Statement of Verification

Technology:	AgroBioClean
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Verification Body		**Proposer**	
Name:	ETA-Danmark A/S	Name:	Assentoft Silo A/S
Contact:	Thomas Bruun	Contact:	Peter Damgaard Nielsen
Address	Göteborg Plads 1 DK-2150 Nordhavn	Address:	Silovej 1 DK-8960 Randers SØ Denmark
Telephone:	+45 72 24 59 00	Telephone:	+45 86 49 45 66
E-mail:	tb@etadanmark.dk	E-mail:	info@assentoftsilo.dk
Web:	www.etadanmark.dk	Web:	www.assentoftsilo.dk

Signed,

Verification Body

Proposer

DANAK
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Medlem af EA MLA

Verified according to the ISO Standard 14034 on Environmental Management: Environmental Technology Verification

Statement of Verification is available at: https://ec.europa.eu/environment/ecoap/etvg

1. Technology description

AgroBioClean is a technology to reduce nitrogen content in slurry to facilitate a more balanced application of nutrients to the fields in regions with high livestock density. First, some organic matter is separated from the raw slurry. Then, the liquid fraction from the pre-separation is purified in AgroBioClean in a number of process steps involving both nitrification and denitrification reactors.

The AgroBioClean purification process converts the main part of nitrogen in the slurry to nitrogen gas (N_2), which is lead to the atmosphere, where it has no negative environmental effect. During the pre-separation part of the phosphorous is separated from the raw slurry before treatment of the liquid fraction in AgroBioClean. Additional phosphorous can be filtrated from the liquid output fraction from AgroBioClean after the purification process steps.

AgroBioClean is built into a container, which can easily be transported and installed at a livestock production facility. Figure 1 is a cross-section of the AgroBioClean-container.

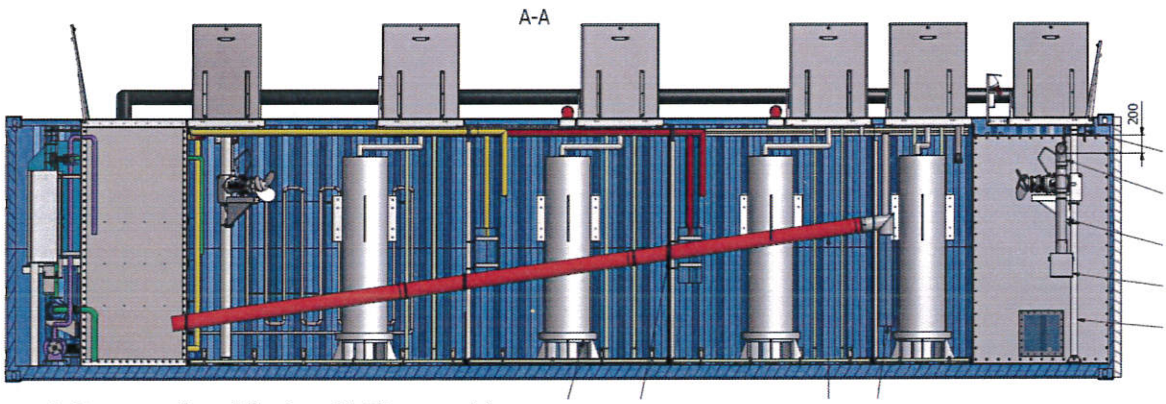

Figure 1. Cross-section of the AgroBioClean container.

2. Application

The intended application of AgroBioClean is described in terms of the matrix and the purpose.

2.1. Matrix

The matrix refers to the type of material the technology is intended for. AgroBioClean is developed for treatment of all types of livestock slurry but the present verification focusses on measuring the performance on pig slurry.

2.2. Purpose

The purpose is a measurable property that is affected by the technology. The purpose of AgroBioClean is to minimise the concentration of total-nitrogen in the output liquid leaving the container after treatment.

2.3. Conditions of operation and use

The slurry has to be pre-separated before it is pumped into the AgroBioClean container. This is done to remove part of the organic matter from the raw slurry. The pre-separation can be done using different mechanical separators like for instance a screw press. The pre-separation unit is not an integrated part of the AgroBioClean technology and thus not part of this verification.

Figure 2 gives an overview of the set-up used for the test of the AgroBioClean.

