

# VERA VERIFICATION STATEMENT

## VERIFICATION OF ENVIRONMENTAL TECHNOLOGIES FOR AGRICULTURAL PRODUCTION

It is hereby stated (verified) that

### **Technology:**

#### **Munters Air Cleaner Version 1.0**

(with maximum capacity of 25,000 m<sup>3</sup> air h<sup>-1</sup>)

#### **Manufactured by: MUNTERS A/S**

has been tested according to the VERA test protocol for  
Air Cleaning Technologies version 1, September 2010.

The following main results have been documented through the test:

#### **Verified environmental efficiency:**

Ammonia emission reduction efficiency at 89 % when applied for finishing pig units  
The air cleaner has no verified reducing effects on odour or dust emissions

#### **Verified operational stability:**

The Munters Air Cleaner Version 1.0 has demonstrated a satisfactory operational stability

A handwritten signature in blue ink, appearing to read 'Thomas Bruun', is written over a horizontal line.

*Mr. Thomas Bruun, Managing Director, ETA-Danmark A/S*

### *Exemption of liability*

ETA-Danmark A/S does not endorse, certify or approve technologies. VERA verifications are based on an evaluation of the technology performance under specific, predetermined criteria and the appropriate quality assurance procedures.

VERA as a representative for the Danish EPA, the German Federal Ministry of Food, Agriculture and Consumer Protection and the Dutch Ministry of Infrastructure and Environment make no expressed or implied warranties as to the performance of the technology and do not certify that a technology will always operate as verified.

The end user is solely responsible for complying with any and all applicable federal, state, and local requirements. Further the end user must be aware that the countries involved in VERA are having different legal requirements which will influence the status and use of this verification statement in each country.

## The VERA Organisation

VERA – Verification of Environmental Technologies for Agricultural Production – is an international organisation for test and verification of environmental technologies for agricultural production. VERA is established as a co-operation between the Danish Environmental Protection Agency, the Dutch Ministry of Infrastructure and Environment and the German Federal Ministry of Food, Agriculture and Consumer Protection.

The purpose of VERA is to enhance a well-functioning market for environmental technologies to increase the environmental protection of agricultural production by substantially accelerating the acceptance and use of improved and cost-effective environmental technologies.

VERA verifies the performance of technologies by carrying out tests according to pre-defined test protocols. A VERA Verification Statement secures validated documentation for the environmental efficiency and operational stability of the technology and is an important step in introducing the technology to the market. Based on information from the test reports, the VERA Verification Statement gives a general and short description of the technology, its principle of operation, and the main results and conclusions from the VERA test.

## Applicant Data

Technology type	Chemical air cleaner with at maximum capacity on 25,000 m <sup>3</sup> air h <sup>-1</sup> applied for finishing pig units
Applied for	Reduction of ammonia from exhaust air of forced-ventilated animal housing systems
Technology name	Munters Air Cleaner (MAC) Version 1.0
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Test institute	Pig Research Centre, Danish Agriculture and Food Council, Axeltorv 3, 1609 København V, Denmark

## Technology Description

The Munters Air Cleaner (MAC) version 1.0 is a chemical air cleaning system without filters, with mist eliminators using water acidified with sulphuric acid. The maximum airflow through the air cleaner is  $25,000 \text{ m}^3 \text{ air h}^{-1}$ . The air cleaner was regulated by setting the target pH to 2.0. The MAC was installed and tested at two pig finishing units. Exhaust air is supplied from the side of the finishing unit through two connection tubes each with a diameter of 830 mm. Air flows through the tube and into the cleaning chamber where sulfuric acid solution is sprayed into the air stream via nozzles. At the top of the air cleaner, the air passes through two mist eliminators retaining the acidic water in the air cleaner. Intercepted acidic water is dripped back into the cleaning chamber from the mist eliminators and is recirculated to the nozzles.

