FCSI ApS
Pig housing unit, Frølundvej 83
Measurement of air emissions
Test of the effect of Active NS on emissions of odour and ammonia

Accredited Report No. 114-28344

Measurements taken in May 2015

Lars K. Gram
Authorised signatory

Arne Oxbøl
Project Manager

Contact:
Metrology and Aerial Environment
Arne Oxbøl, Project Manager
Direct line +45 43 26 71 30
Mobile: +45 22 69 71 30
E-mail: aox@force.dk

FORCE Technology
Park Allé 345
DK-2605 Brøndby, Denmark
+45 43 26 70 00
+45 43 26 70 11
info@forcetechnology.dk
www.forcetechnology.com

Executive summary

FORCE Technology has measured emissions for odour and ammonia in two sections in a pig housing unit, one of which uses an agent, Active NS, to reduce evaporation of ammonia. Table 1 shows the main results of the measurement:

Table 1 Overview of results

Housing unit section	Emissions		
	OU/s/1000 kg of animal	g HN_3-N/h/animal	g HN_3-N/h/1,000 kg of animal
1 – With Active NS	80	0.15	1.4
2 – Without Active NS	128	0.22	2.6
Reduction %	37	34	45

The measurements show that Active NS significantly reduced emissions of both odour and ammonia during the measurement period.

Continual measurements of ammonia throughout a 24-hour period indicate that Active NS significantly reduces the concentration of ammonia.

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1 Introduction

In May 2015, FORCE Technology measured emissions into the air from a pig housing unit at the request of FCSI ApS.

Address: Svineavler [pig farmer] Anders Rahbek, Frølundvej 83, Hammerum, DK-7400 Herning, Denmark
Client: FCSI ApS; contact: Karl Erik Molbech

Measurements taken by: Claus Degn
This report was prepared by: Arne Oxbøl
Measurement parameters and the duration of the measurements are shown in the overview of results in Chapter 2.1.

Sampling and analysis were performed in accordance with FORCE Technology's DANAK accreditation No. 51.

The following are not included in the accreditation:
- Determination of flow
- Measurement of ammonia

The result of the measurements is valid only in respect of the system in question, the current measurement periods and the current operating situations.

1.1 Purpose

As the basis for the trial, pig farmer Anders Rahbek uses a slurry additive, Active NS, supplied by FCSI ApS, as an agent to reduce emissions of ammonia and odour. The purpose of taking measurements is to document whether the additive is effective.

The measurement will also serve as an indication of whether it is relevant to initiate an ETV test of the effect of the agent.

2 Results

2.1 Overview of results

Odour emission results are stated as OU/s/1,000 kg of animal in accordance with the Danish Pig Research Centre report.[1] The result for ammonia reduction is stated as g NH_3-N/hour/animal in accordance with the presentation of corresponding results from SEGES[2] and as g NH_3-N/hour/1,000 kg of animal. The latter unit is calculated in order to facilitate a comparison on the same basis as the odour results.

[1] http://vsp.lf.dk/Publikationer/Kilder/lu_medd/2010/883.aspx?full=1: Announcement no. 883 from SEGES: Different types of floor with and without floor extraction for slaughter pigs during a summer period.
[2] Kristoffer Jonassen, Danish Pig Research Centre: Results from testing Active NS at Grønhøj, 4 April 2013.

Table 2 shows the result of odour measurements taken in parallel in the treatment and control sections on 28 May 2015 in the period 11:35 to 13:49.

Table 2 Results of odour measurements, 28 May 2015

Housing unit section	Volume flow	Odour			Pigs		
		Concentration	Emission			Weight	Total
	m^3/h (operation)	OU/m^3	OU/s	OU/s/1000 kg of animal	Number	kg/animal	tonnes
1 – With Active NS	37,533	318	3,314	80	405	102	41.3
2 – Without Active NS	37,712	535	5,604	128	508	86	43.7

Based on emissions per 1,000 kg of pigs, the odour reduction during the measurement period is calculated as 37% when using Active NS.

Table 3 shows the result of ammonia measurements taken in parallel in the treatment and control sections on 28 May 2015 in the period 11:35 to 13:49.

Table 3 Results of ammonia measurements, 28 May 2015

Housing unit section	Volume flow	Ammonia				Pigs		
		Concentration	Emission				Weight	Total
	m^3/h (operation)	mg NH_3/m^3	g NH_3/h	g NH_3-N/h/animal	g NH_3-N/h/1000 kg of animal	Number	kg/animal	tonnes
1 – With Active NS	37,533	1.9	72	0.15	1.4	405	102	41.3
2 – Without Active NS	37,712	3.7	138	0.22	2.6	508	86	43.7

Based on emissions of g NH_3-N per hour per animal, the reduction in ammonia during the measurement period is calculated as 34% when using Active NS.

