



Solvent aging-effect on emissions of CESAR1 and performance of emission mitigation technologies after 500 h and 32,000 h operation

Peter Moser, Georg Wiechers, RWE Power AG

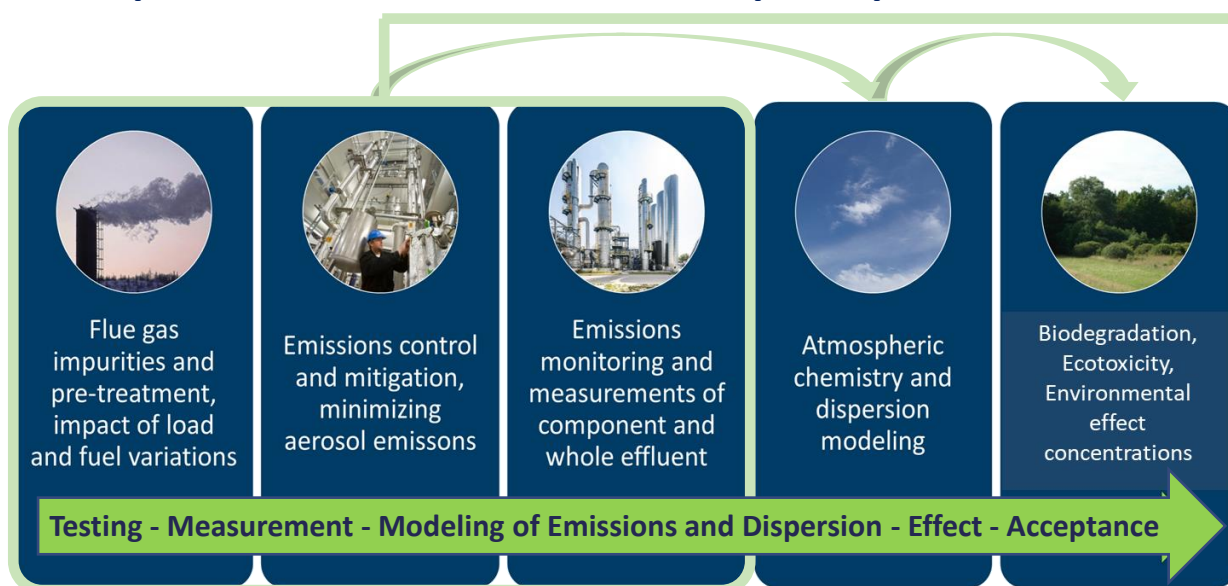
Susana Garcia, Laura Herraiz-Palomino, Heriot-Watt University

Hallvard F. Svendsen, Maxime Francois, Hanna K. Knuutila, NTNU Kjemisk Prosessteknologi

Juliana Garcia Moretz-Sohn Monteiro, Eirini Skylogianni, TNO

SCOPE – Sustainable OPERATION of post-combustion Capture plants

Follow the continuous path of the treated gas from source to recipient and ensure a sustainable and environmentally safe operation of the amine-based capture plant



Demonstration and holistic analysis of emission management technologies at capture pilot plants

- Validated models to predict volatile and aerosol-based emissions
- Reliable process and operational data, operational and maintenance costs from tests at 6 industrial sites for the assessment of the performance of emission mitigation technologies
- Dependence of emissions on solvents, solvent aging, flue gas properties, plant operation, and capture rate

 Hengelo



 Niederaussem



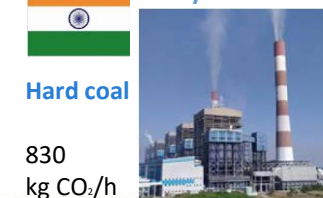
 Tiller CO₂ Lab



 Alkmaar



 Vindhyachal



 Tuticorin



Test of emission mitigation technologies for CESAR1 at Niederaussem

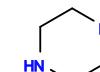


- Flue gas source: 1,000 MW **lignite**-fired power plant
- Operation mode: **24/7**, 300 kg_{CO2}/h@90% capture rate, 120-130°C/1.75-2.4 bar(a)
- Solvent: **CESAR1**, aqueous blend of 3.0 M AMP and 1.5 M PZ
- Test campaigns with more than **20 configurations of emission mitigation technologies**: water wash, double water wash, acid wash, dry bed (OASE aerozone®), pretreatment.
- Wet ESP (WESP) is used to increase the particle number concentration in the feed gas by a factor of 100.



