Metrology Support for Carbon Capture Utilization and Storage

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Objective

Metrological sound calibration and measurement methods are needed to accurately measure **CO_2 flows** to determine the amount of CO_2 stored and **emissions of CO_2** to ensure it does not escape from pipelines and storage locations. **Primary reference materials** are needed to determine the **purity and composition** of the captured CO_2 and its impurities. **Experimental measurement data** is needed to understand the **unique fluid properties of CO_2** in combination with impurities. Currently these are **developed within the MetCCUS project**.

Metrology

Metrology is the **science of measurement** and starts at the **international system of units** or the SI units. National Metrology Institutes (NMIs) have the public task to maintain and develop the **national measurement standards**. Via NMIs the **metrological traceability** is passed on to calibration laboratories and industry and testing laboratories through production of reference materials and by calibration of equipment. Via **multiple calibration** steps everyday **measurements** are **connected to the SI**.

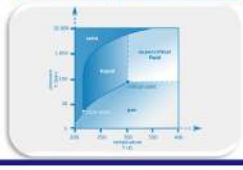
CCUS measurement challenges

Flow metering

Emission monitoring

Chemical metrology

Physical properties



Flow metering

Gas-flow

- Metrology infrastructure for monitoring CO_2 flow
  - < 50 m^3/h and low pressure
  - Up to 400 m^3/h and higher pressure
- Primary and transfer standards
  - Intercomparison using flow meters
  - Theoretical investigate the impact of impurities on transfer standards
  - Uncertainty 1.5 % - 2.5 %

Liquid flow

- Study to determine the current state of the art of traceable liquid CO_2 flow measurement and liquid CO_2 primary standard requirements [1] & good practice guide for CCS fiscal metering

Emission monitoring

Review requirements for monitoring **pollutants in CO_2** in the **emission from ducts and flues** from carbon capture processes

- Focus on pollutants from **amine capture** → gas matrix and methods for monitoring nitrosamines/amines have been identified → facilities have been developed to generate test matrices to test monitoring methods

Review **performance requirements** for the **detection of CO_2**, including leak monitoring techniques based on EN 1779 [2].

Detection and quantification of **CO_2 emissions** from **geological storage**

- Isotopic measurements
- Addition of tracers
- Use of acoustic techniques

Chemical metrology

Primary reference materials for impurities in CO_2 [3]

- Key impurities e.g.; H_2O, NO_x, sulphur compounds, hydrocarbons, alcohols and amines
- Permanent gases: O_2, Ar, N_2, CH_4, CO, H_2

Material compatibility for **CO_2 sampling** [4]

Online CO_2 monitoring

- Development and validation of online methods
- Round Robin Test for the measurement of impurities in CO_2

Offline analytical methods for CO_2 quality

- CO_2 capture, transport and storage
- CO_2 conversion, utilisation and recycling

Physical properties

Experimental measurements CO_2 mixtures with MEA and DEA [5]

- Density, Isobaric Heat Capacity, Vapor Liquid Equilibrium and Speed of Sound

Equation of state models relevant for CCUS process & flow metering

1. EoS-CG 2019
2. GERG-2008

Monitoring CCUS infrastructures

- Corrosion testing of CO_2 pipeline materials → test facility has been developed → validation measurement methods for H_2O and O_2 in dense phase CO_2
- Calibration method for online humidity sensors used in CCUS processes
- On-line measurement equipment for impurities in CO_2 manufactured →

Conclusion

The MetCCUS project is the first to develop metrological sound standards and calibration methods and measurement techniques enabling the CCUS industry to obtain **reliable measurement results** and **comply with specifications**, such as the EU ETS. The obtained results will support the development of key **documentary standards**, **specifications** and **regulations**. Furthermore, the project will help the CCUS industry to successfully **grow and ensure efficient and safe operation**. Eventually ensuring industry can become **carbon neutral** by the year 2050 to **overcome climate change**.

References

[1] A. Abdulrahman, M. Schakel, D. van Putten, Y. Arellano, 2024, https://zenodo.org/records/11118645

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[5] S. Lago, R. Romeo, D. Vega-Zaza, A. Moreau Ortega, 2024, https://zenodo.org/records/11119890

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