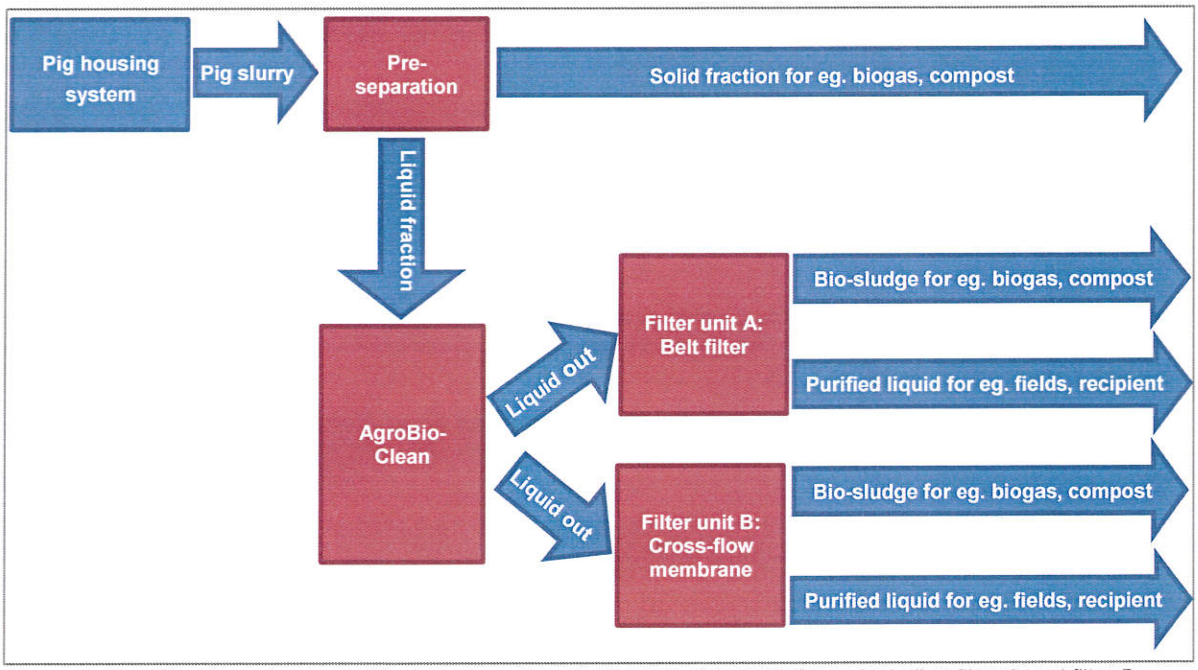

Figure 2. Simplified flow-diagram to illustrate the set-up for the test of AgroBioClean including filter A and filter B.

2.4. Verification parameters definition summary

Table 1. Description of parameters included in the verification of AgroBioClean.

Performance parameters	• Total-nitrogen in output liquid from AgroBioClean *before* filtration • Total-nitrogen in output liquid from filter unit A: Belt filter with polymers. • Total-nitrogen in output liquid from filter unit B: Cross-flow membrane filter.
Operational parameters	• Treatment capacity: Amount input liquid treated per day • Consumption of electricity • Consumption of carbon as energy source
Environmental parameters	• Emission of methane (CH_4) • Emission of nitrous oxide (N_2O) • Emission of ammonia (NH_3)

3. Test and analysis design

3.1 Existing and new data

The verification is based on new data from measurements done by the test institute from 8th October 2018 to 15th October 2018. No existing data from previous tests were used.

3.2 Laboratory or field conditions

The test of AgroBioClean was undertaken under field conditions at a commercial pig farm in the Netherlands using a full scale version of the AgroBioClean container. Two filter units were tested for treatment of the liquid output fraction from AgroBioClean. Filter A was a belt filter in full-scale whereas filter B was a cross-flow membrane filter in laboratory scale (see figure 3).

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Figure 3. Left photo show filter A: belt filter. Right photo shows filter B: cross-flow membrane filter.

3.3 Matrix compositions

AgroBioClean was tested using pig slurry as matrix. As mentioned in section 2.3 the raw pig slurry was initially separated into a solid fraction and a liquid fraction. After this pre-separation the liquid fraction was pumped into the AgroBioClean container for purification.

3.4 Test and analysis parameters

Table 2 gives an overview of the performance parameters and corresponding analytical method.

Table 2. Performance parameters and corresponding analytical methods used.

Parameter	Measurement methods
Total-nitrogen in the output liquid from AgroBio-Clean *before* filtration.	Representative samples were sent for analysis at a certified laboratory, Eurofins. Analytical method: DIN ISO 13878.
Total-nitrogen in the output liquid from AgroBio-Clean <u>after</u> filter A: Belt filter with application of flocculation additive.	Representative samples were sent for analysis at a certified laboratory, Eurofins. Analytical method: DIN ISO 13878.
Total-nitrogen in the output liquid from AgroBio-Clean after filter B: Cross-flow membrane filter without application of flocculation additive.	Representative samples were sent for analysis at a certified laboratory, Eurofins. Analytical method: DIN ISO 13878.

4. Verification results (performance, operational and environmental parameters)

In table 3 the results from analyses of samples of input liquid to and output liquid from AgroBio-Clean are presented. The samples were taken on four sampling days throughout the 8-days test period from 8th October 2018 to 15th October 2018.