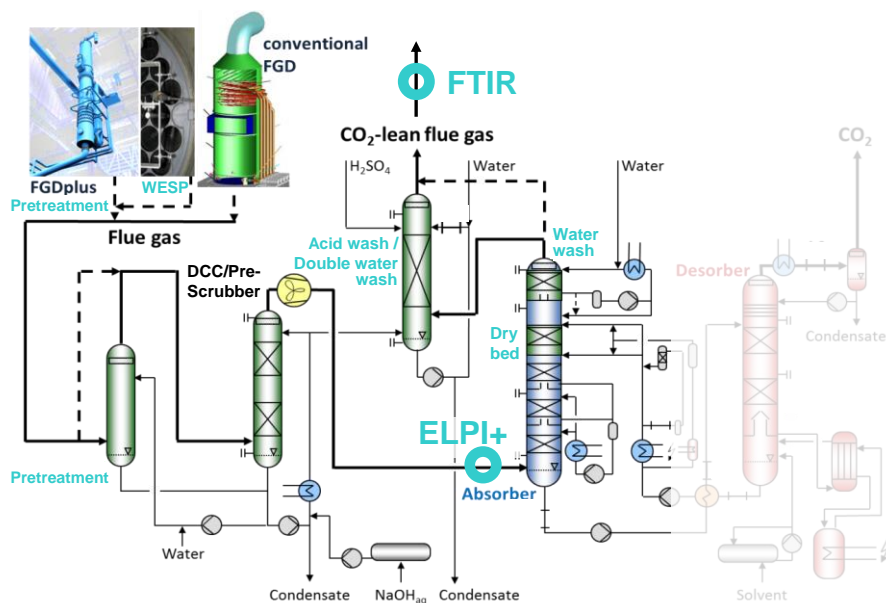
AMP:

2-amino-2-methylpropan-1-ol

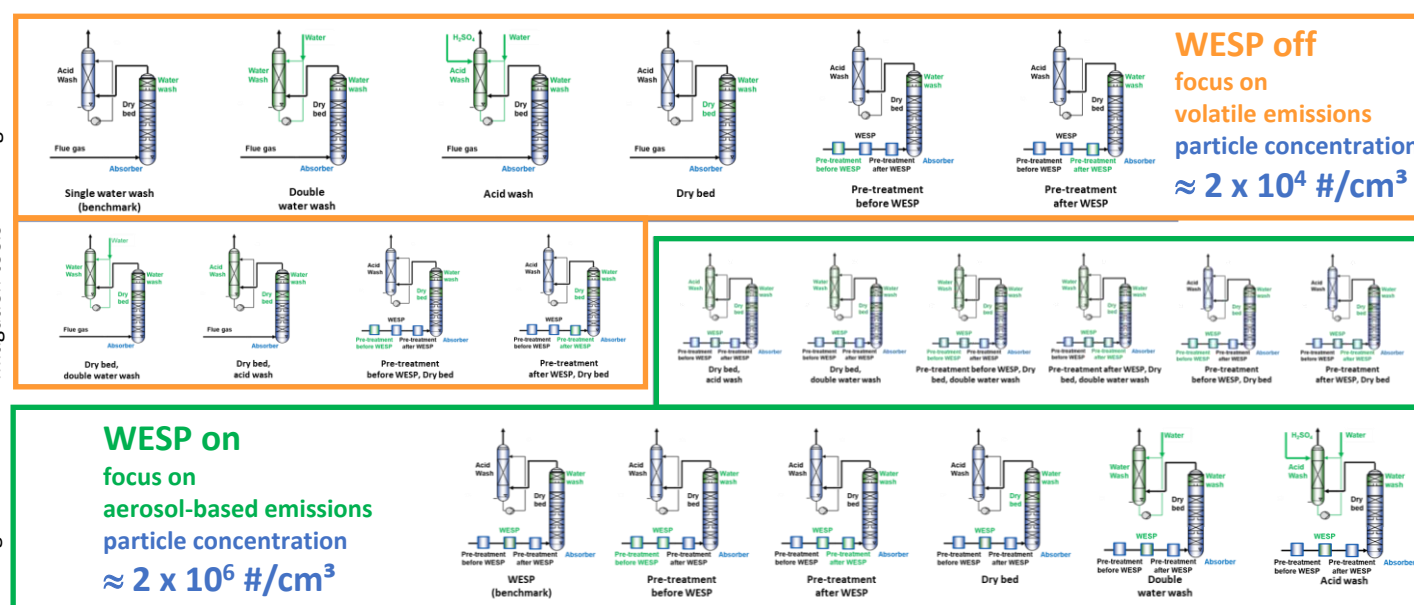


PZ:

