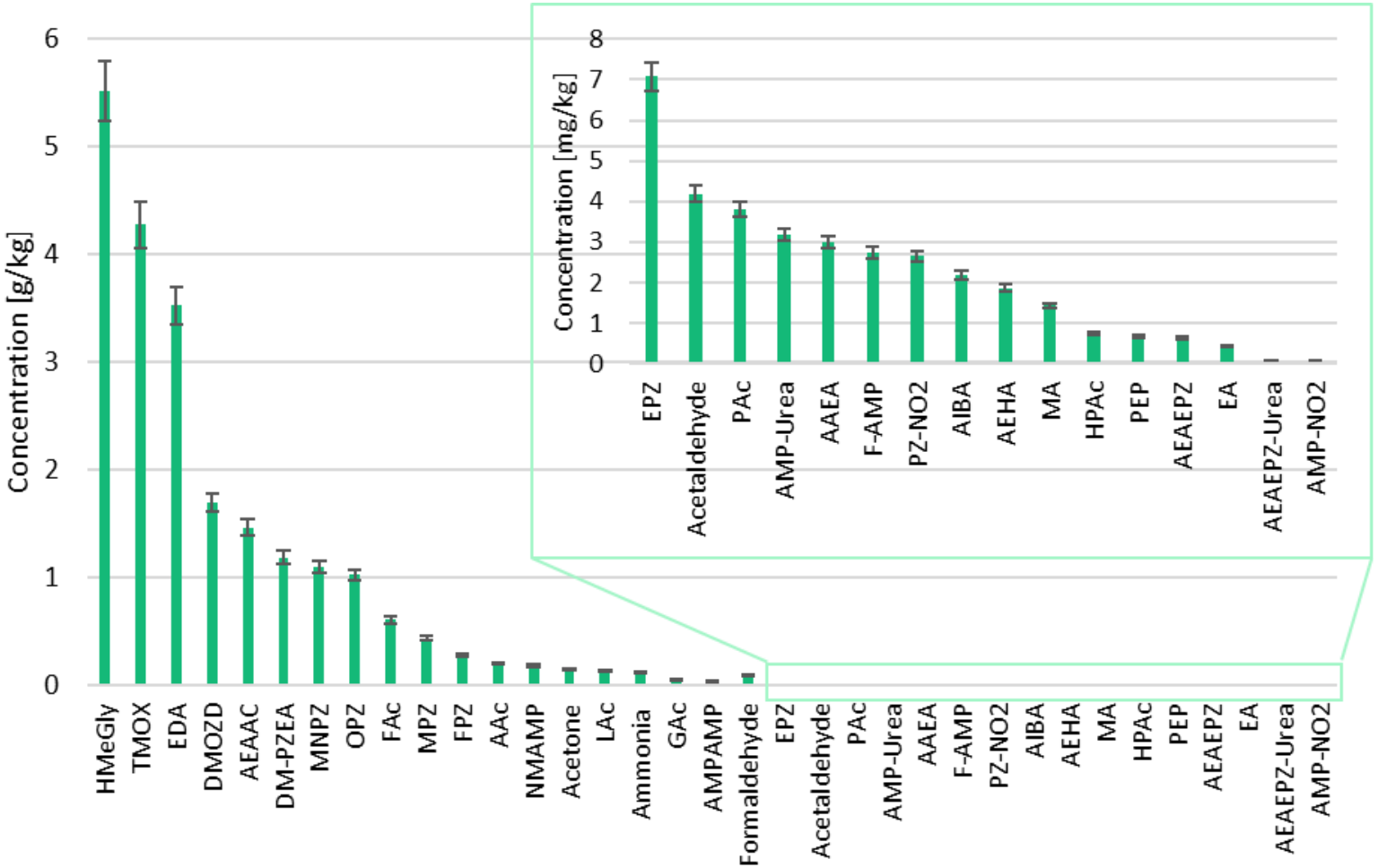
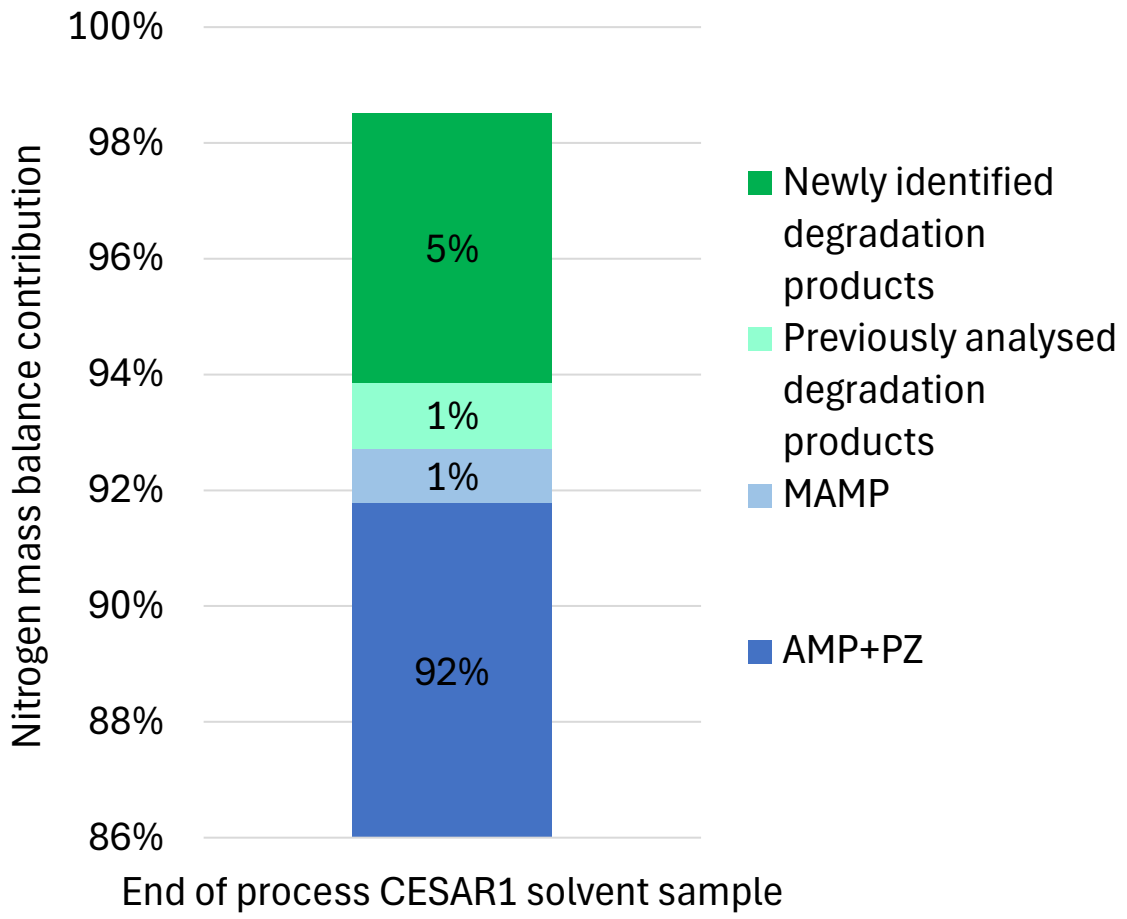


