

Effect of Agro Clima Unit on ammonia emission from broiler houses

Test plan



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1 INTRODUCTION

This test plan is developed for the verification of Agro Clima Unit following the Agro-Tech Test Centre Quality Manual.

1.1 Verification protocol reference

This test plan is made to meet the requirements defined in the verification protocol for the Agro Clima Unit.

1.2 Name and contact of proposer

Agro Clima Unit is developed by the Dutch company Agro Supply. In Denmark Agro Clima Unit is marketed and sold by Rokkedahl Energi, Nymøllevej 126B, Kølby, 9240 Nibe, Denmark. Website: www.rokkedahl.dk.

Contact person of Rokkedahl Energi: Mark Rokkedahl. E-mail: adm@rokkedahl-energi.dk. Phone: +45 30 28 72 10.

1.3 Name of test body and test responsible

The test is performed by DANETV, AgroTech, Agro Food Park 15, DK-8200 Aarhus N, Denmark.

Test responsible: Martin N. Hansen. Phone +45 8743 8429. E-mail: mno@agrotech.dk.

2 TEST DESIGN

[The test design refers to the design described in the verification protocol].

2.1 Test site

2.1.1 Types

The test will take place at a commercial poultry farm Rokkedahl A/S. At the farm two equal housing sections will be chosen as test sections (Figure 1). These test sections shall house an equal number and type of broilers and have the same ventilation system apart the technology tested. Besides feeding, manure handling and housing systems shall be equal for case and control test sections. Chickens in both test sections shall be equally feed and shall be simultaneously put into and taken out of production.



Figure 1. Picture of the test sections at the test farm Haubro, Nibe. The test section denoted 4 is the control test section, the test section denoted 3 is the case (ACU) test section.

2.1.2 Addresses

The test will take place at Rokkedahl, Løgstørvej 9600 Aars, Denmark.. Contact person of test site is:

Else Marie Olsen Phone: +45 2272 4650. E-mail: 'elsemarieolsen7@hotmail.com
Mark Rokkedahl. Phone: 40366008. E-mail: Mark@Rokkedahl-landbrug.dk.

2.1.3 Descriptions

The technology evaluated is the Agro Clima Unit (ACU) developed by the company Agro Supply. Broiler production has a high energy requirement in the first part of the production period due the high heat requirement of small chicken. The Agro Clima Unit is a heat exchange system that uses the thermal energy of the outgoing air from the chicken house to heat and dry incoming air by a countercurrent exchange system. The potential ammonia emission reducing principle of the Clima Unit is the drying of the manure layer caused by the the heat exchanger and the continuously circulation ventilation in house. The heated fresh air passing the Clima Unit is blown into the house in the top of the building. The ACU system includes an internal mixing of in-house air which potentially results in homogenisation of in-house temperatures and improved drying of the manure layer.

The Clima Unit is situated next to the poultry house (Figure 2). Air is drawn through the Clima Unit to the ridge of the chicken house and distributed to the front and back side of the building by means of four additional in-house supporting vents. This results in an improved distribution of the fresh air in the building. When air is drawn by ridge vents this is mixed with the air of from the Clima Unit system by means of circulation vents. The mixed air is pushed towards both ends of the building at the top of the house. The mixed internal air is then pushed back towards the centre of the pen above the broilers and the litter layer.



Figure 2. Picture of the Agro Clima Unit situated outside a broiler house. Ventilation air to and from the broiler house are drawn through the Agro Clima Unit by a countercurrent principle to utilise the heat content of ventilation air to heat up inflowing air.

2.2 Tests

2.2.1 Test methods

The overall principle for testing the performance of Agro Clima Unit is to compare the emission of ammonia from a test section attached an Agro Clima Unit (case section) with the emission of ammonia from a equal test section without an Agro Clima Unit (Control section). As broilers are housed in mechanically ventilated housing system, the emission will be measured by simultaneously measurements of ventilation rate and concentration of ammonia in ingoing and outgoing air.

Emission measurements require measurement of the air exchange (ventilation) in the housing system. The ventilation rate will be continuously on-line measured by air anemometers (Stienen 600) situated in ventilation ducts during the test periods.

Concentrations of ammonia in ingoing and outgoing air is continuously on-line measured by use of an on-line automatic photoacoustic multigas analyser (INNOVA, 1412).