piperazine



Individual emission mitigation tools

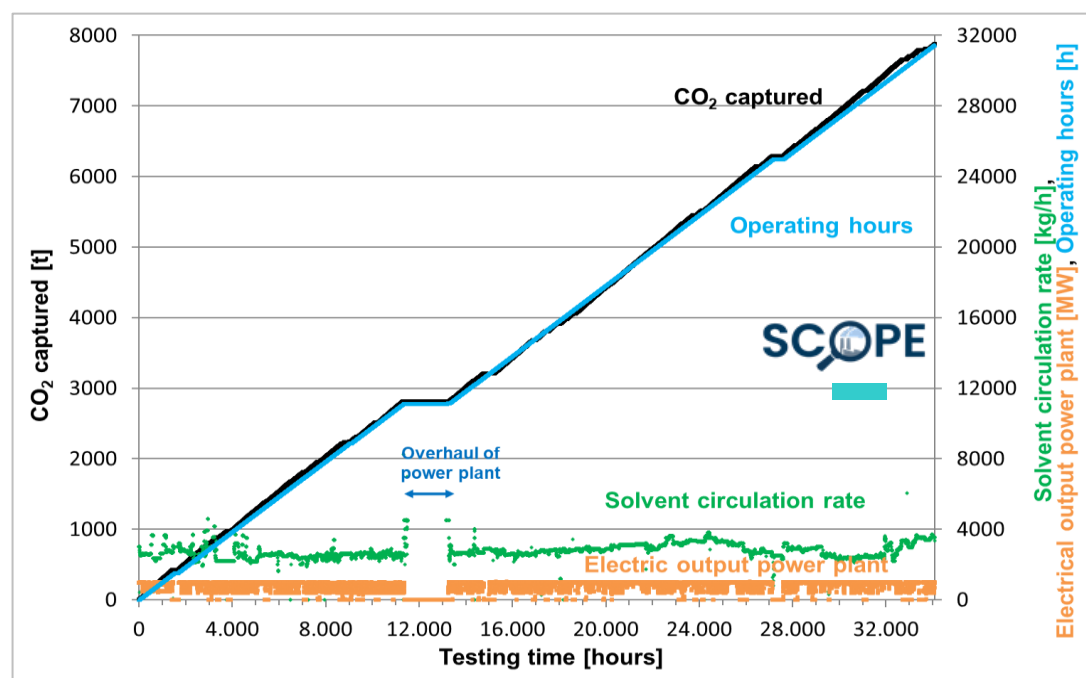


WESP off
focus on
volatile emissions
particle concentration
 $\approx 2 \times 10^4 \text{ \#/cm}^3$

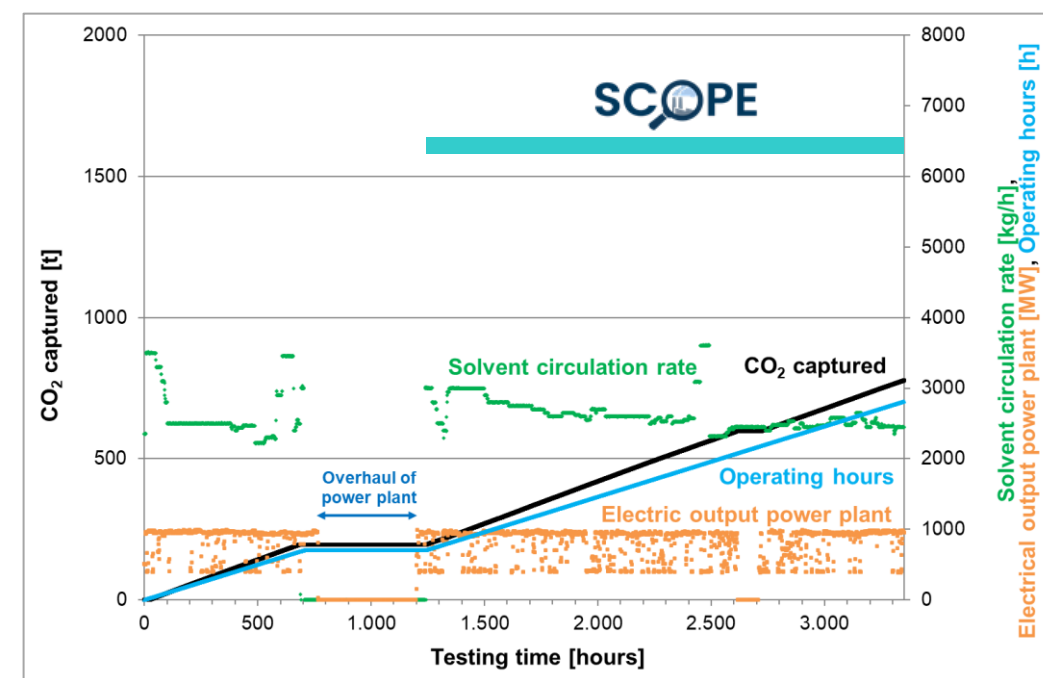
WESP on
focus on
aerosol-based emissions
particle concentration
 $\approx 2 \times 10^6 \text{ \#/cm}^3$

