METCCUS

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NEWSLETTER

Metrology Support for Carbon Capture Utilisation and Storage

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MetCCUS Impact

The outcomes of MetCCUS are very relevant for various stakeholders from industry, research and academia. Furthermore, metrological requirements for the future CO_2 infrastructure must be reflected in common standards that help establish guidelines for aspects such as safety and quality specifications. For that purpose, MetCCUS partners disseminate the progress and results of the project on a regular basis to technical committees in standards development bodies such as CEN, ISO and Euramet.

Feedback from stakeholders through advisory board meetings and workshops have been crucial to understand specific industry needs and identify the biggest measurement challenges related to CCUS processes, always seeking alignment with project activities. In the end, the objective is that MetCCUS contributes to EU ambitions such as the 90% emissions target reduction by 2040 (compared to 1990 levels) and carbon neutrality by 2050; for instance, the 280 million tonnes of CO_2 that need to be captured yearly in the EU by 2040 (EU Industrial Carbon Management Strategy) represent a huge endeavour.

The MetCCUS project will address four measurement challenges identified together with the CCUS industry: 1) flow metering, 2) emission monitoring, 3) chemical metrology and 4) physical properties.

Flow Metering

Significant progress has been made on the development of primary standards for gaseous CO_2. Project participants NEL repurposed and upgraded its hydrogen primary standard PVT facility to operate with gaseous pure CO_2. INRIM and VSL repurposed and upgraded its existing intermediate scale primary volumetric facilities to run with pure CO_2 and CO_2 mixtures. VSL and FORCE has repurposed and upgraded its large scale primary piston prover to operate with gaseous pure CO_2 These facilities will soon be used to carry out **flow meter calibration** tests. A large-scale intercomparison will also be conducted using flow meters from two different technologies.

An initial technical protocol for the intercomparison has been developed in order to compare the performance of the calibrations of gas meters in different gas flow laboratories in Europe (Qmax up to 400 m3/h).

The state of the art of the traceable measurements of liquid CO_2 covered aspects such as the SI-traceable calibration of liquid CO_2 flow meters and existing datasets on CO_2 flow meter performance. A report on liquid CO_2 flow measurement and primary standard requirements will be out soon!

Finally, the regulatory framework applicable for CCS fiscal metering has been analysed by the MetCCUS team at international and European level. It showed that there is still a lack of standardization across different regions and countries. The current basis for custody transfer metering regarding the European ETS is provided by the EU ETS 2018/2067 (see document).

Emissions Monitoring

The team has been reviewing the requirements for monitoring pollutants and CO_2 in the emission ducts/flues from carbon capture processes, with a focus on pollutants from amine capture. In fact, a gas matrix has been defined and methods for monitoring nitrosamines/amines have been identified for subsequent performance evaluation. Facilities at NPL have been developed to be able to generate test matrices to assess monitoring methods in post-combustion capture emissions.

Regarding CO_2 emissions from CCUS process infrastructure, the team is finalising a report detailing the proposed performance requirements for the detection of CO_2, including the proposal of leak monitoring techniques based on EN 1779. A Controlled Release Facility has also been modified to generate CO_2 releases.

The **IEA CCUS Projects Explorer** is a worldwide database of all large-scale CCUS projects commissioned or in planning 🦉: Explore interactive database

Chemical Metrology

Below the identification of key impurities within CCUS, with the corresponding amount fractions:

Component	Amount fraction
water (H_2O)	≤50 ppm
Hydrogen (H_2)	≤0.75%
total sulfur-contained compounds (incl. mercaptan)	≤20 ppm
Hydrogen sulfide (H_2S)	≤10 ppm
Sulfur oxide (SO_x)	≤20 ppm
Total Nitrogen oxides (NO_x) (NO_2/NO)	≤10 ppm
Total amine compounds (MEA)	≤1 ppm
Total glycol compounds (MEG/TEG)	≤0.025-0.05 ppm
Ammonia (NH_3)	≤50 ppm

Following this, the team has prepared several primary reference materials (PRMs), including multi-component mixtures. Before starting with the preparation a literature review was performed to investigate the commercial available cylinder materials for the preparation of these PRMs (find it here). These are being analysed, to determine the stability and uncertainty. Examples of mixtures that have already been analysed are H_2O in CO_2 and NO_2 in CO_2. All PRMs will allow the measurement of low-level impurities in CO_2. Next to PRMs in high pressure cylinders, set-ups are under development to dynamically prepare calibration gas mixtures with CO_2 compositions relevant for CCUS applications (See Figure 1). Furthermore, different sampling methods have been compared (see full report), to determine the material compatibility of the key impurities in carbon dioxide. For instance, the sampling of 6-8 ppm methanol in CO_2 was carried out using different types of gas sampling bags such as True Blue, Multi-Layer Foil, Cali-5-Bond and ALTEF, in order to determine the most compatible one.

Additional efforts are directed towards advancing a methodology for analysing CO_2 purity under moderate to high CO_2 pressures (1 bar – 40 bar).

Methods for the purity analysis of carbon dioxide will be developed to meet the recommendations of ISO/TR 27921. An outline of the analytical methods for the analysis of the impurities has been defined, for subsequent validation.

Figure 1 – dynamic gas mixture system at VSL

Physical Properties

The first task on experimental measurements has progressed well. The team developed a protocol for the preparation of binary mixtures such as aqueous amine and CO_2 and a second protocol for the preparation of binary mixtures of pure amine and CO_2. For binary mixtures of CO_2+ Monoethanolamine (MEA), properties like density, isobaric heat capacity and the Vapor Liquid Equilibrium (VLE) were measured at various temperature and pressure ranges. In Figures 2 & 3, preliminary results of experimental density are shown. These will be useful for future improvement of EOS-CG formulation. Speed of Sound (SoS) measurements for the binary mixtures have started.