The emission of ammonia from the the test units is quantified by the following equation.

$$E_{NH_3_t} = \sum_{i=1}^n V_{i_t} \times (C_{in_{i_t}} - C_{out_{i_t}})$$

where

$E_{NH_3_t}$ = Emission of ammonia from the housing systemet at time t, in mg NH₃ h⁻¹

i = Type of ventilation (roof ventilation, Agro Clima unit, gable wall)

V_{i_t} = Air flow, m³ air h⁻¹

$C_{in_{i_t}}$ = Ammonia concentration in outgoing air at time t

$C_{out_{i_t}}$ = Ammonia concentration in ingoing air at time t

t = time of measurement

The daily emission of ammonia per chicken is quantified by the following equation

$$E_{NH_3} = \sum_{j=0}^n \frac{24}{N_j} \times \bar{E}_{NH_3j}$$

Where

E_{NH_3} = Daily ammonia emission per chicken, mg NH₃ animal⁻¹ day⁻¹

n = number of measuring days

j = Measuring day

N_j = Number of broilers in test section

\bar{E}_{NH_3t} = Mean emission of ammonia from the housing system at day j, in mg NH₃ h⁻¹

The ammonia emission from both case and control sections will be measured over three full production cycles each lasting more than 30 days. To incorporate the yearly climatic change the production cycles one of the measurement periods will be placed in the summer period, one will be placed in the autumn/spring period and one in the winter period.

Ammonia is the primary performance parameter of the test. In addition to the primary performance parameters a number of operational parameters are measured throughout the test period. A list of the operational parameters is found in Table 2.

2.2.2 Test staff

The staffs involved in the test of Agro Clima Unit are:

Søren Rasmussen, AgroTech, Agro Food Park 15, Skejby, DK-8200 Aarhus N.

Phone: +45 3091 0324. E-mail: sor@agrotech.dk

Linda Veggebro, AgroTech, Agro Food Park 15, Skejby, DK-8200 Aarhus N.

Phone: +45 3092 1795. E-mail: liv@agrotech.dk

Amparo Gómez Cortina, AgroTech, Agro Food Park 15, 8200 Aarhus N, Phone: +45 8743 8470, E-mail: aco@agrotech.dk

2.2.3 Test schedule

The test schedule for the performance test is presented in the table below.

Table 1. Test schedule for performance testing of the technology

Task	2012								
	Week no.	37-38	39-40	41-42	43-44	45-46	47-48	49-50	51-52
Test plan preparation		X	X						
Practical planning		X	X						
Period for testing			X	X	X	X			
Test report drafting							X		
Test report quality assurance								X	
Test report final version									X

2.2.4 Test equipment

The equipment used for the test is described in Table 2.

Table 2. Analytic methods and detection limits and uncertainty of the measure equipment used for measurement of the different relevant parameters.

Parameter	Analytical method	Limit of detection	Uncertainty
NH ₃	ISO 7150/2, Photo acoustic multigas analyser	0,20 mg/m ³	15 % RSD
CO ₂	ISO 7150/2, Photo acoustic multigas analyser	1,5 mg/m ³	---
CH ₄	ISO 7150/2, Photo acoustic multigas analyser	0,4 mg/m ³	---
N ₂ O	ISO 7150/2, Photo acoustic multigas analyser	0,03 mg/m ³	---
Temperature	VE10 universal input from VENG system combined with a temperature sensor	---	0,2 °C
Relative humidity	VE14 universal input from VENG system combined with a humidity sensor	---	---
Ventilation	Air anometers, ø 600, Stinen.	---	---

Note: RSD: Relative standard deviation.

The accuracies of the measurement techniques described above are given in Table 2. The accuracies of the photo acoustic analyser are expressed by the standard error under repeatability conditions, show levels that are within 1% to 3% range (Mosquera et al., 2002; Mosquera et al., 2005 ; Ogink, 2005).

2.2.5 Type and number of samples

Table 3 shows the primary measurement parameters, and the analytical method and number and length of sampling periods.

Table 3. Primary analytical parameters, numbers of samples and corresponding analytical methods.

Parameter	Analytical method	Number of samples	Length of sampling period
Ammonia	ISO 7150/2, NIOSH6015, VDI 2461/1 Innova 1412	Continuously sampling during three poultry produktions periods.	Each sampling period lasts more than 30 days

2.2.6 Operation conditions

Operational parameters like in-house and outdoor temperature, air humidity, and ventilation rate will be continuously on-line measured during the test periods. Mechanical breakdown of technology or housing system will be recorded during the test period by a logging protocol.