Aging of CESAR1 – 24/7 operation and longtime testing

1. campaign: >29,800 hours (1,242 days) very aged



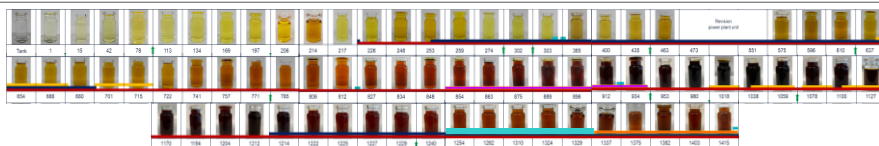
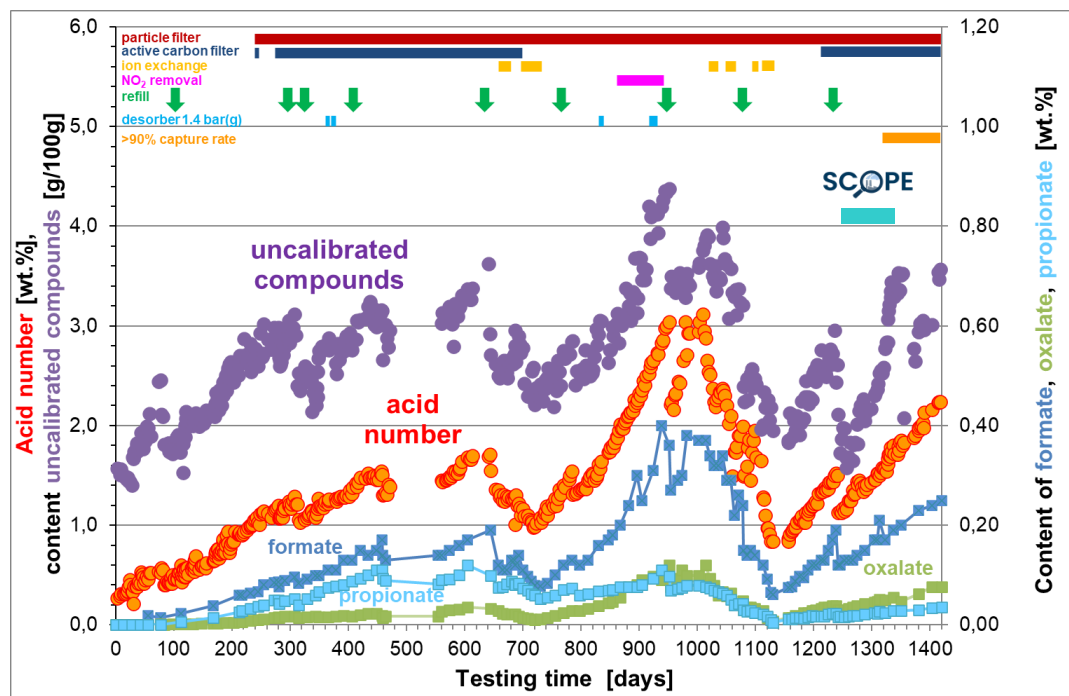
2. campaign: >1,350 hours (56 days) fresh



Aging of CESAR1 – acid number and uncalibrated compounds differed by a factor of 3 in the two campaigns on emission mitigation

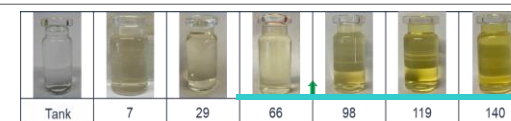
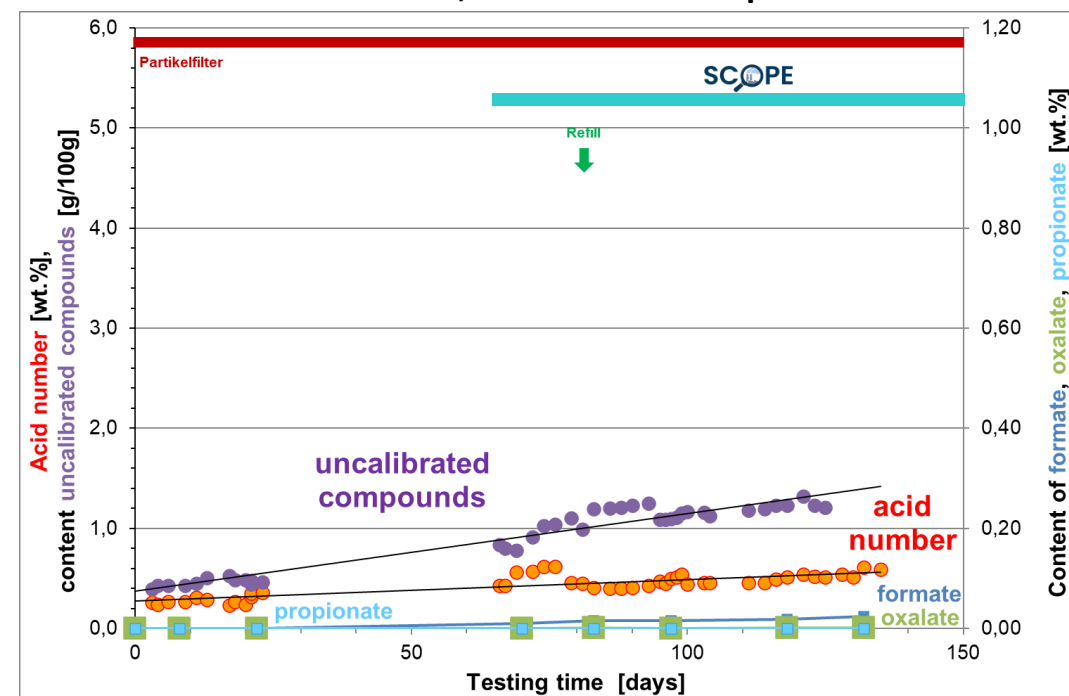
1. campaign: >29,800 hours (1,242 days) – very aged

