

ENVIRONMENTAL TECHNOLOGY VERIFICATION



ETV Verification Statement

Technology type	Biological aircleaner	
Application	Reduction of emissions of odour, ammonia and dust from pig houses	
Technology name	Dorset Biological Combi-Aircleaner	
Company (vendor)	Rotor A/S	
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DANETV, The Danish Centre for Verification of Climate and Environmental Technologies, undertakes independent tests of environmental technologies and monitoring equipment.

DANETV is a co-operation between five technological service institutes, DHI, Danish Technological Institute, FORCE Technology, Delta and AgroTech. DANETV was established with financial support from the Danish Ministry of Science, Technology and Innovation. Information and DANETV documents are available at www.etv-denmark.com.

AgroTech Verification Centre undertakes verifications of environmental technologies for the agricultural sector. The verifications and tests are planned and conducted in accordance with the guidelines for the ETV Scheme currently being established by the European Union.

This verification statement summarizes the results from the ETV test of the Dorset Biological Combi-Aircleaner applied for reduction of odour, ammonia and dust emissions from pig houses.

Descriptions of technology

The Dorset Biological Combi-Aircleaner is designed to reduce emissions of ammonia, odour and dust in ventilation air from livestock buildings through a biological air cleaning process. The air cleaner is a biotrickling filter using a counter current water and air flow.

The filter material is made of plastic and consists of a plurality of feeding pipes with 90° bends for every 10 cm. Exhaust air from an animal house enters the filter in the bottom and leaves the filter in the top. The filter is sprinkled both from the top and bottom with water to keep the filter wet and to remove loose biofilm and dust. The filter is sprinkled with recycled water from a reservoir built in the filter.

Ammonia, odour and dust are absorbed by the liquid and made available to microorganisms. The microorganisms are immobilized in a biofilm on the surface of the filter material. This biofilm partly degrades ammonium into nitrite and nitrate and odours and dust into carbon dioxide and water.

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Discharged water is replaced with fresh water according to the conductivity which is measured online and kept at a constant level. When the conductivity reaches a defined level, a small dose of filter water is discharged from the reservoir. Fresh water is added to the water reservoir whenever water is drained or a significant amount has evaporated. Figure 1 shows the Dorset Biological Combi-aircleaner seen from the outside installed next to a pig house (left) and a drawing of the aircleaner from the inside (right).

