Calibration testing of an ammonia sensor for pig buildings

Harper Adams University
Project Report

SUMMARY

- Limits have been proposed by the European Union on ammonia emissions from pig buildings in the UK and other EU countries. Currently there is no practical means of measuring the ammonia levels in livestock buildings.
- The aim of this study was to assess the capacity of a sensor, LG 200, to monitor ammonia at typical levels for pig buildings, and to calibrate it.
- Many practical tests were undertaken to assess the reliability and stability of the sensor. Overall, the sensor proved suitable for monitoring ammonia levels within the expected range. The recommended flow rate is 3 litres per minute (LPM). The temperature around the sensor should be stabilised and the start-up time before measurements are taken should be at least 1.5 hours.

AMMONIA LEVELS REGULATIONS

The level of ammonia emissions in pig buildings is becoming an important environmental issue. Ammonia can be produced as a gas from slurries and manures and causes soil acidity and damage to plants. Reductions in ammonia emissions from farm livestock buildings, by 2020, have been proposed by the European Union under the revised National Emission Ceilings Directive (NECD). For the UK the proposed reductions are expected to be in the region of 10%.

However, currently there is no suitable technology to measure and monitor the levels of ammonia in livestock buildings at a practical level. A standard sensing system, known as the Innova PhotoAcoustic, can be used for research purposes but would be costly for farm-scale use.

The British Pig Executive (BPEX) recognised the need for a cost-effective monitoring system with low maintenance for measuring and monitoring ammonia levels in pig buildings. This would be integrated into a sensing system for the building which would include other functions such as the measurement of carbon dioxide, temperature and humidity.

AIM OF THIS STUDY

The aim of this Harper Adams University study, commissioned by BPEX, was to assess the capacity of a particular sensor, the LGF 200,to monitor ammonia emissions at typical levels in pig buildings and to calibrate it for those levels.

PRACTICAL TESTING

Tests were undertaken to check the reliability and stability of the LGF 200 which incorporates the technology of TDLS (see box). The tests included:

- the effect of temperature and humidity;
- reading stabilisation after a cold start;
- linearity and relative accuracy;
- precision;
- response time;
- calibration and zero drift.

Authors

Dr Tomas Norton, Senior Lecturer in Engineering,

David Clare, Senior Lecturer in Engineering,

Harper Adams University

Technical Author

Caroline Kettlewell,

Harper Adams University

Tunable Diode Laser Spectrometry (TDLS)

Tunable diode laser spectrometry works on the principle that all gases have a characteristic absorption band in the infrared wavelength region so gases can be identified and measured.

Acknowledgements

The external funding for this project from the British Pig Executive (BPEX) is gratefully acknowledged.

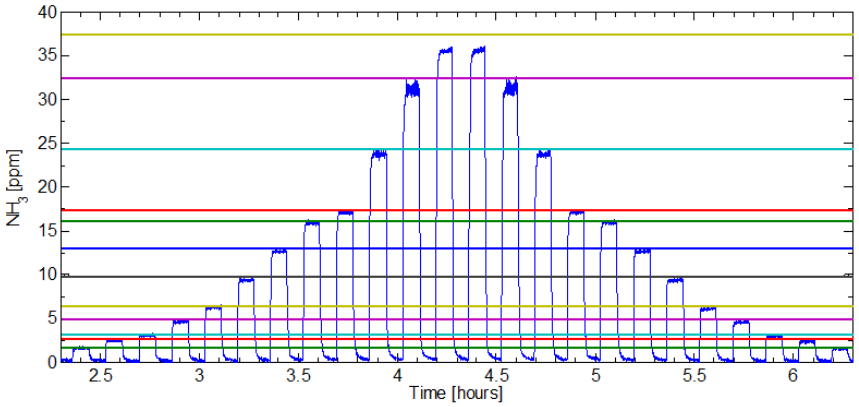
Harper Adams University, Newport, Shropshire, TF10 8NB
Telephone: +44 (0)1952 820280 Fax: +44 (0)1952 814783 Website: www.harper-adams.ac.uk

Harper Adams University

Calibration testing of an ammonia sensor for pig buildings

TEST RESULTS

The tests were all undertaken at Harper Adams University. The chart below shows the relative accuracy and repeatability from the testing of the sensor (twice) with different known ammonia concentrations. The agreement of the sensor with standard dilutions is very evident for most of the values tested. (The higher ammonia concentrations showed the greatest deviation from the standard dilution.)



Accuracy of the sensor when exposed to different ammonia (NH_3) concentrations

OVERALL ADVANTAGES

The advantages of the LGD F200 sensor for ammonia measurement include the following.

- The high sensitivities are comparable to those obtained by the standard Innova PhotoAcoustic.
- There is a reduced possibility of interference from other gases.
- The cell volume is very small thus reducing the amount of sample and calibration gas needed, and the instrument is compact and lightweight (approximately 3 kg).
- No consumables are needed, keeping operational costs low.
- The functional temperature range is from -30^{O}C to 65^{o}C.
- This sensor is considerably cheaper than the standard Innova PhotoAcoustic.

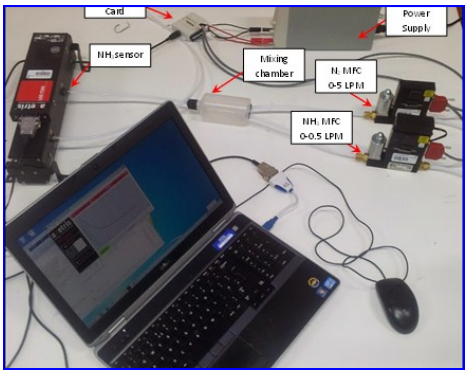
LIMITATIONS

Limitations of the LGD 200 sensor include the following.

- The system is based on a multipass measurement cell which may present a problem with the maintaining of optical alignment.
- Absorbance is measured indirectly.
- Only ammonia and water vapour concentration can be measured in the sample simultaneously.

CONCLUSION AND RECOMMENDATIONS

Overall the LGD F200 proved suitable for measuring ammonia levels within the range that is expected in the field. The largest deviations from the dilution standards were seen when flow rates through the sensor were less than that those used by the vendor during calibration. Therefore, the recommended flow rate is 3 litres per minute (LPM). Additionally, it is advised that the temperature around the sensor is kept stabilised and the start-up time should be at least 1.5 hours (see box).



Effects of Temperature

The results demonstrated that a temperature increase of around 1°C per second added low frequency noise to the reading which took about 40 minutes to stabilise.

When the sensor was rapidly heated from cold it also took time (1.5 hours) for the reading to stabilise.

Further Information

Axetris, 2013. Product Datasheet LGD F200 (A) / LGD F200 (H). Available from: www.axetris.com/laser_gas_detector_datassheet.htm.

Omega (2013) Users guide FMA-2600A Series Mass Flow Controllers. Available from: www.omega.com/manuals/manualpdf/M3791.pdf.

LumaSense (2013). Gas Detection Limits. Available from: www.bruel.sk/PDF_files/Lumasense%20Wall_Chart_2009_1.pdf

HAU Project Report 100

Disclaimer

Although care has been taken to ensure that the information in this document is correct at the time of publication in 2014, Harper Adams University cannot be held responsible for the outcome of any actions taken arising from the information it contains.

© Harper Adams University 2014

You may copy this work provided that this copyright notice is displayed, you do not alter, transform or build on the work, you do not charge others to access or copy the work and you make clear to others that this notice applies to them if they use or share this work.