Acid number 1.1 - 1.7 wt.%; uncalibrated compounds 1.7 - 3.2 wt.%



2. campaign: >1,350 hours (56 days) – fresh

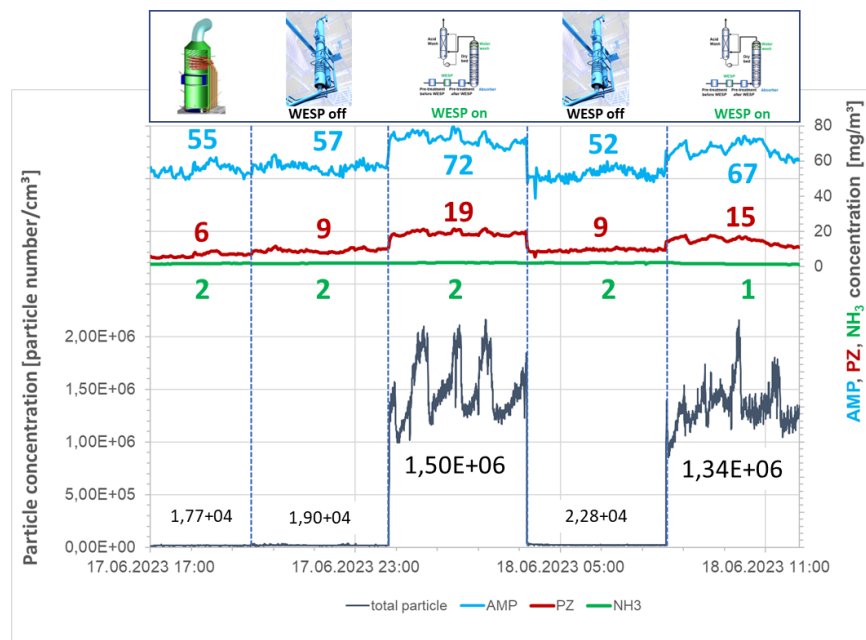
Acid number 0.4 - 0.6 wt.%; uncalibrated compounds 0.8 - 1.3 wt.%




Effect of aging of CESAR1 on emissions – Water Wash and WESP on/off

50% less AMP emission for the aged solvent, no significant effects for PZ

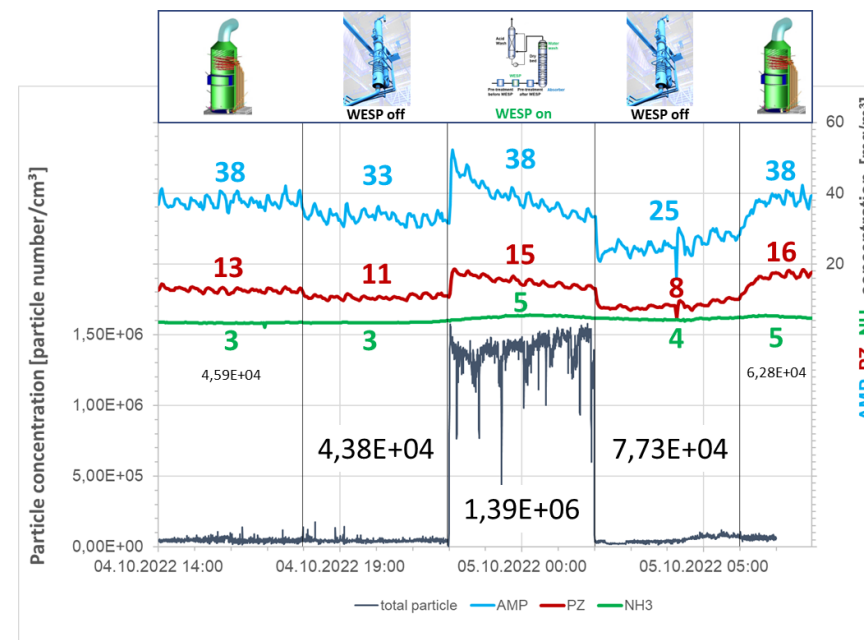
fresh solvent




AMP [wt.-%]	PZ [wt.-%]	Acid number calculated as HCOOH [wt.-%]	Uncalibrated Compounds [wt.-%]
27.9	13.7	0.43	0.67