The cleaning chamber is 1.9 m high with a diameter of 1.6 m and a total volume of  $3.8 \text{ m}^3$ . The sump in the bottom of the air cleaner has a volume of 450 L, which serves as a process tank for recirculating the acidic water. To avoid precipitation of  $(\text{NH}_4)\text{SO}_4$ , a small amount of water was discharged and replaced with fresh water each day for 20 seconds. This corresponds to an additional clean water consumption of about 50 L, which was pumped into the discharged water.

## Test Design

The MAC air cleaner was tested in Denmark by the Danish Pig Research Centre (VSP) who carried out a VERA test at two test sites that in the following are named test site A and test site B, respectively.

### Test site A

At test site A the MAC was tested at a pig finishing unit consisting of 24 pens housing 525 pigs. The finishing unit was 30.0 m long and 12.3 m wide. The walls were 2.8 m high and there was a ceiling with a 30 degree roof pitch. Each pen was 5.75 m long and 2.5 m wide. The floor consisted of 1.75 m slatted flooring, 2.0 m drained flooring and 2.0 m slatted flooring.

The feeding system was dry meal feed ad libitum. During the production period, only one feed mix was used (31.5 kg to slaughter weight), and the raw protein content was 15.0 %. Between each batch of finishing pigs, the finish unit was cleaned, disinfected and dried before new pigs entered the unit.

The unit had a system for vacuum flushing of the slurry that was divided into 13 transverse channels with one plug per channel. The slurry channel was 60 cm deep.

The air inlet consisted of 36 wall inlets. There were three existing exhaust outlets in the finishing unit, but only two were used during the test period. The third exhaust outlet was closed and was not used in the test period.

The MAC was placed outside the finishing unit. The maximum airflow capacity through the air cleaner was  $25,000 \text{ m}^3/\text{h}$ . Half of the ventilation air from the pig unit passed through the air cleaner, and the other half passed through the fans placed in ceiling.

## **Test site B**

At test site B the MAC was tested at a pig finishing unit consisting of 21 pens housing a total of 420 pigs. The finishing unit was 24.8 m long and 13.3 m wide. The walls were 2.12 m high and there was a ceiling with a 30 degree roof pitch. Each pen was 6.1 m long and 2.3 m wide. The floor in the pens consisted of 1.0 m solid flooring and 5.7 m slatted flooring. However, under and beside the feeding trough there was also solid floor. The total solid area in the pen was 38%.

The feeding system was wet feed and the feeding times were at 7:00, 11:00, 15:00 and 21:00 hours. During the production period, one feed mix was used (from 30-100 kg). The raw protein content in the feed mix was 15.7 %. Between each batch of finishing pigs, the finish unit was cleaned, disinfected and dried before new pigs entered the unit.

The unit had a system for vacuum flushing of the slurry that was divided into transverse channels with one plug per channels. The manure channel was 1.0 m deep, but the slurry was flushed out at a height of approximately 40 cm.

The air inlet consisted of 27 wall inlets.

The MAC was placed outside the finishing unit. The maximum airflow capacity through the air cleaner was 25,000 m<sup>3</sup>/h. Instead of cleaning a fixed percentage of the pig unit ventilation air as at test site A, the cleaner treated all ventilation air until the ventilation requirements exceeded the maximum capacity of 25,000 m<sup>3</sup> h<sup>-1</sup>. Additional outlet capacity was then provided by two fans in the ceiling (totally 17,000 m<sup>3</sup> h<sup>-1</sup> in the pig unit).

## **Test periods**

The MAC was tested at test site A in the period from February 2012 to February 2013. Ammonia measurements were carried out in one summer period from 20 May to 1 August 2012 and during to winter periods from 3 March to 19 April 2012 and 17 December to 9 January 2013, respectively.

The MAC was tested at test site B in the period from 19 August 2010 to 4 August 2011. Ammonia measurements were carried out in one summer period from 25 May to 13 July 2011 and during one winter period from 11 October and 13 December 2010.

The ammonia concentrations were measured using INNOVA 1412 photoacoustic gas analyser.