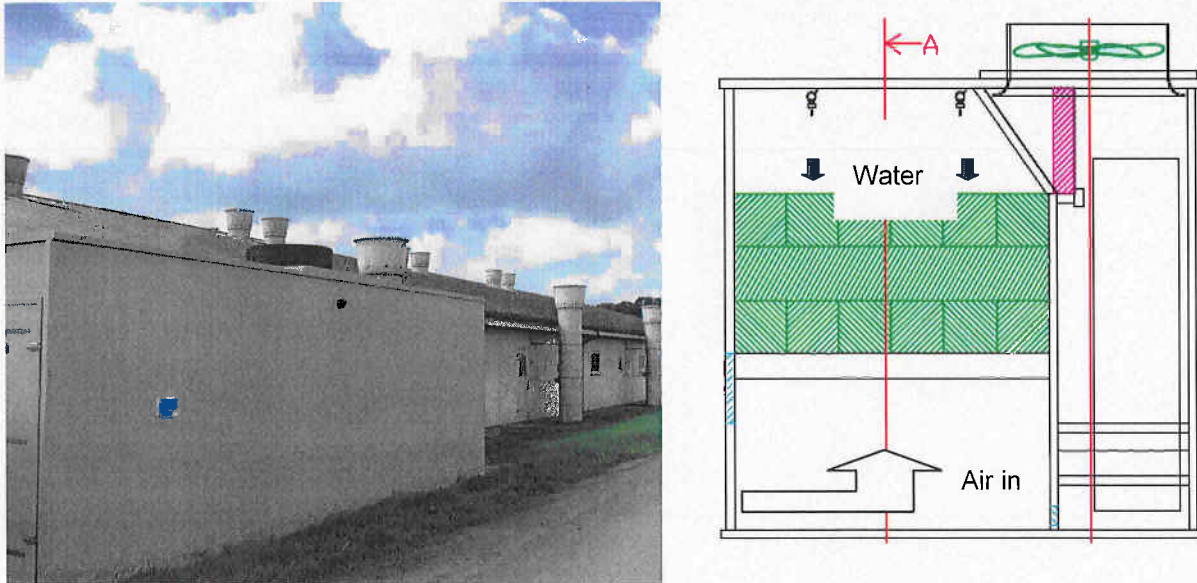


Figure 1. Dorset Biological Combi-Aircleaner seen from the outside, left, and from the inside, right. The green cubes indicate the filter material. The purple square is a water drop collector.

Application of technology

The intended application of the Dorset Biological Combi-Aircleaner is defined in terms of the matrix, the target and the effect of the air cleaner.

The matrix is the type of material that the product is intended for. Targets are the measurable properties that are affected by the Dorset Biological Combi-Aircleaner. The effects describe how the targets are affected by air cleaner.

Matrix	The matrix of the application is ventilation air from forced-ventilated pig housing systems in Denmark, Germany, the Netherlands and other countries with similar temperature regimes and housing systems.
Targets	The targets of the application are concentrations of ammonia, odour and dust (PM10, PM 2.5 and total) in the ventilation air leaving the air cleaner. These are the primary performance parameters.
Effects	<p>The effects of the application are removal performance with respect to the targets, ammonia, odour and dust. The removal performance is expressed as reduction in concentrations in ventilation air leaving the air cleaner compared to ventilation air entering the air cleaner. The effects for application are set in terms of average and 95% confidence interval.</p> <p>In addition to the claimed effects on the primary performance parameters additional parameters such as pressure loss, electricity consumption and water consumption are also evaluated.</p>

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Exclusions	<p>The test is designed to document the performance of the Dorset biological Combi-Aircleaner installed in housing systems for pig production only. In this test there is no intention to document the effect of the Dorset biological Combi-Aircleaner installed in housing systems for poultry, cattle or other animal types.</p> <p>The test is not intended to produce results that necessarily are valid if the Dorset biological Combi-Aircleaner is installed in pig housing systems that differ significantly from the state-of-the-art pig housing systems in Denmark, Germany and the Netherlands.</p> <p>Similarly, the test is not taking into account the impact on performance if the Dorset biological Combi-Aircleaner is installed in a pig housing system located in a region with climate conditions that vary significantly from the climate conditions in Denmark, Germany and the Netherlands.</p>
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Description of test

The overall principle for testing the performance of the Dorset Biological Combi-Aircleaner is to take samples of the air led into the cleaner (inlet air) and samples of the air leaving the air cleaner (outlet air). These sets of samples are analyzed with respect to concentrations of the primary performance parameters, odour, ammonia and dust (see verification report for details). By comparing the concentrations of inlet air and outlet air it is possible to calculate the removal performance of the air cleaner. The removal performance will be expressed as:

- The removal performance over the basis of 6 months covering measurements done during summer period and measurements during winter period.
- The removal performance during the summer period.

In addition to the primary performance parameters a number of operational parameters are measured throughout the test. A list of the operational parameters is found in the test report.

Verification results

This section summarizes the results of the test and verification as described in the test report and verification report respectively. In the 6 tables below the test measurements are summarized.

Table 1. Results of ammonia measurements including the estimated sample means and 95% confidence intervals (shown in square brackets). Measurements are made at the inlet and the outlet of the filter, and the reduction is calculated as the reduction over the filter, relative to the inlet level.