2.2.7 Operation measurements

The operation measurements will be measured by equipment described in Table 2

2.2.8 Maintenance

During the test periods the maintenance of the Agro Clima Unit will be performed according to the scheduled maintenance plan. No additional maintenance shall be per-

formed unless the maintenance company is contacted by the farmer due mal function of the equipment. The reason for contact to the maintenance company, the length of the down time period, and the maintenance performed by the maintenance company shall be reported by the farmer and the maintenance company in a logging file, situated at the farm.

For more information see Agro Supplies operational manual.

2.2.9 Health, safety and wastes

As the Agro Clima Unit does not affect health, safety and waste, these issues will not be evaluated

3 ANALYSIS AND MEASUREMENTS

3.1 Analytical laboratory

Manure samples taken at the test farms will be analysed by Eurofins Denmark. Address: Smedskovvej 38, DK-8464 Galten, Denmark. Phone: +45 7022 4266. E-mail: info@eurofins.dk.

3.2 Analytical and measurement parameters and methods

The gas analytic equipment is thoroughly calibrated once per year by Lumascence technology, according to the AgroTech Test Centre Quality Manual. During sampling periods the performance of equipment is daily inspected for irregularities. If irregularities are found, the system is inspected, recalibrated and repaired if requested.

Three time per production cycle inhouse concentrations of measured ammonia and CO₂ Concentrations shall be compared with concentrations obtained by use of precision gas detector tubes (Kitagawa, range 2-20 ppm). If irregularities are found the measuring system is inspected, repaired and recalibrated if requested.

3.3 Analytical and measurement performance requirements

All sample analyses will be analysed by external laboratories accredited for the specific analyses.

Performance requirements for gas measurements Control for performance, analyses and measurements can be seen in

3.4 Preservation and storage of samples

All manure samples shall be sampled in airtight storage systems. If samples are not analysed within 24 hours after sampling, samples shall be stored at -18 °C before analyzed. All samples will be analysed by analytical laboratories. There is not need of preservation or storage of samples, that there has not been sampling of samples during this test.

3.5 *Data management*

Data management including filing and archiving procedures are described in the AgroTech Test Centre Quality Manual. Results from external laboratories are sent to AgroTech test staff electronically by email or in paper version by mail. The procedure for receiving external data from laboratories is described in the AgroTech Test Centre Quality Manual.

3.6 *Data storage, transfer and control*

Data concerning the performance of technology and the broiler production shall be reported daily by the test staff at the test site in pre-prepared log books. Appendix 6 includes data recording sheets to be used for registration of these data.

The procedure for archiving test plans, test reports, and internal and external data is described in the AgroTech Test Centre Quality Manual. An overview of the data compilation and storage can be seen in Table 4.

Table 4. Data compilation and storage summary.

Data type	Data media	Data recorder	Data record timing	Data storage
Test plan and test report	Protected pdf-files.	Test responsible	When approved	Files and archives at AgroTech
Data manually recorded at test site	Data recording forms	Test staff at test site	During collection	Files and archives at AgroTech
Calculations	Excel files	Test responsible, AgroTech	During calculation	Files and archives at AgroTech
Analytical reports	Paper / pdf-files	Test responsible, AgroTech	When received	Files and archives at AgroTech

4 *QUALITY ASSURANCE*

4.1 *Test plan review*

The test plan will be subject to internal review by the verification responsible from AgroTech Test Centre.

External review of the test plan will be done by Arne Grønkjær Hansen, the technical expert assigned to this verification task.

4.2 *Performance control – analysis and measurements*

Control for performance, analyses and measurements can be seen in 3.3

4.3 Test system control

The stability of the test equipment is controlled continuously by daily supervision and recording of data. Procedures for ensuring that test facilities and equipment are calibrated and fit for the purposes are described in the Quality Manual for the Laboratories of AgroTech. These procedures are subject to internal audits from the AgroTech Management.

4.4 Data integrity check procedures

All transfers of data from printed media to digital form and between digital media are checked by spot check undertaken by test responsible. If errors are found in a spot check, all data transfers from the specific data collection are checked.