Buvik, et al. CESAR1 Solvent Degradation in Pilot and Laboratory Scale

Closing the nitrogen balance

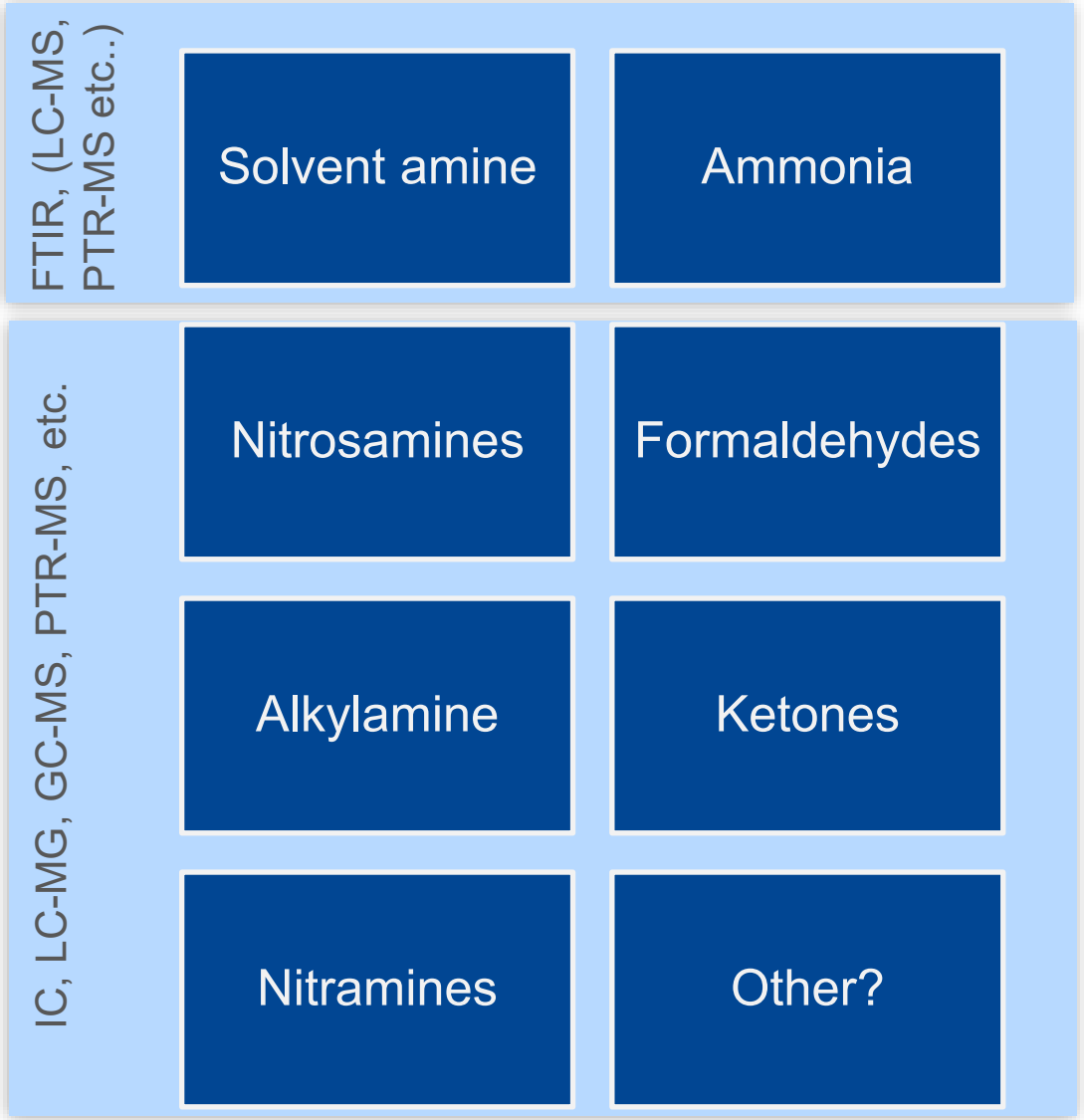


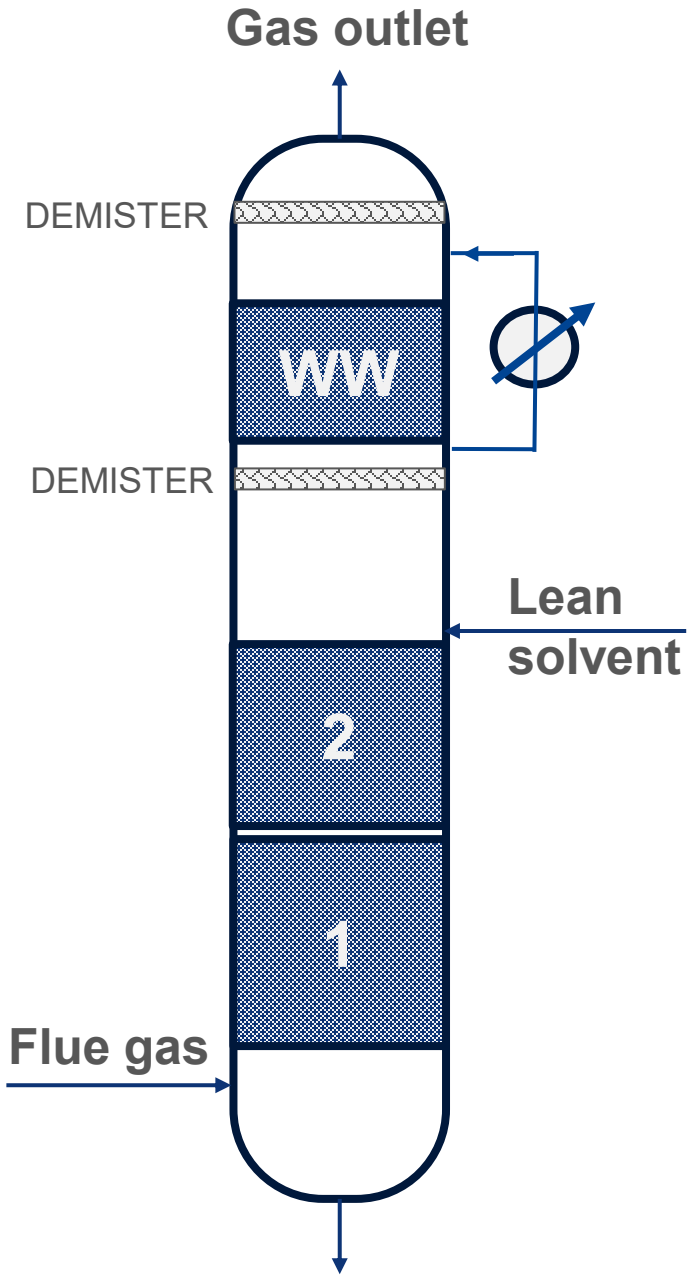
- Optimisation of operational conditions
- Flue gas pretreatment
- Solvent reclamation
- Online monitoring of solvent degradation

Buvik, et al. CESAR1 Solvent Degradation in Pilot and Laboratory Scale

Piloting and demonstration

- Measurement of process performance (SRD)
- Operability and long-term performance
- Solvent management studies
- Design of emission mitigation technologies



