European Partnership on Metrology

Delivering Impact



Supporting new technology for effective carbon capture utilisation and storage

To protect the environment, the emission of carbon dioxide into the atmosphere must reduce dramatically. Carbon capture, utilisation and storage (CCUS) technology is an important tool to achieve this goal, but water vapour contamination can cause damage in pipelines and let carbon dioxide escape. To ensure CCUS systems are robust, improved humidity measurements supported by appropriate calibration procedures are needed.

Europe's National Measurement Institutes working together

The European Partnership on Metrology has been developed as part of Horizon Europe, the EU Framework Programme for Research and Innovation. Metrology Partnership funding is drawn from 25 participating EURAMET member states to support collaborative research between Measurement Institutes, academia and industry both within and outside Europe to address key metrology challenges and ensure that measurement science meets future requirements.

Challenge

The European Union's Green Deal aims for Europe to become the world's first carbon neutral continent by 2050. Along with alternative fuels and energy storage, Carbon Capture, Utilisation and Storage (CCUS) has been highlighted as a priority area in reaching this goal.

In CCUS, CO_2 from factories and power plants is captured before it is emitted into the air. This is then used (e.g., to boost plant growth in greenhouses, in fire extinguishers) or transferred to geological storage deep underground. During this process, operators must be able to monitor captured CO_2 throughout the system and detect impurities. This is essential not only for quality control but also for ensuring safe transport and storage.

One of the most critical impurities is water. The presence of water can promote both corrosion and hydrate formation. Hydrates are crystalline solids that form when water and CO_2 combine under specific pressure and temperature conditions, potentially causing blockages and damage to transport and storage infrastructure. In addition, sulfur oxides (SO_x) and nitrogen oxides (NO_x) can react with water to form corrosive acids, accelerating the degradation of pipelines, vessels, and storage materials. Effective monitoring and control of these impurities are therefore crucial for the safe and reliable operation of CCUS systems.

Solution

The MetCCUS project addressed this issue by conducting trial calibrations for humidity in CO_2. As part of this work, project partner NPL, the National Metrology Institute for the UK, adapted a primary standard humidity generator for use with CO_2. The facility has now been developed into a new service, able to dynamically generate traceable levels of humidity in CO_2 at a range of pressures to calibrate hygrometers used in CCUS process monitoring.

Impact

Michell Instruments is a UK-based manufacturer specialising in humidity instrumentation. With customers in diverse industries, from food and pharmaceuticals to semiconductor manufacturing and nuclear power, it has been providing high-precision measurement solutions across the globe for 50 years. When the company developed its trace moisture analyser for CO_2, the new device needed to be calibrated to ensure its accuracy. However, available reference standards were inadequate as they were based on moisture in air rather than in CO_2.

Michell Instruments used the new service at NPL to enhance the accuracy of its analyser, calibrating it against CO_2 generated with a range of humidity values. The analyser is now providing more accurate and reliable humidity measurements for the company's customers, improving their ability to monitor a key impurity in CO_2.

The MetCCUS project's work will continue to support the development and uptake of robust CCUS systems. This will help to reduce the emission of CO_2 into air, protecting the environment and mitigating the effects of climate change.

Support for carbon capture, utilisation and storage

MetCCUS was the first project to address the measurement challenges of the CCUS industry, delivering the metrological infrastructure needed for reliable CO_2 transport, storage, and accounting. The project:

- Developed primary CO_2 flow calibration facilities and demonstrated calibration uncertainties below 1.5 % through successful intercomparisons
- Established new traceable methods for monitoring nitrosamine emissions from capture processes
- Developed calibration services, controlled release facilities, and field validation methods for CO_2 leak detection and quantification, including subsea applications
- Identified key CO_2 impurities, developed primary reference materials, and established sampling, analysis, and online monitoring methods for CO_2 quality assessment
- Generated new data on the thermophysical properties of CO_2 mixtures, improving equations of state and thermodynamic models for CCUS applications
- Developed methods for corrosion testing, humidity measurement in CO_2, and online monitoring of phase transitions in CO_2 transport systems



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