European Metrology Research Programme
Delivering Impact

Greater accuracy for ammonia monitors

Ammonia is a harmful pollutant produced by intensive farming which damages ecosystems. Monitoring networks assess environmental ammonia levels and the success of strategies for meeting EU emissions targets. Performing spot checks and ensuring test exercises supply specified ammonia concentrations to the samplers used requires accurate real-time measurements. Optical gas measurement technologies could provide these, but first ways to compensate for effects created by water vapour in the sample are needed.

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

When released, ammonia reacts with atmospheric acids to form harmful particles which damage the environment, ecosystems and human health. To combat this, the EU National Emission Ceilings Directive has set emissions reduction goals, requiring member states to track ammonia emissions reductions via a network of monitors. These monitors collect ammonia samples from air, and laboratory analysis provides the average amount of ammonia in the environment.

Accurate real-time ammonia measurements could help build a more detailed picture of peaks and troughs in emissions and could also validate ammonia levels used in exercises to assess sampler performance during environmental monitoring.

Laser-based optical techniques such as Cavity Ring-down Spectroscopy have the potential to provide these real-time measurements. A laser beam specifically tuned to the absorption wavelength of ammonia is shone into a cavity containing the sample under analysis. Highly reflective mirrors in the cavity quickly fill it with light to a pre-set intensity, then the laser is abruptly turned off. The remaining light steadily loses its intensity and the time for the light to die away or "ring down" is measured. This is used to calculate the concentration of ammonia in the gas sample. Based on fundamental physical properties, this technology is stable long-term, which greatly reduces instrument calibration requirements.

However, results from laser-based measurement techniques are distorted by variations in atmospheric water vapour content created by ambient weather conditions. To improve their reliability, new facilities are needed for characterising instrumentation under conditions that simulate those in the environment.

Solution

The EMRP Project, *Metrology for Ammonia in Ambient Air,* investigated how humidity levels affect ammonia measurements.

The Controlled Atmosphere Test Facility for environmental gas testing, CATFAC was extended in the project to cover ammonia testing permitting researchers to create highly precise compositions of ammonia gas with well-defined humidity levels. This enabled the evaluation of laser based optical techniques, allowing comparison of measured results with known accurate compositions. These results improved understanding of how water vapour interacts with laser signals, information which was used to develop models to remove humidity effects, and so improve the accuracy of optical techniques.

Impact

Picarro, a leading provider of gas measurement technologies, became an early user of the upgraded CATFAC facility to assess and improve its Cavity Ring Down Spectrometer, a laser-based ammonia monitoring instrument.

Picarro were able to evaluate their instrument's performance by measuring samples containing accurately known concentrations of water vapour and ammonia. This enabled Picarro to improve their models and to minimise water vapour interference effects that reduce the accuracy of ammonia measurements. These measurements, performed at the CATFAC facility, provided independent validation of their spectrometer, increasing confidence in its performance.

These improvements enable the instrument to operate at higher levels of accuracy, making it viable as a transfer standard for comparing laboratory-based calibration results to those achieved by sampling devices in the field. It also opens applications in other areas where precise ammonia monitoring is required, such as leak detection in semiconductor cleanrooms. This will bring greater accuracy to environmental ammonia monitoring, which will be important for spotting trends and assessing the success of ammonia reduction strategies.

Measuring ammonia in air

The EMRP project *Metrology for Ammonia in Ambient Air* 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. Testing using the CATFAC facility to supply both environmental levels of ammonia and water vapour has enabled accurate characterisation of laser-based spectroscopy technologies suitable for real time ammonia monitoring. Greater measurement accuracy for ammonia emission reporting will assist member states demonstrate compliance with the EUs Industrial Emissions Directive.

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