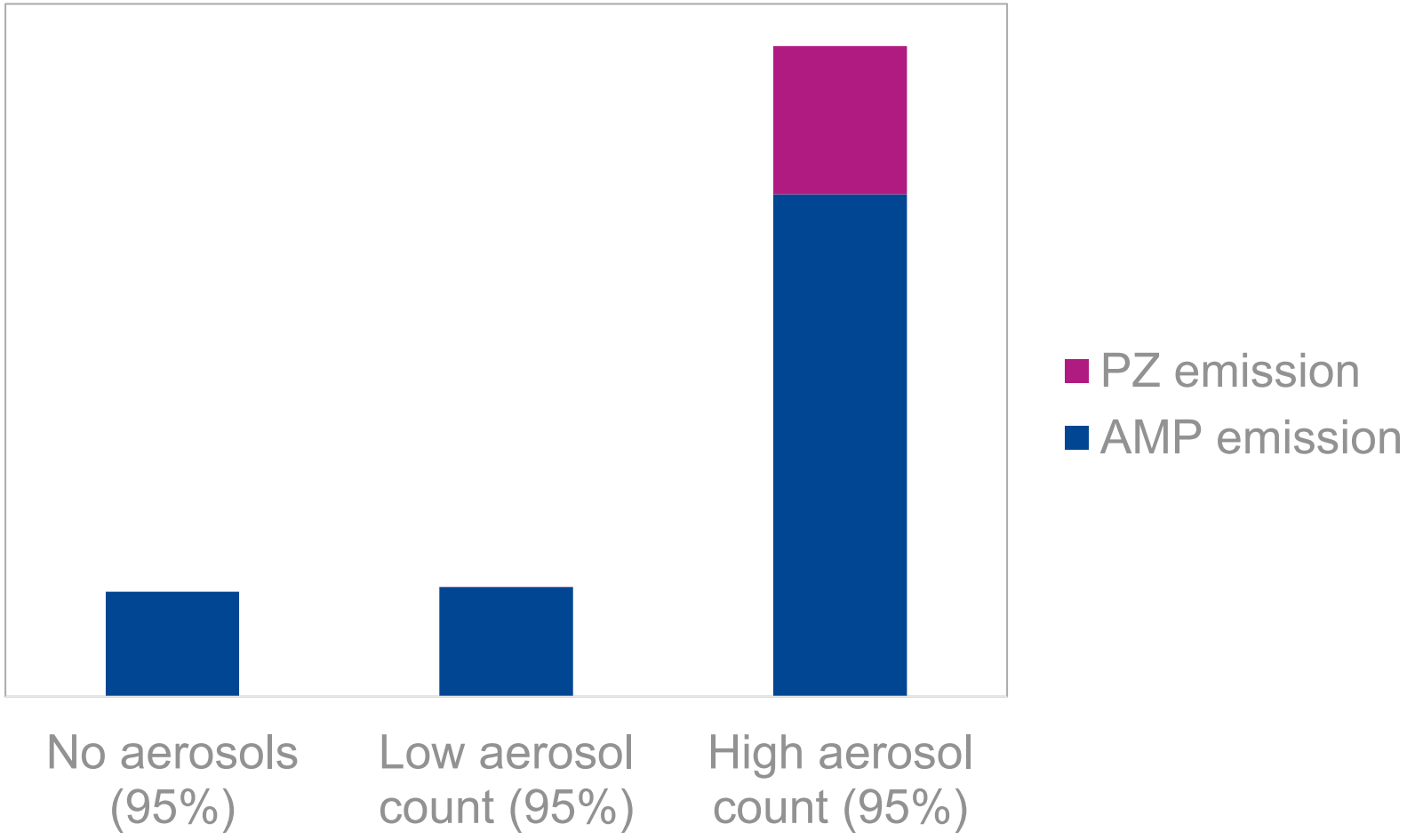


Emissions

