Monitoring gases from pig buildings: development of a multi-channel monitor (Phase 2)

Harper Adams University
Project Report 102

SUMMARY

- There is a recognised need for a cost-effective monitoring system to reliably measure ammonia, CO_2 and other parameters across a range of pig buildings.
- The first phase of this 3-phase study assessed and calibrated the capacity of an ammonia sensor, LGD F200, (based on the tunable diode laser principle) to monitor ammonia concentrations at typical levels for farm buildings. The aim of this second phase of study (reported here) was to design and build a multi-channel monitor for farm-scale research to meet the specific requirements of the commissioned brief.
- The designed monitor successfully met the set brief and could record data for more than 14 days.

THE NEED FOR A MULTI-CHANNEL MONITOR

The level of ammonia emissions within and from pig buildings is an important environmental issue. The AHDB Division-BPEX recognised the need for a cost-effective and portable monitoring system that could be used for farm-scale research. Harper Adams University was commissioned to design and build a suitable system with the following requirements:

- to measure ammonia, CO_2, temperature and humidity;
- to be able to monitor up to twelve points within a building;
- to monitor for extended periods without supervision;
- to achieve low running costs;
- to be easily portable and fit in a car boot; and
- to be easy to set up by non-technical staff, with only minimal training.

THE CONCEPT

The concept that Harper Adams University devised was to use an LGD F200 Tunable Diode Laser Spectrometer to measure the ammonia level and a CO_2 (COZIR) analyser to measure CO_2, temperature and humidity. The cost of monitoring 12 points using 12 individual LGD F200 units would be prohibitive. Therefore, a system of pipes and a vacuum pump would be used to suck air from 12 points around the building, with solenoid valves to sequentially direct the air flow through the sensors.

PNEUMATIC VALVE SYSTEM

The pneumatic valve system had a total of 13 stainless steel two-way valves, switched by 12V solenoids (see figure 1). These gave rise to twelve sampling points and a clean air input. A 240V vacuum pump continuously sucked air from all 12 sample points and the clean air input. Each valve could be switched to direct air from a particular sample point to the sensors via a moisture trap.

It is possible that, over a period of time, ammonia could contaminate the sensors, therefore, between each sample, clean air was directed to the sensors, purging them to help stop long-term contamination. The material used for the system pipe work was an important aspect (see box).

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System pipework

All pipework, both internal and external, was either stainless steel or Teflon®. This ensured that ammonia did not affect any of the pipes and there was no risk of plasticiser leaching which could have affected the measurements being taken.

Acknowledgement

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CONTROL SYSTEM

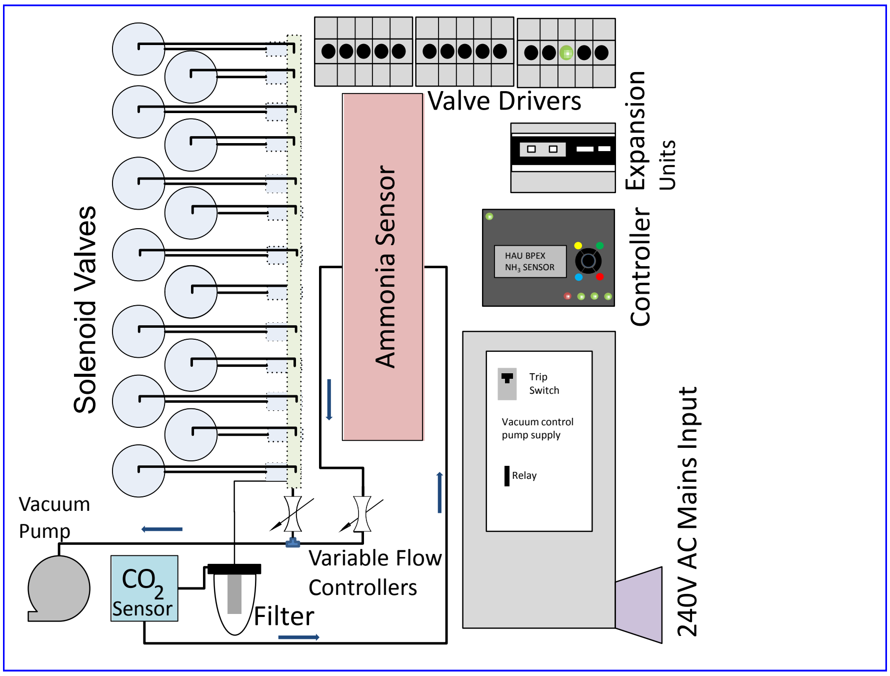

Fig 1. Diagram showing pneumatic and electrical elements of sensing system

The heart of the control system (see figure 1) was a **Matrix Industrial Automotive Controller (MIAC)** which was a **programmable logic controller (PLC)**. The basic PLC had a built-in 16 x 4 character screen which was used to display the status of the system, with buttons to control the operation of the system.

A MIAC Serial expansion module and Advanced expansion module were also used. These modules had serial input ports through which data from the sensors was transferred. They also increased the number of outputs, enabling the thirteen valves and vacuum pump to be individually controlled. The outputs from the expansion modules were low current transistor-transistor logic (TTL) outputs. These were connected to the valves via valve drivers (built in-house) to enable the system to control the higher current required by the valves.

The Advanced expansion module had a real time clock with a battery backup to allow the collected data to be time stamped. **The Serial expansion module** had a Secure Digital (SD) card slot, enabling data to be stored directly to an SD card.

The whole system was programmed using **Matrix's Flowcode 5 graphical programming language.**

SYSTEM ENCLOSURE

The control system and valves were enclosed in a steel industrial enclosure which could be locked to prevent tampering when in use. Externally there were power connections for the 240V mains supply and vacuum pump. The pipework could be easily connected and cleaned (see box).

CONCLUSION

The multi-channel monitor met the set brief and could record data for more than 14 days. It was successfully tested on the Harper Adams University pig unit and is now in use by AHDB Division-BPEX. Future units could include additional sensors for dust detection, or other gases.

Pipework Connections

The pipework could be easily connected, without the use of special tools. This was aided by the 14 quick-fit pneumatic connections for the 12 sample points, clean air input and vacuum pump. Disposable filters on the Teflon® pipes stopped dust entering the system.

Further Information

Norton, T. and Clare, D. 2014. *Monitoring gases from pig buildings: testing and calibration of an ammonia sensor (Phase 1).* HAU Project Report 100. Available from: http://ofi.openfields.org.uk/1.14040633

Norton, T. and Clare, D. 2014. *Monitoring gases from pig buildings: field evaluation of a multi -channel monitor (Phase 3).* HAU Project Report 104. Available from: http://ofi.openfields.org.uk/1.14070030

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