very aged solvent

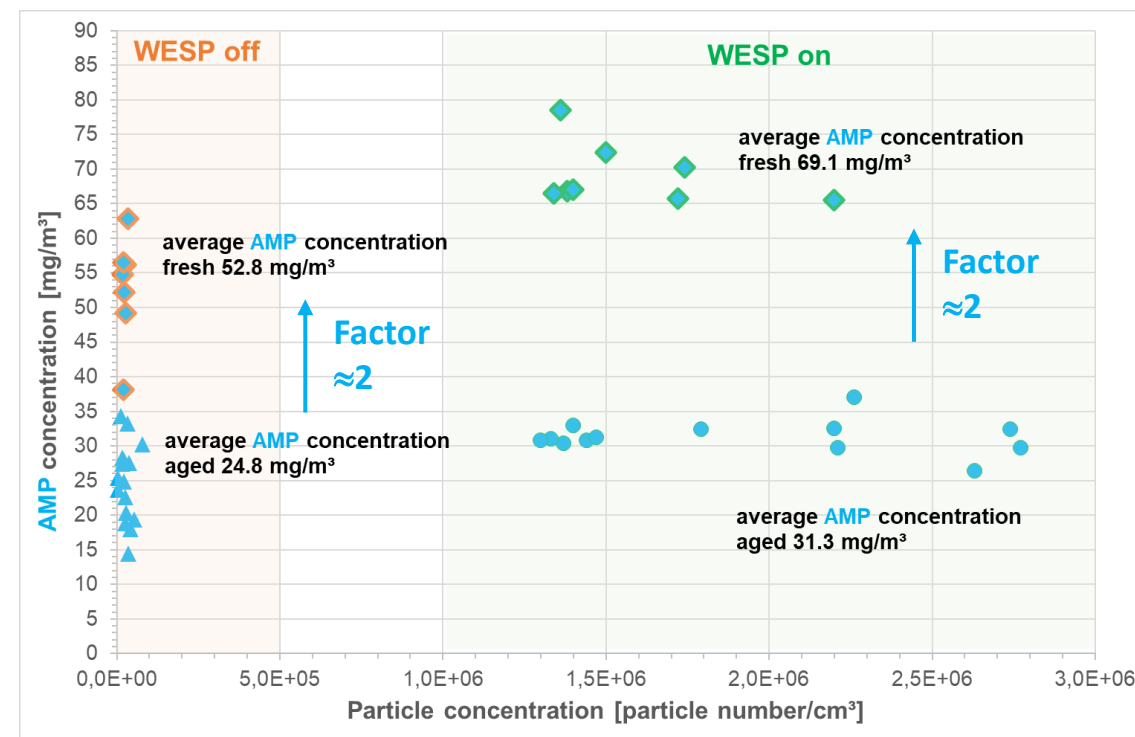
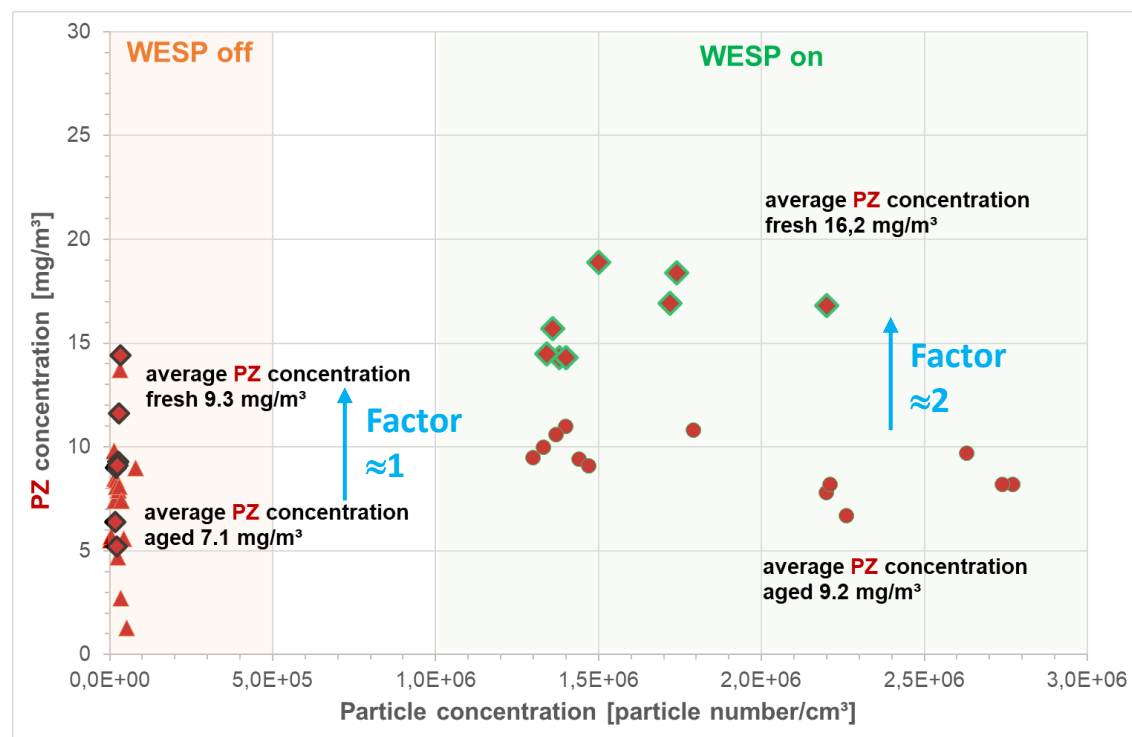