Ammonia	Inlet-concentration mg NH ₃ /m ³	Outlet-concentration mg NH ₃ /m ³	Reduction % of inlet-conc.
Summer measurements	4.5 [3.2; 6.4]	1.5 [0.8; 2.9]	67.1
Summer and winter measurements	7.8 [5.0; 12.1]	2.2 [1.3; 3.5]	72.2

Table 2. Results of odour measurements including the estimated sample means and 95% confidence intervals (shown in square brackets). Measurements are made at the inlet and the outlet of the filter, and the reduction is calculated as the reduction over the filter, relative to the inlet level.

Odour	Inlet-concentration OU _E / (s x ton)	Outlet-concentration OU _E / (s x ton)	Reduction % of inlet-conc.
Summer measurements	469 [132; 1670]	220 [21; 2330]	53 [23; 71]
Summer and winter measurements	359 [89; 1450]	215 [30; 1520]	40 [10; 60]

* Results of odour measurements are expressed per ton of animals.

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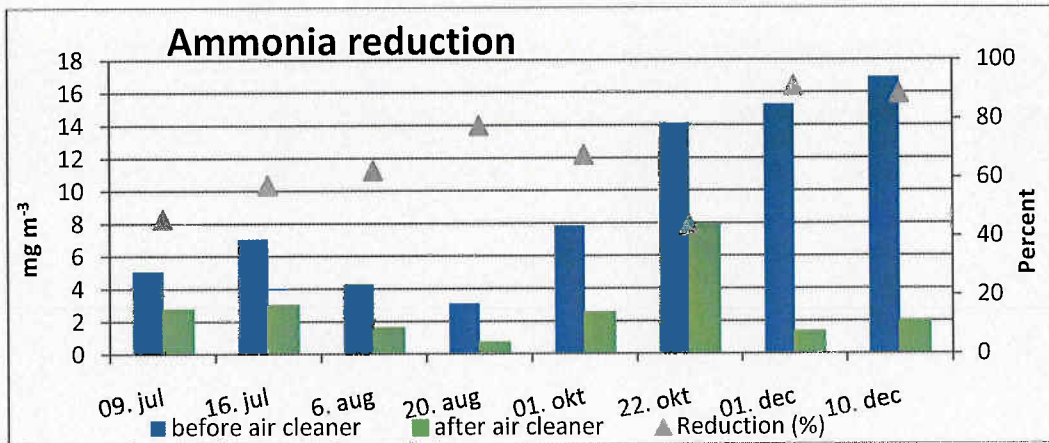


Figure 1. Concentration of ammonia before and after the air cleaner and reduction in %.

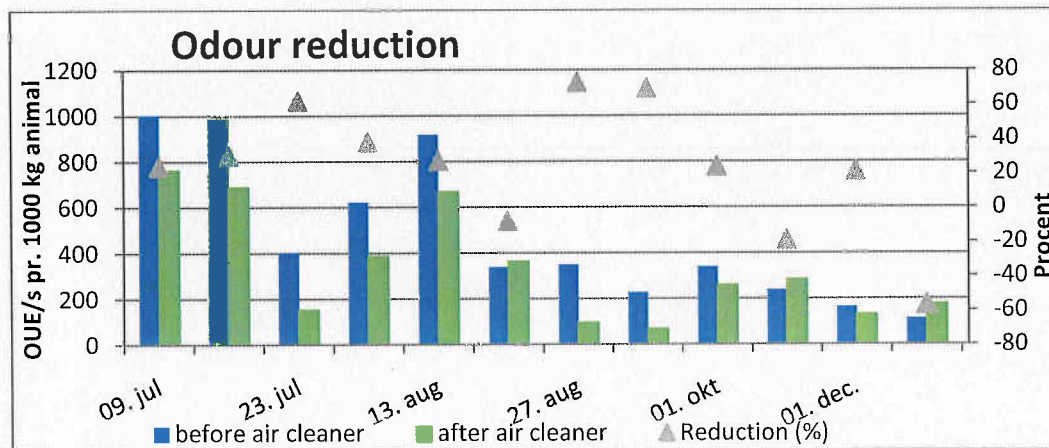


Figure 2. Concentration of odour before and after the air cleaner and reduction in %.