Based on emissions of g NH_3-N per hour per 1,000 kg of animal, the reduction in ammonia during the measurement period is calculated as 45% when using Active NS.

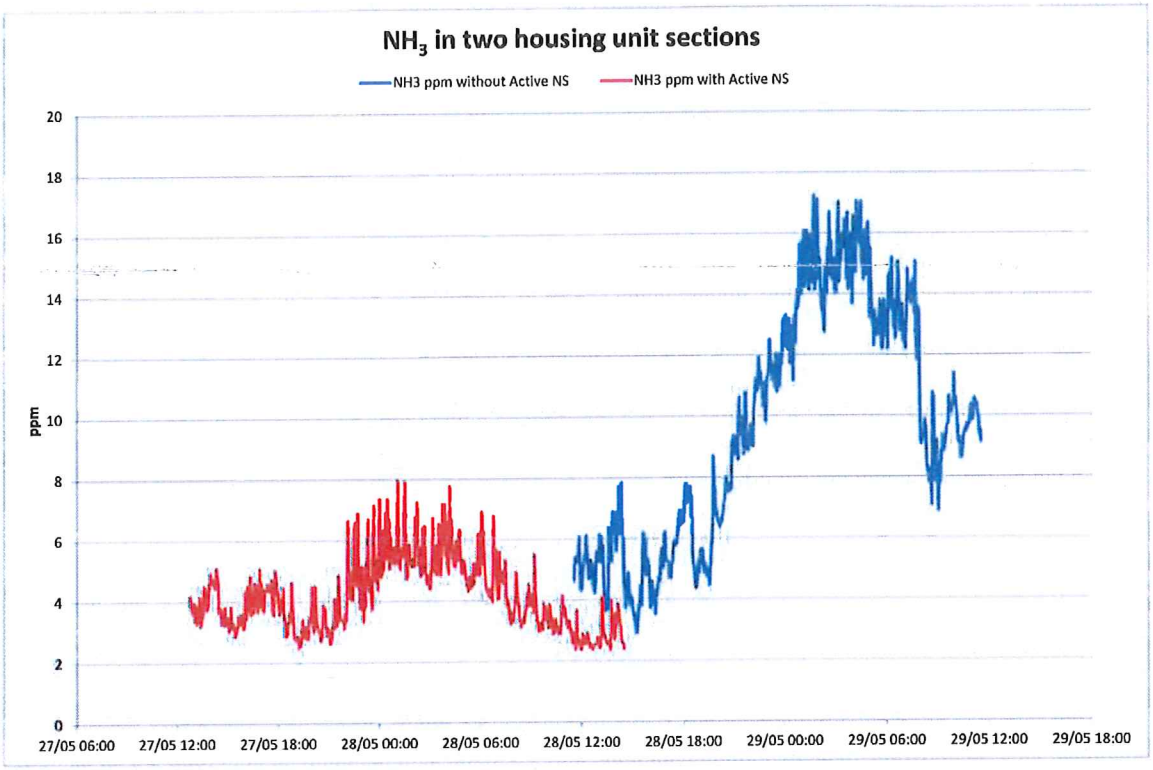

Figure 1 Graph to show ammonia concentrations in two housing unit sections

The measurements were taken in parallel during the period in which the odour samples were extracted.

2.2 Result of previous odour measurements

FORCE Technology took odour measurements in the same two housing unit sections on 5 February 2015 in the period 10:30 to 12:03. Table 4 shows the results of these measurements.

Table 4 Results of odour measurements, 05 February 2015

Housing unit section	Volume flow	Odour			Pigs		
		Concentration	Emission		Number	Weight	Total
	m^3/h (operation)	OU/m^3	OU/s	OU/s/1000 kg of animal		kg/animal	tonnes
1 – With Active NS	7,500	2,480	5,167	125	510	81	41,3
2 – Without Active NS	6,300	4,000	6,999	201	505	69	34,8

Based on emissions per 1,000 kg of pigs, the odour reduction during the measurement period is calculated as 38% when using Active NS.

2.3 Comments on the results

The reduction in odour at the time of measuring on 28 May 2015 is 37%, which is very close to the result of 5 February 2015. Each measurement on 28 May 2015 was taken by sampling four points in the housing unit over a total of half an hour, and assessed to be representative of the measurement period. The average of the three measurements for each housing unit section was assessed to provide a true and fair view of the odour and thus the odour reduction achieved.

Similarly, the results of the continual ammonia measurements are assessed to give a true and fair view of the ammonia concentrations and the reduction in ammonia.

