European Metrology Research Programme

Delivering Impact

Developing the technology to accurately measure ammonia

Ammonia, a highly reactive gas, has been linked to severe health effects. As it can be absorbed by components in measurement instruments, its atmospheric levels are hard to monitor accurately. Most emissions are from agriculture thus monitors need to be field-deployable, but the data these provide can be influenced by environmental conditions. Improved instrumentation is required to meet emission targets and protect the environment.

Europe's National Measurement Institutes working together

The European Metrology Research Programme (EMRP) brings together National Measurement Institutes in 23 countries to address key measurement challenges at a European level. It supports collaborative research to ensure that measurement science meets the future needs of industry and wider society.

Challenge

Ammonia (NH_3), a colourless, reactive gas, can cause substantial health damage due to its adverse effects on air quality. Once released into the atmosphere, it can form fine particulate matter ($PM_{2.5}$) that has been linked to tens of thousands of premature deaths annually. It can also be absorbed by soils and plants, damaging the biodiversity of sensitive ecosystems. It is one of five pollutants covered by the National Emission Reduction Commitments (NEC) directive, which aims to reduce emissions for contaminants that have significant negative impacts on human health and the environment.

Agriculture accounts for 94% of anthropogenic NH_3 release in Europe, thus the majority of instruments to monitor its levels need to be field-deployable. Many utilise near-infrared lasers to probe the gas, measuring how much light is absorbed, and linking this to its concentration.

However, measurements can be affected by instrument noise, the adsorption of NH_3 to material used in the detector, or the detector's performance. In-situ measurements using lasers can also be affected by environmental conditions, such as fog, rain, or dust.

Improved instrumentation is required – able to accurately measure the levels of this harmful pollutant.

Solution

During the *MetNH3* project a Controlled Atmosphere Test Facility (CATFAC) was upgraded to provide standardised testing capability for passive samplers used in airborne monitoring networks. Prior to the project, these instruments did not have a method to confirm their performance in the field. The upgraded CATFAC system provides a standardised testing capability for these devices, by evaluating how polluting gases interact with materials at the low concentrations encountered in the atmosphere.

Mirico were an early user of the facility, testing a monitor system utilising a mid-infrared (IR) laser (~2500 nm-25 µm), which gives a more sensitive reading than conventional near-IR systems. During this testing, as well as determining the effects of NH_3 absorption on to the instruments components, the company determined the effectiveness of mid-IR laser versus near-IR measurement systems.

Impact

Mirico is a leading provider of high-performance gas sensing instrumentation for those aiming to meet net zero emissions and air quality targets. The work of the company with the *MetNH3* project provided new data on the use and sensitivities of mid-IR lasers for NH_3 detection. This prompted the company to focus development on their 'open path' system utilising their unique dispersion technology, which they now provide as the Orion® NH_3. Unlike measurements based on light absorption, this system measures the change in frequency of the light that passes through the NH_3 and compares it to a beam that does not – giving a differential measurement that is independent of environmental factors. This system does not have any components in direct contact with the ammonia under investigation thus avoiding gas adsorption onto instrument surfaces.

The Mirico Orion employs a multi-beam approach to give spatial information allowing detection of environmental NH_3 down to the 1 ppb level, making it ideally suited to inform customer actions.

In 2022 Mirico performed a field trial of the Orion® NH_3 with one of the partners in the original *MetNH3* project – confirming its measurement superiority under real-world conditions.

The company acknowledge that working with the *MetNH3* project has been valuable in developing and verifying the accuracy of their new instrument.

The introduction of improved sensors, like the Orion® NH_3, will allow better measurements of NH_3 released by agriculture and other sectors. This in turn will allow improved mitigation strategies for this pollutant, help countries meet European emission targets and protect both human health and the environment.

Developing the technology to accurately measure ammonia

The EMRP project Metrology for Ammonia in Ambient Air (*MetNH3*) developed ammonia reference gas standards for use in calibrations and in-the-field device performance assessments and upgraded the existing CATFAC facility for use with ammonia. This was then used to evaluate material/ammonia interactions to help inform user selection decisions.

The facility has enabled the exposure of ammonia measuring devices to well characterised ammonia atmospheres similar to those encountered in the field and followed by a pioneering field study, has enabled manufacturers to appreciate the importance of reliable characterisation data for sampler measurement accuracy.

The CATFAC tests also included water vapour as a cross interferent at levels likely to be observed in the environment and assisted the introduction of laser-based spectroscopy technologies for real time ammonia monitoring.

Greater measurement accuracy for ammonia emission reporting will assist member states demonstrate compliance with the EUs Industrial Emissions Directive and National Emission Ceilings (NEC) directive.

Heavy tractor spreading manure on arable farmland

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