AMP [wt.-%]	PZ [wt.-%]	Acid number calculated as HCOOH [wt.-%]	Uncalibrated Compounds [wt.-%]
26.4	12.8	1.44	2.01



Effect of aging of CESAR1 on emissions – Water Wash and WESP on/off

Comparison of 44 measurements with in total 340 hours measuring time

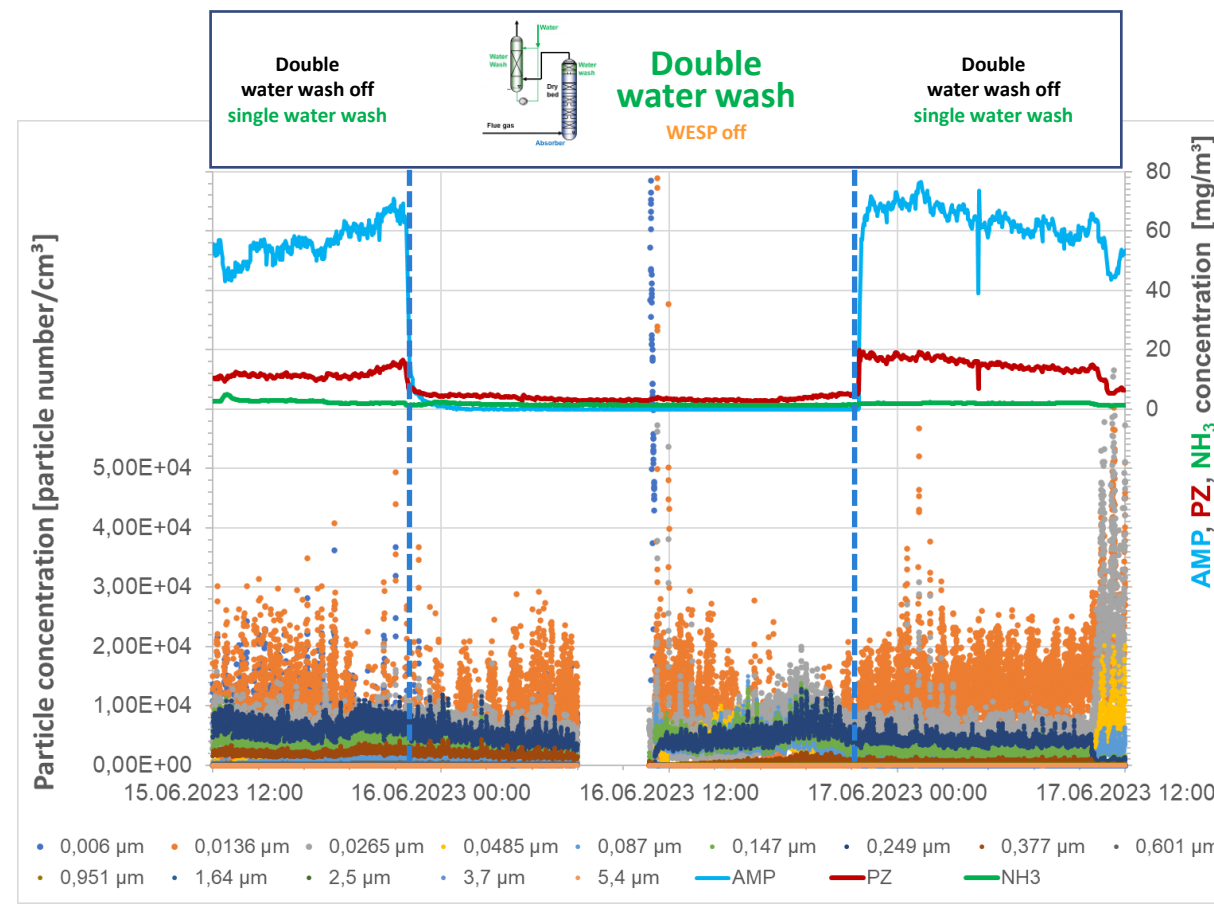
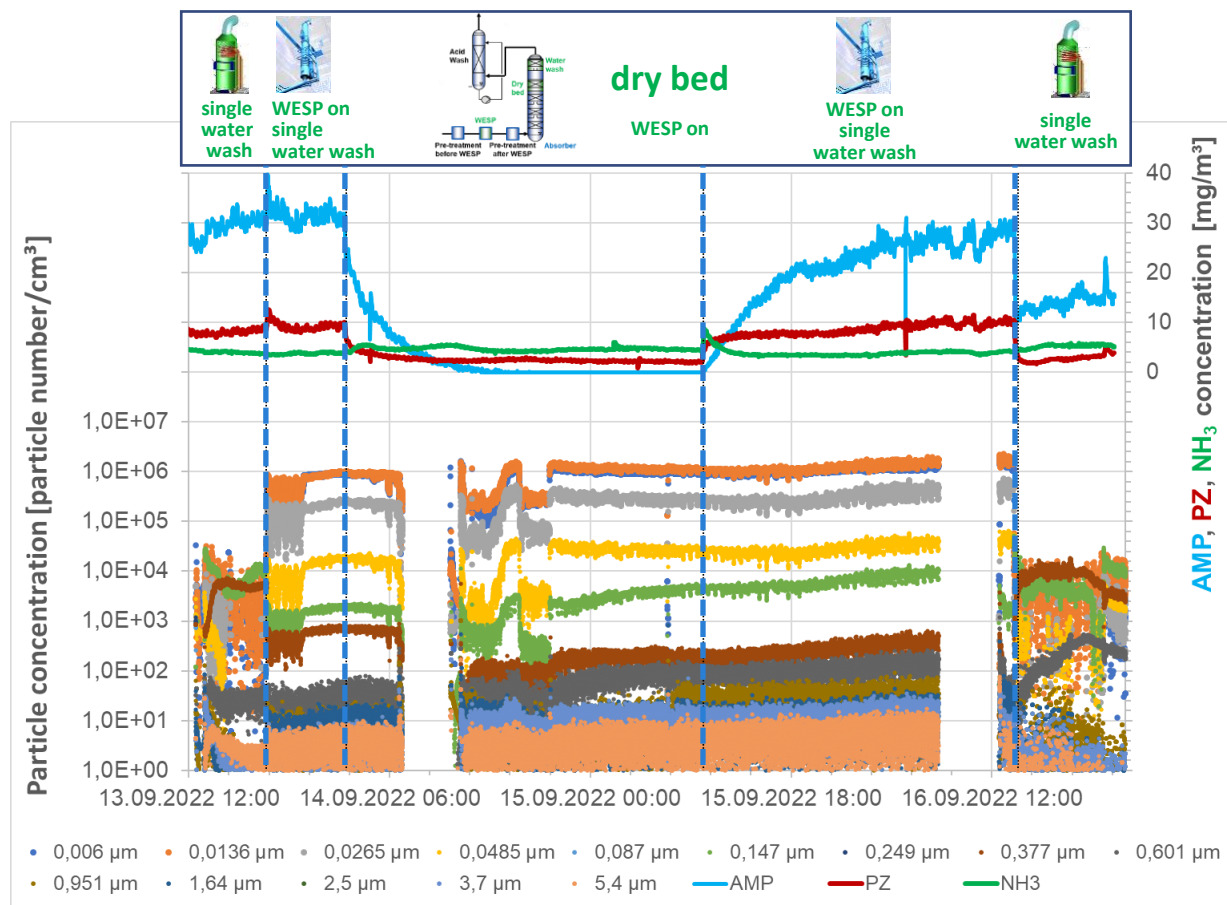