The curves in Figure 1 make it clear that the concentration in the section without Active NS is highest during the sampling period.

The progression of the curve in the time before and after the sampling period is not parallel, but if other conditions are otherwise the same for both housing units (temperature, activity), the curves indicate that Active NS has an effect. It is important to note, however, that ammonia emissions are also dependent on ventilation. However, it must be assumed that the ventilation in both sections is comparable for the same times of day/night.

The concentrations rise at night, when the temperature-controlled ventilation is low. The relative rise is greatest in the section where Active NS is not used.

3 System description

The measurements were taken in sections 1 and 2 of a housing unit comprising four sections. Each section houses approximately 500 pigs for most of their growing period. Towards the end of the growing period, groups of pigs are removed as and when they reach slaughter weight. All sections are ventilated by four ventilators, controlled by the temperature in the housing unit.

In section 1, Active NS is used corresponding to a concentration of 20 g/m^3 of slurry in filled containers.

3.1 Operating conditions during measurements

No particular remarks.

4 Taking the measurements

4.1 Measurement methods

The measurement methods used and their associated uncertainty are described in Appendix A.

The ventilation in the housing unit was not measured, but read from the company's control system (by SKOV Ventilation) in connection with the odour sampling. The ventilation from other periods is unknown, including in respect of the continual measurements of ammonia outside the sampling period.

4.2 Factors of significance to measurement uncertainty

Arrangement of the measurement site
Each housing unit section has four Teflon pipes (external diameter 6.3 mm), one to each of the four ventilators in the section and at the same height as the ventilators. The Teflon pipes lead out through a hole in the wall to the passageway outside the housing unit sections.

During sampling, 1 litre of air per minute was extracted using a vacuum drum (see Appendix A). First, air is extracted through the first hose for 8 minutes, then for 8 minutes through each of the other three to produce a total collection time of 32 minutes. Thus, a mixed sample is taken from four points in the housing unit section. Before the actual sampling, the pump is used to evacuate all four Teflon pipes of "dead" air. The uncertainty as to the representativeness of the samples for the entire section during the measurement period is assessed to be minimal.

In addition, another Teflon pipe (external diameter 4 mm) is fitted at a half-way point in each housing unit section at the same height above the floor as the other Teflon pipes. The positions in the two sections are identical with regard to distance from the monitor and height above the floor. Air for the continual ammonia meter is extracted through this Teflon pipe (see Appendix A). The representativeness for the entire housing unit section is thus not as good as for the odour sampling. As the two positions are the same for the two sections, the representativeness for the comparison between housing unit sections is considered to be good.

Deviations from accredited methods
Measuring ammonia with B&K 1302 is not included in the accreditation, but the measurement was taken in accordance with the same principle as the accredited measurements using continual metering instruments. Thus, a control was performed with nitrogen (zero) and an ammonia blend with known concentrations of ammonia both before and after the measurement. The results were adjusted to take account of any deviations from zero and the known concentration.

Appendix A Measurement methods

Determination of ammonia:

The sample gas is extracted through a cold sampling system where water must not condense out, and where particles are filtered out. A photoacoustic monitor (PAIR) is used, labelled B&K 1302. The PAIR monitor measures the concentration of specific gases by heating the air with pulsating infra-red light using a rotating disk with holes. The gas molecules which are capable of absorbing the infra-red light expand and contract again when the disk turns off the light. This way, fluctuations of between 200 and 300 Hz are formed; these are picked up by a sensitive microphone. The gas concentrations are determined based on the size of the pressure fluctuations. The B&K 1302 contains six different IR filters which filter the IR (infra-red light) depending on the type of gas to be measured. One of the six filters is a water filter, which ensures that there is always an adjustment for absorption resulting from the current water content.

Odour concentration:

Extraction of air/gas sample in a suitable plastic material (Teflon pipe and Nalophan bags) using an evacuated container. When sampling non-humid air (dew point < 20°C), the sample is extracted directly into the bag. When sampling humid air (dew point > 20°C), the sampled air is diluted with nitrogen, which is mixed with the air sample to avoid condensation. The amount of nitrogen dosed is estimated based on information about the water content of the sampled air. At the laboratory, the content of oxygen and/or carbon dioxide is determined in order to establish the degree of dilution of the sample. The air samples are analysed by olfactometry in accordance with Danish Environmental Protection Agency Guideline No. 4/1985.

Measuring range: 25 – 2,000,000 LE/m^3 (20°C,f)

Detection threshold of this method: 25 LE/m^3 (20°C,f)

Uncertainty/Variation: A factor of 1.8 on each side of the measured value (95% confidence interval).

FORCE Technology method: LU-01-01

Reference/standard: DS/EN 13.725, MEL-13