Table 3. Results of PM 2.5 measurements including the estimated sample means and 95% confidence intervals (shown in square brackets). Measurements are made at the inlet and the outlet of the filter, and the reduction is calculated as the reduction over the filter, relative to the inlet level. BLD: below detection limits.

Dust – PM 2.5	Inlet-concentration µg/m ³	Outlet-concentration µg/m ³	Reduction % of inlet-conc.
Summer measurements	BDL	BDL	-
Summer and winter Measurements	57.1 [0; 132.5]	7.4 [5.1; 9.6]	87.1

* Results from summer measurements are below detection limits and calculation of reduction is based on winter measurements only, therefore only winter values are considered here.

Table 4. Results of PM 10 measurements including the estimated sample means and 95% confidence intervals (shown in square brackets). Measurements are made at the inlet and the outlet of the filter, and the reduction is calculated as the reduction over the filter, relative to the inlet level.

Dust – PM 10	Inlet-concentration µg/m ³	Outlet-concentration µg/m ³	Reduction % of inlet-conc.
Summer measurements	81.3 [40.3; 122.2]	37.9 [8.1; 67.7]	53.4
Summer and winter measurements	100.8 [51.1; 150.4]	47.8 [28.5; 67.0]	52.6

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Table 5. Results of Total dust measurements including the estimated sample means and 95% confidence intervals (shown in square brackets). Measurements are made at the inlet and the outlet of the filter, and the reduction is calculated as the reduction over the filter, relative to the inlet level.

Dust – Total	Inlet-concentration µg/m ³	Outlet-concentration µg/m ³	Reduction % of inlet-conc.
Summer measurements	147.5 [60.8; 234.3]	51.4 [11.2; 91.6]	70.4
Summer and winter measurements	162.3 [89.3; 235.2]	72.5 [39.2; 105.7]	55.3

Table 6. Results of consumption and pressure loss, estimated sample means. Consumption of electricity, water and waste water production are given per produced pig. Pressure loss is given as the maximum pressure loss through the air cleaner.

Operational parameters	Electricity consumption kWh/pig	Water consumption L/pig	Waste water production L/pig	Maximum pressure loss Pa
Summer and winter measurements	18	408	186	47

Evaluation of performance parameters

Table 7. Evaluation of performance parameters for the Dorset biological Combi-aircleaner


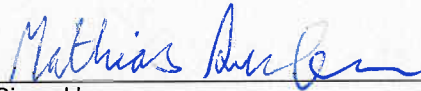
Performance parameter	Claimed performance	Verified performance
Ammonia, % reduction	Min. 70	72
Odour, % reduction	Min. 80	40
Dust, PM 2.5, % reduction	Min. 60	87.1
Dust, PM 10, % reduction	Min. 60	52.6
Dust, Total, % reduction	Min. 60	55.3
Pressure loss, Pa through filter	Max. 40	47
Electricity consumption (kWh/produced pig)	Max. 25	18
Water consumption (L/produced pig)	350 – 700	408

On the basis of this test the claims for ammonia, PM2.5, electricity consumption and water consumption have been confirmed. The claim for removal efficiency of odour could not be confirmed based on the results from this test and the verified performance is only half of the expected performance. The claims for PM10, total dust and pressure loss could not be confirmed but the verified performance is close to the expected values.

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Quality assurance

The test and verification have been performed according to the AgroTech Test Centre Quality Manual. As a part of the quality assurance two technical experts provided review of the planning, conducting and reporting of the verification and tests.

	29.04.10		29.04.10
Signed by Lars Byrdal Kjær AgroTech Management representative	Date	Signed by Mathias Andersen Verification responsible, AgroTech	Date

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