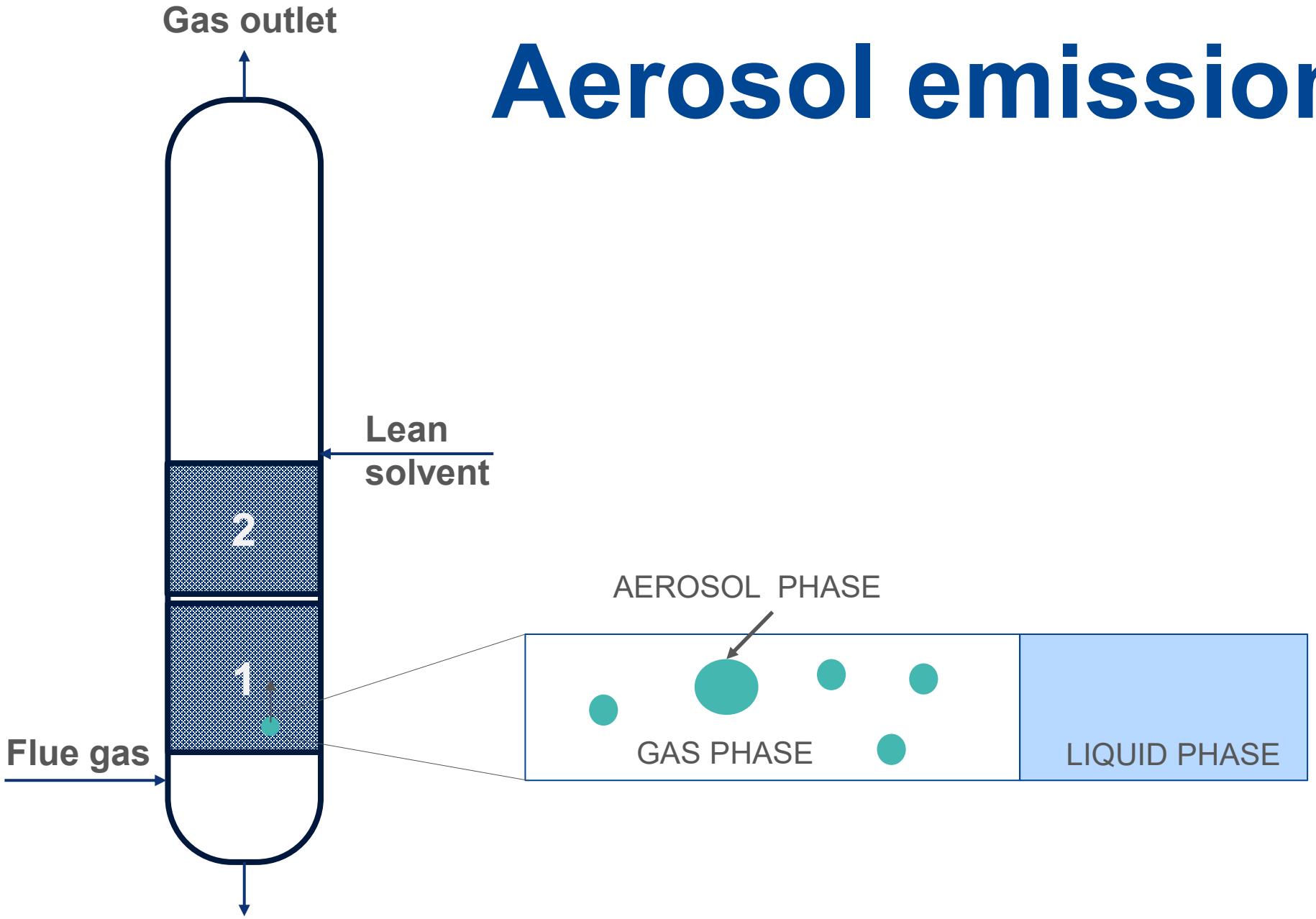
Emissions = Volatile + Aerosol + Entrainment