Table 3. Total-nitrogen and total-solids in input liquid to and output liquid from AgroBioClean.

Sampling day number	Input liquid to AgroBioClean		Output liquid from AgroBioClean before filtration	
	Total-nitrogen (mg/L)	Total-solids (%)	Total-nitrogen (mg/L)	Total-solids (%)
1 (8/10/18)	7350	6.64%	2190	2.74%
2 (10/10/18)	7380	6.55%	1610	1.66%
3 (12/10/18)	7460	6.74%	920	1.64%
4 (14/10/18)	7520	7.03%	1030	1.22%
Average	***7428***	***6.74%***	***1438***	***1.82%***

Table 4 and 5 present the results from analyses of the output liquid from filter unit A (belt filter with application of polymers) and filter unit B (cross flow membrane filter) respectively.

Table 4. Total-nitrogen and total-solids in output liquid from filter A, belt filter with polymers (250 µ).

Sampling day number	Total-nitrogen in the output liquid from filter unit A (mg/L)	Total-solids in the output liquid from filter unit A (%)
1 (9/10/18)	770	0.79%
2 (10/10/18)	850	0.77%
3 (11/10/18)	920	0.78%
4 (12/12/18)	1010	0.92%
Average	***888***	***0.82%***

Table 5. Total-nitrogen and total-solids in output liquid from filter B, cross-flow membrane without polymers (0.8 µ).

Sampling day number	Total-nitrogen in the output liquid from filter unit B (mg/L)	Total-solids in the output liquid from filter unit B (%)
1 (12/10/18)	570	0.68%
2 (13/10/18)	490	0.64%
3 (14/10/18)	450	0.54%
4 (15/10/18)	400	0.54%
Average	***478***	***0.60%***

The results from measuring operational parameters of AgroBioClean are presented in table 6.

Table 6. Treatment capacity, electricity consumption and carbon consumption of AgroBioClean during the test period.

Parameter	Unit	Verified value
Treatment capacity	Tons input liquid/day	5.22
Electricity consumption	kWh/ton input liquid treated	140
Carbon consumption for purification	Kg/ton input liquid treated	0

No carbon was added as energy source to the microorganisms of AgroBioClean during the test since it seemed that there was sufficient carbon in the input slurry for the purification process.

Table 7 shows the results of the environmental parameters. Emissions of CO_2, N_2O, CH_4 and NH_3 have been calculated based on the measured concentrations and calculated flow rate.

Table 7. Emissions of CO_2, N_2O, CH_4 and NH_3 in exhaust air from AgroBioClean.

Gas	Total emission per year from AgroBioClean		Emission per 1000 m³ treated slurry
	Emission (kg/year)	Standard deviation	Emission (kg/year)
CO_2	79,462	± 5 %	46,685
N_2O	110	±49 %	65
NH_3	145	±38 %	85
CH_4	82	±38 %	48

An ammonia emission of 145 kg/year is equivalent to the annual ammonia emission from a pig house with approximately 330 produced pigs. The emission of N_2O and CH_4 from AgroBioClean is equivalent to the emission of N_2O and CH_4 from producing 63 pigs in a pig house.

To evaluate the climate effect of the technology a full life cycle assessment (LCA) should be undertaken. This would include e.g. calculations of energy consumption and loss of green-house gasses from microbial degradation after field application of treated contra non-treated manure.

5. Additional information, including additional parameters

The total-nitrogen and total-solids content in the input liquid to AgroBioClean were higher than expected. It means that the required reduction in total-nitrogen to be done by AgroBioClean was larger than expected. Still, during the test period the total-nitrogen concentration in the output liquid from AgroBioClean was reduced by more than 80% compared with the input liquid.

In addition, it seems that the AgroBioClean was not in steady-state operation from the beginning of the test period. If that is the case the results from the last two days represent a more realistic picture of the performance under normal operation with the purification process in steady state.

6. Quality assurance and deviations

Quality assurance was undertaken according to the requirements in the EU ETV General Verification Protocol version 1.3 submitted by the European Commission on the 1st April 2018.

An external review of the specific verification protocol and the verification report was undertaken by Amparo Gomez Cortina. A test system audit was conducted following general audit procedures by a certified auditor (Peter Fritzel) from the verification body, ETA-Danmark. The audit took place at the pig farm in the Netherlands where the test was undertaken.

Due to high humidity in the ventilation air and difficulties with condensation in the air hoses it was not possible to use the planned air flow measuring system. In addition, it was observed that air was leaving the AgroBioClean container from other places than the two air outlets. It means that measuring flow rate only in the two air outlets would have underestimated the amount of air leaving the AgroBioClean container. Therefore, the flow rate was calculated using data on the capacity of the blower injecting air into the container.

It is judged that these flow rates represent a "worst case"-scenario with respect to emission of green-house gasses and ammonia from AgroBioClean.