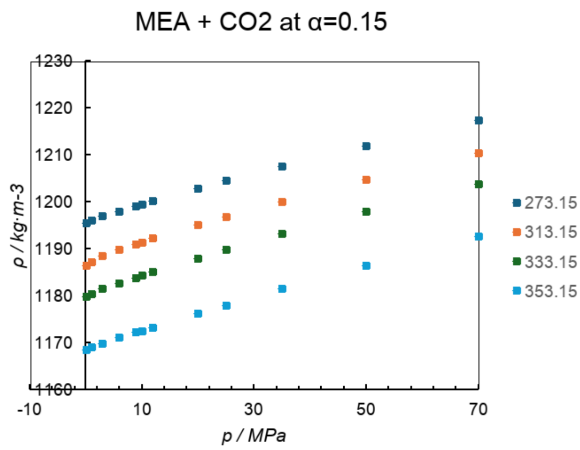

Figure 2 – Experimental density results of binary system MEA + CO_2 at α = 0.15 (mol of CO_2/mol of MEA), UVa

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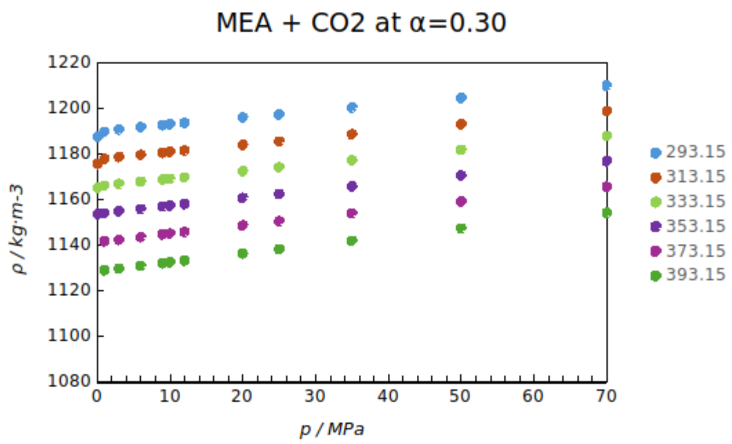

Figure 3 – Experimental density results of binary system MEA + CO_2 at α = 0.30 (mol of CO_2/mol of MEA), UVa

The team has evaluated existing Equations of State (EoS) from the literature, such as the paper from McKay et al. (2022) on recommendations for the selection of equation of state during design and operation of impure CO_2 transport and storage. It has been identified EoS-CG 2019 as the most appropriate EoS for CCUS applications, whenever possible; if not possible, GERG-2008 is the second best.

Furthermore, the role of impurities in the measurement of physical properties in both gaseous and liquid phase was investigated.

A new test facility to perform corrosion rate measurements in dense phase CO_2, with controlled dosing and monitoring of various impurities, has been developed. Validation of methods of controlling and measuring the concentration of impurities (H_2O and O_2) in dense phase CO_2 is currently in progress. Test protocol for corrosion testing is under development and sensitivity analysis to identify and assess key test parameters and their impact on corrosion test results will be performed this year.

Concerning the on-line measurement of impurities in CO_2, the cell for CO_2 phase transition measurements is manufactured and tested up to 230 bar (see Fig. 4).

MetCCUS will produce several public reports that will be available on the publications section of our website. Keep an eye there 😉 😉 [link to publications]

Figure 4 – Piece of equipment for CO_2 phase transition measurements, DTU

Other news

- CO_2 Value Europe mention the MetCCUS project on LinkedIn: see post.
- Successful MetCCUS seminar in October 2023. Find the presentations and recordings on our website: MetCCUS Seminar 2023.
- Valuable inputs received from project stakeholders. You can still participate in our stakeholder questionnaire.
- The Horizon Europe project, **COREu**, the largest research and innovation project in CCS ever funded by a European programme, kicked-off in January 2024. It will demonstrate key technologies for the entire CCS value chain in Southern Europe, supporting the development of CCS routes linking emitters with storage sites in Central Eastern Europe. Follow their page.
- **EU Industrial Carbon Management Strategy**: after the public consultation in 2023, the strategy was adopted by the Commission the 6th of February 2024. This initiative will assess the role of CCUS technologies for EU decarbonisation by 2030, 2040 and 2050. By 2030, the Net Zero Industry Act set a 50 Mt per year CO_2 injection capacity target → see more details
- **EU carbon removals certification framework**: The European Council and Parliament reached a political agreement on February 2024, on a regulation to establish the first EU-level certification framework for permanent carbon removals, carbon farming and carbon storage in products → see the main elements of the agreement

Metrology / CCUS terms of the newsletter

Conformity Assessment	Demonstration that specified requirements are fulfilled Source: International Vocabulary of Legal Metrology (VIML) - 2022 Edition
Sampling	Selection/collection of material or data regarding an object of conformity assessment. Source: International Vocabulary of Legal Metrology (VIML) - 2022 Edition
BECCS	Bioenergy with carbon capture and storage (BECCS): Capturing and permanently storing CO_2 from processes where biomass is converted into fuels or directly burned to generate energy. Because plants absorb CO_2 as they grow, this is a way of removing CO_2 from the atmosphere. Source: International Energy Agency (**IEA**)

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