- Solvent amines
- Degradation compounds like ammonia, aldehydes, etc.

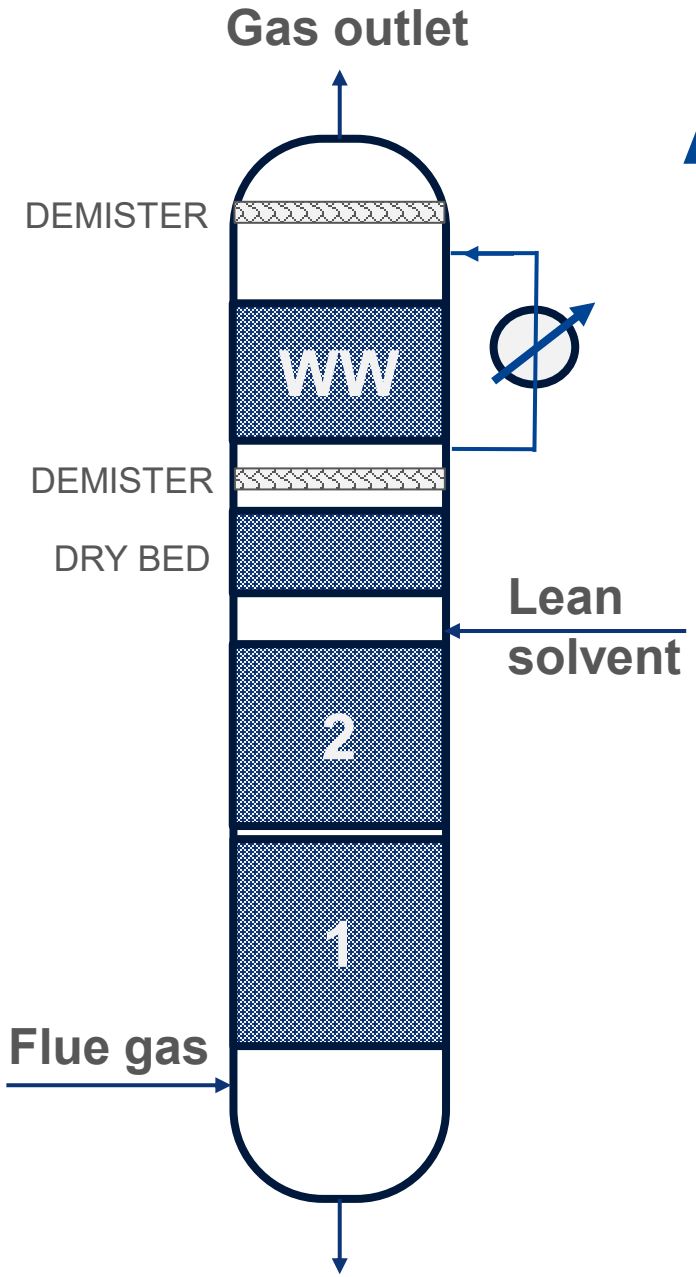
Volatile / aerosol emissions

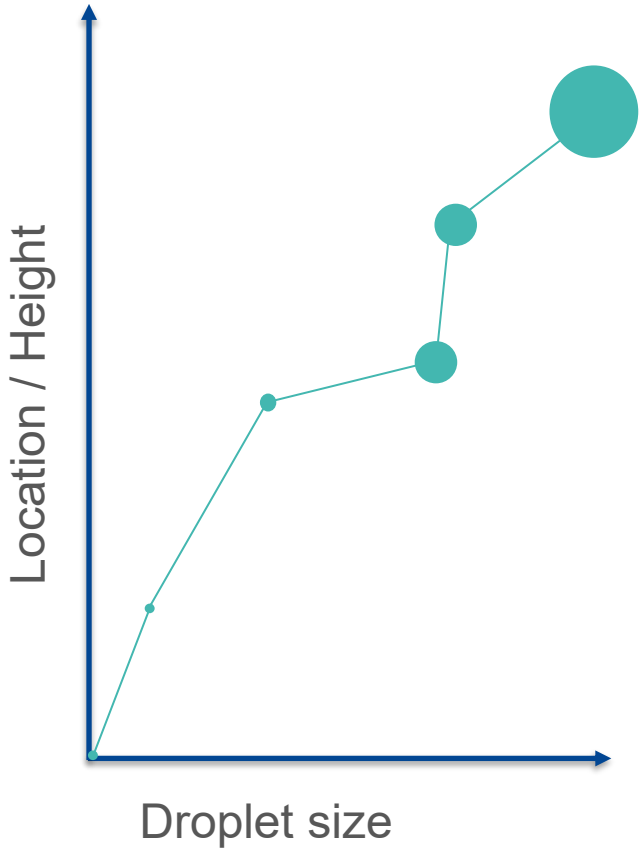


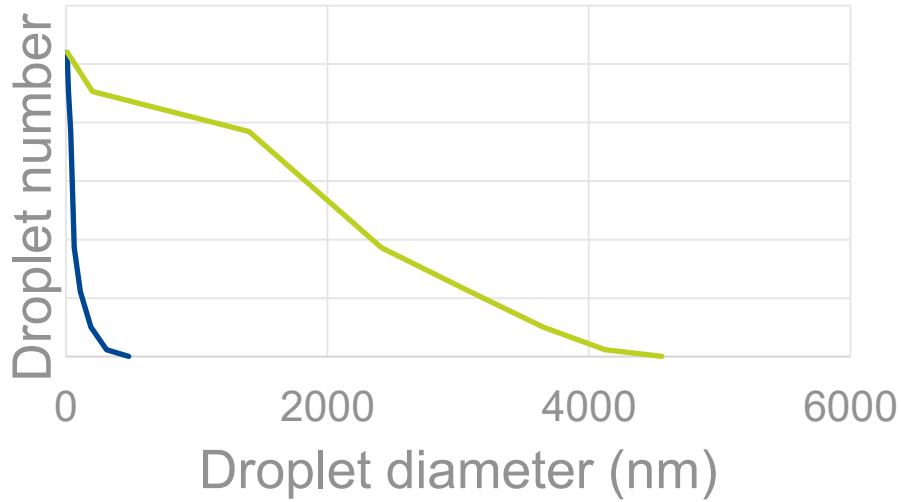