- Effect solvent aging: 50% less AMP emission for the aged solvent, no significant effects for PZ without WESP
- Effect of WESP: Increase of emission of AMP and PZ by 100% when WESP is active
- So far, comparative investigation of fresh and aged CESAR1 using an ebulliometer showed no differences in the amine volatility

Effective emissions mitigation technologies are available, regardless of particle number concentration or solvent aging

very aged solvent

fresh solvent



Conclusion

- Need of sufficient testing time to reach steady-state and repeat measurements (especially for the water-wash section)
- The AMP/PZ/H₂O/CO₂ system is complex and becomes more complex when contaminants are added
- The emission behaviour of AMP and PZ is currently further investigated by simulations and laboratory experiments with samples of fresh and very aged CESAR1 and amine solution with controlled addition of contaminants
- For further model validation measurement data on the water wash, including the demister, will be used
- Effective emissions mitigation technologies are available, regardless of particle number concentration in the flue gas or solvent aging

Acknowledgements

This project is funded through the ACT programme (Accelerating CCS Technologies), ACT 3 Project No 327341. Financial contributions made by the Research Council of Norway (RCN), Rijksdienst voor Ondernemend Nederland (RVO), Department for Business, Energy & Industrial Strategy UK (BEIS), Forschungszentrum Jülich GmbH, Projektträger Jülich (FZJ/PtJ) Germany, Department of Energy (DoE) USA and Department of Science and Technology (DST) India are gratefully acknowledged.

www.scope-act.org

 @SCOPE_ACT