4.5 Test system audits

Internal audits from AgroTech will be done following the procedure described in the AgroTech Test Centre Quality Manual.

4.6 Test report review

The test report will be subject to internal review by the verification responsible from AgroTech Test Centre.

External review of the test report will be done by Arne Grønkjær Hansen (TI), who is the technical expert assigned to this verification task as part of the review of the verification report. The test report shall be seen as an integrated part of the verification report.

5 TEST REPORT

The test report will follow the template of the AgroTech Test Centre Quality Manual and will be included as an appendix in the verification report.

5.1 Amendment report

In the test report there is a section on amendments to and deviations from the test plan. This section will compile all changes of the test plan occurring before testing with justification of deviations and evaluation of any consequences for the test data quality.

5.2 Deviations report

In the test report there is a section on amendments to and deviations from the test plan. This section will compile all changes of the test plan occurring during testing with justification of deviations and evaluation of any consequences for the test data quality.

6 REFERENCES

AgroTech 2009. AgroTech Test Centre Quality Manual. Not published.

Mosquera, J., P. Hofschreuder, J. W. Erisman, E. Mulder, C. E. van 't Klooster, N. Ogink, D. Swierstra, and N. Verdoes. 2002. Methods for measurement of gaseous emissions from animal husbandry (in Dutch). Report 2002-12. Wageningen, The Netherlands: Instituut voor Milieu- en Agritechniek (IMAG), Wageningen UR.

Mosquera J.; Monteny G.J.; Erisman J.W. 2005. Overview and assessment of techniques to measure ammonia emissions from animal houses: the case of the Netherlands. Environmental pollution 135:(3), 381-388.

Ogink, N. W. M., 2005. Unpublished data. Wageningen, The Netherlands: Agrotechnology and Food Innovations, Wageningen UR.



A P P E N D I X A

Terms and definitions

Word	DANETV
Analytical laboratory	Independent analytical laboratory used to analyse test samples
Application	The use of a product specified with respect to matrix, target, effect and limitations
DANETV	Danish center for verification of environmental technologies
(DANETV) test center	Preliminary name for the verification bodies in DANETV with a verification and a test sub-body
Effect	The way the target is affected
(Environmental) product	Ready to market or prototype stage product, process, system or service based upon an environmental technology
Environmental technology	The practical application of knowledge in the environmental area
Evaluation	Evaluation of test data for a technology product for performance and data quality
Experts	Independent persons qualified on a technology in verification
Matrix	The type of material that the product is intended for
Method	Generic document that provides rules, guidelines or characteristics for tests or analysis
Performance claim	The effects foreseen by the vendor on the target (s) in the matrix of intended use
Performance parameters	Parameters that can be documented quantitatively in tests and that provide the relevant information on the performance of an environmental technology product
Procedure	Detailed description of the use of a standard or a method within one body
Producer	The party producing the product
Standard	Generic document established by consensus and approved by a recognized standardization body that provides rules, guidelines or characteristics for tests or analysis
Target	The property that is affected by the product
Test center, test sub-body	Sub-body of the test center that plans and performs test

Word	DANETV
Test center, verification sub-body	Sub-body of the test center that plans and performs the verification
Test/testing	Determination of the performance of a product for parameters defined for the application
Verification	Evaluation of product performance parameters for a specified application under defined conditions and adequate quality assurance



A P P E N D I X B

Reference methods



Here are reference methods described.
The reference methods are described in section 3.3.



A P P E N D I X C

In-house test methods



Here are in-house test methods described.
The in-house test methods are described in section 2.2.1.



A P P E N D I X D

In-house analytical methods and measurements



No in-house analytical methods or measurements will be performed. All analyses will be performed by external analytic laboratories.



A P P E N D I X E

Data reporting forms

Table 7. Key characteristics of the test farm.

Parameter	Test site characteristics
Farm owner	Mark Rokkedahl
Address	Ny Møllevej 126b, 9240 Nibe / Løgstørvej 9600 Aars
Contact Info	Mark Rokkedahl : +45 4036 6008
Number of animal places	31.000
weight range (g)	46 - 2453 gram
Bedding material and amount	sawdust
Space of test section	17 m wide, 90 m long, 5,5 m height (kip)
Manure removal system	All manure was cleaned out of test section between each production cycle.
Feed composition	Depending on production cycle
Feeding system	Automatic feeding system
Ventilation	Skov , DOL92A