Aerosol emissions



Aerosol emissions

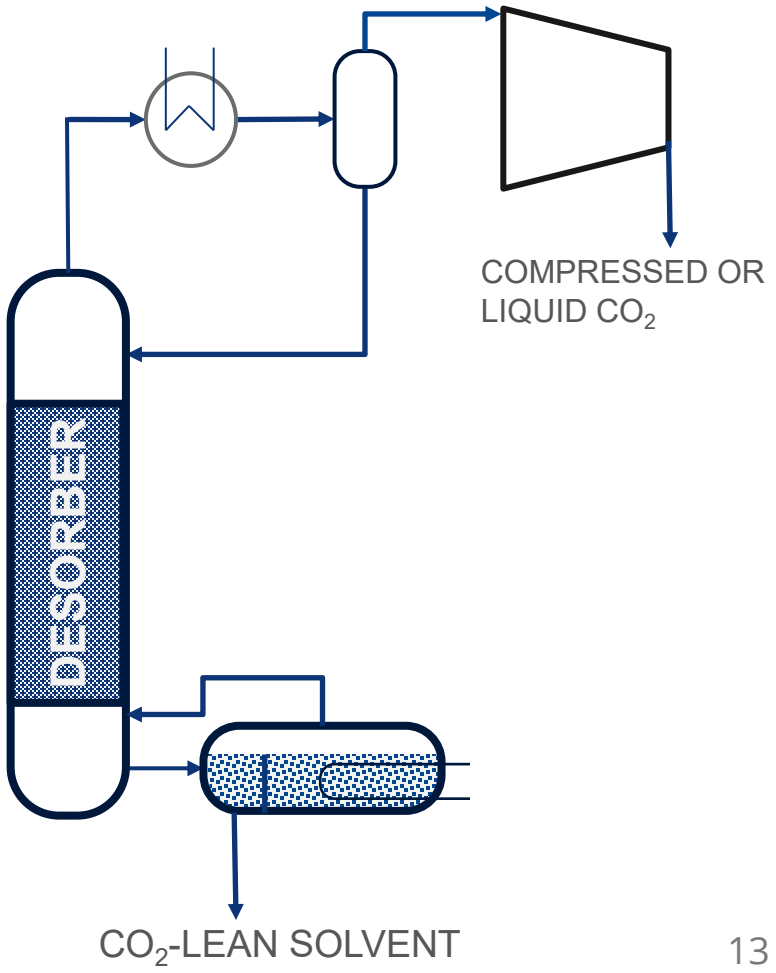






CO_2 purity

- Amines
- Volatile degradation compounds
- Oxygen/Nitrogen
- NOx?



CO_2 purity

- Amines
- Volatile degradation compounds
- Oxygen
- NOx?