# Test Results

## Environmental Efficiency

### Ammonia reduction

The measured ammonia concentrations before and after the MAC air cleaner at test site 1 and 2 are presented in table 1. The mean ammonia removal efficiencies and the overall ammonia removal efficiency are presented in table 2.

**Table 1:** Ammonia concentration before and after the air cleaner during the summer and winter test periods together with ammonia removal efficiency.

		Summer		Winter	
		Before the air cleaner	After the air cleaner	Before the air cleaner	After the air cleaner
Test site 1	Ammonia concentration (ppm)	10.50	1.32	19.50	1.79
	Ammonia reduction (%)	87.4		90.1	
	Ammonia emission (g NH <sub>3</sub> -N hour <sup>-1</sup> pig <sup>-1</sup> )	0.32	0.036	0.16	0.016
Test site 2	Ammonia concentration (ppm)	11.5	1.95	21.5	1.50
	Ammonia reduction (%)	83.0		93.0	
	Ammonia emission (g NH <sub>3</sub> -N hour <sup>-1</sup> pig <sup>-1</sup> )	0.263	0.047	0.107	0.007

**Table 2:** Reduction percentages of ammonia by the air cleaner given for test site 1 and 2, respectively, and as the overall mean.

Ammonia reduction (%)	Mean
Test site 1 summer	87.4
Test site 1 winter	90.8
Test site 2 summer	83.0
Test site 2 winter	93.0
Overall	88.6

<sup>a</sup> Raw data not available

The ammonia emission was on average reduced with 89 %, when air was passed through the filter.

## *Operational Stability*

The test proved that the air cleaning system had satisfying operational stability. The MAC air cleaner is delivered with a complete user manual, which describes relevant directions for system operation, maintenance and safety.

Particularly, the following issues shall be observed as described in the use manual:

- Pressure drop over the filter: The user shall ensure that the mist eliminators are clean
- pH-level: The user shall monitor and register the pH-level and it shall be ensured that the level is maintained at  $2 \pm 0,5$
- Electricity consumption: The user shall monitor and register the electricity consumption
- Use of sulphuric acid: The user shall monitor and register the amount of sulphuric acid used per kg ammonia
- Water consumption: The user shall monitor and register the consumption of water
- It is important to ensure emergency ventilation as the air cleaner is connected directly to the pig units ventilation systems.

No technical problems during the test periods that led to Air cleaner to stop. 100 % uptime during the test period was registered.

The Air cleaner shall be inspected at least every 6 months and all necessary maintenance shall be carried out in accordance with the instructions from Munters A/S

## *Identified Side Effects*

None observed.

## *Additional Results*

None observed.

## **Additional Information**

No additional information.

## **Test Institutes**

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## Validity and Terms of Use

### *Validity*

This VERA Verification Statement is only valid for the specific verified product/technology and the tested animal category. There is no time limit for the validity of this VERA Verification Statement as long as the product/technology stays unmodified.

ETA-Danmark A/S can, however, at any time invalidate the VERA Verification Statement if it is found to be misused or if significant modifications have been made to the product/technology that are estimated to have a negative effect on the environmental efficiency or operational stability. In regard to the latter ETA-Danmark A/S can require that a new VERA test should be performed.

### *Terms of Use*

The use of this VERA Verification Statement must be in compliance with these terms:

- Munters A/S must inform ETA-Danmark A/S if any modifications are applied to the technology that can significantly influence the environmental efficiency and/or the operational stability
- This verification cannot be considered an endorsement, approval, authorization or warranty of any kind, and the performance parameters provided cannot be extended to other applications or to other technologies
- Munters A/S agrees not to use this VERA Verification Statement, the test reports, or to refer to those for any other technology than the one specified in the statement.
- The VERA Verification Statement will be made available for public access at the ETA-Danmark website: [www.etadanmark.dk](http://www.etadanmark.dk).
- All other information obtained or produced during the verification process is considered confidential and will not be made available for others than the part owning the intellectual property rights.

## Contact Information

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