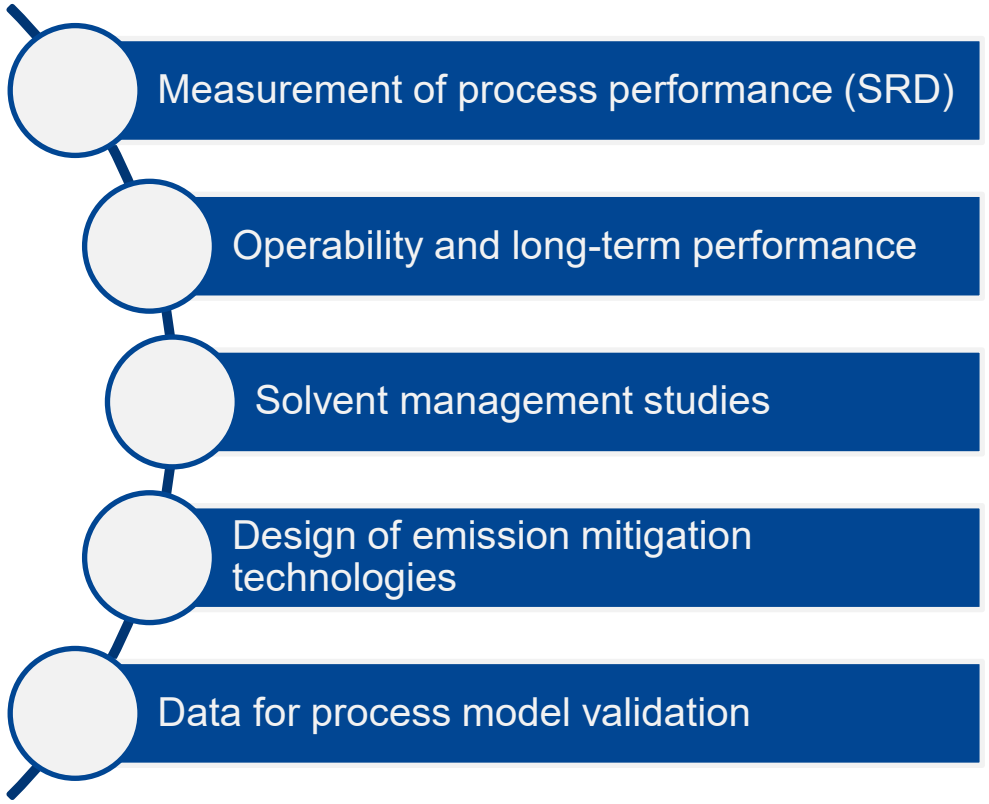
- Online measurements

Table 3. Range and average value measured components sample type 2

Component measured	Range (ppm)	Average (ppm)	Component reference	Limit (ppm)
Sum BTX	0	0	Aromatic hydrocarbon	0.02
Sum CH	0-1.5	0.78	Total volatile hydrocarbons (calc as CH_4)	50
Sum non-methane CH	0.2-1	0.5	Non-volatile organic residue (oil, grease)	5
Acetaldehyde (C_2H_4O)	0-0.03	0.006	Acetaldehyde	0.2
Ammonia (NH_3)	0.02-0.04	0.03	Ammonia	2.5
Benzene (C_6H_6)	0	0	Aromatic hydrocarbon	0.02
Carbon monoxide (CO)	0-0.2	0.1	Carbon monoxide	10
Carbonylsulfide (COS)	0	0	Total Sulfur	0.1
Dimethylether (C_2H_6O_DIM)	0-0.05	0.003	Total volatile hydrocarbons	50
Ethane (C_2H_6)	0.1-0.4	0.18	Total volatile hydrocarbons	50
Ethanol (C_2H_6O_ETH)	0-0.2	0.049	Total volatile hydrocarbons	50
Hydrogensulfide (H_2S)	0.005-0.015	0.011	Total Sulfur	0.1
Methane (CH_4)	0-0.5	0.25	Total volatile hydrocarbons (calc as CH_4)	50
Methanol (CH_3OH)	0-0.3	0.05	Methanol	10
Moisture (H_2O)	0.1-1	0.46	Moisture	20
Nitrogendioxide (NO_2)	0.2-0.8	0.45	Oxides of nitrogen (NO/NO_2)	2.5
Nitrogemonoxide (NO)	0-0.01	0	Oxides of nitrogen (NO/NO_2)	2.5
Oxygen (O_2)	0-30	5.4	Oxygen	30
Propane (C_3H_8)	0-0.08	0.02	Total volatile hydrocarbons (calc as CH_4)	50
Sulfurdioxide (SO_2)	0-0.01	0.0015	Total sulfur (as S)	0.1
Toluene (C_7H_8)	0-0.004	0.00016	Aromatic hydrocarbon	0.02
Total Sulfur (TSC)	0-0,002	2,76E-05	Total sulfur (as S)	0.1
Xylene (C_8H_{10})	0-0,002	0,00013	Aromatic hydrocarbon	0.02

New Public Report on CO2 Purity Released — SCOPE

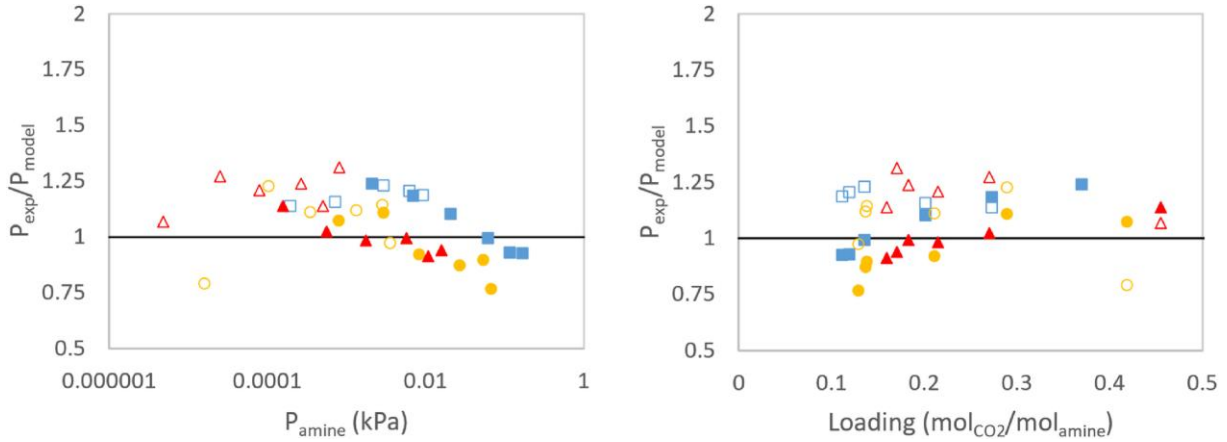
Modelling and simulations



- Rate-based models are the standard
- Models predicting the behaviour of aerosol growth and emissions
- Models describing solvent degradation as part of the process simulations

Experimental solvent characterization

- The heat of absorption of CO_2
- Reaction kinetics and solvent viscosity
- CO_2 vapor-liquid equilibrium data
- Volatility experiments



Left: *Difference between experimental and predicted AMP/PZ partial pressure as a function of the experimental partial pressure;* ***Right:*** *Difference between experimental and predicted AMP/PZ partial pressure as a function of loading.*

François, M., et al. CO_2 solubility and amine volatility data for low-concentration solutions of MEA, AMP, PZ and CESAR-1 blend (AMP/PZ), Results in Engineering, Volume 22, 2024, 102163, https://doi.org/10.1016/j.rineng.2024.102163.

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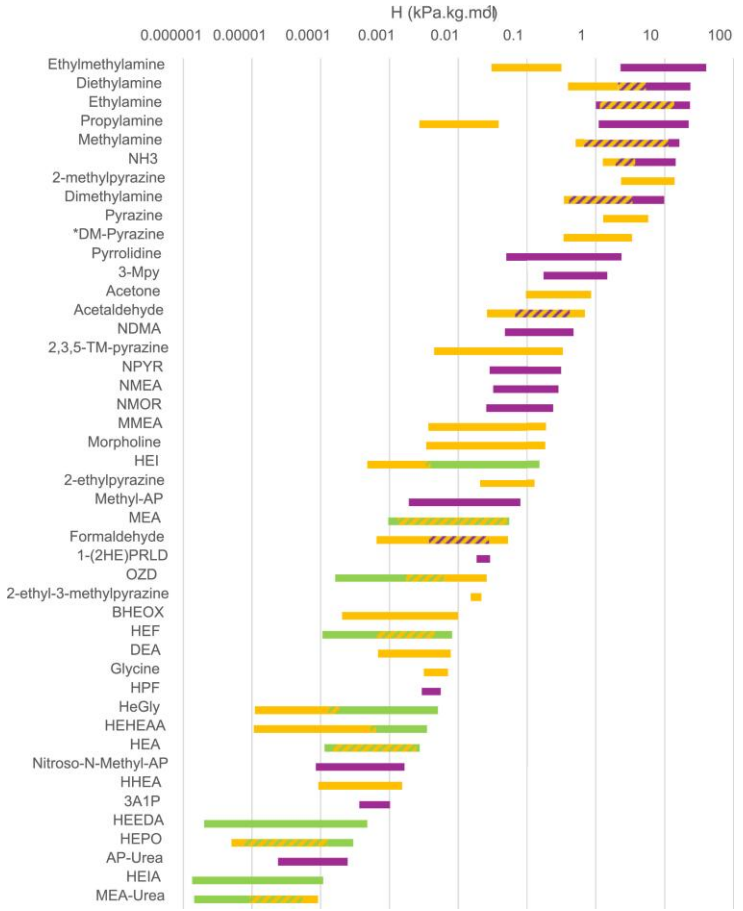

Maxime H.J.-J. François, Vanja Buvik, Kai Vernstad, Hanna K. Knuutila,Assessment of the volatility of amine degradation compounds in aqueous MEA and blend of 1-(2HE)PRLD and 3A1P,Carbon Capture Science & Technology,Volume 13,2024, https://doi.org/10.1016/j.ccst.2024.100326.

Concluding remarks

- High quality pilot data
- Testing of new emission and degradation mitigation technologies
- Studies focusing on CO_2 purity
- High quality laboratory data to support model development and to create fundamental understanding
- Analytical and online monitoring methods to identify and monitor degradation compounds
- Development of new solvents

THANK YOU!