

ENVIRONMENTAL TECHNOLOGY VERIFICATION



**DANISH
TECHNOLOGICAL
INSTITUTE**

ETV Verification Statement

TECHNOLOGY TYPE:	Chemical treatment of biomass
APPLICATION:	Manure from farms (substrate for biogas production).
PRODUCT NAME:	GFE – pretreatment /NIX concept
COMPANY:	GFE Patent A/S (Green Farm Energy + Xergi A/S)
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Pre-treatment of biomass for anaerobic digestion

J.no.1001
Test no.1 Hen Fiber

DANETV was established by four independent Danish research and technology organizations and supported by the Danish Agency for Science, Technology and Innovation under the Danish Ministry of Science, Technology and Innovation to provide environmental technology verification for vendors of innovative environment technologies. Information and DANETV documents are available at www.etv-denmark.com.

VERIFICATION AND TEST DESCRIPTION

The Verification and tests were performed by Danish Technological Institute (DTI) under DANETV and by contract with GFE Patent A/S

The verification was planned and conducted to satisfy the requirements of the ETV scheme currently being established by the European Union (EU- ETV).

The test organization is shown in Figure 1.

The day to day operations of the verification and tests was coordinated and supervised by DTI personnel, with the participation of the vendor, Green Farm Energy and Xergi A/S.

Experts from DTI Testcentre (Test sub-body) performed all samplings for further analysis and incubation for test of biogas potential laboratory.

GFE personnel operated the pressure cooker at the biogas plant and assisted with all tasks described as necessary for verification according to the contract.

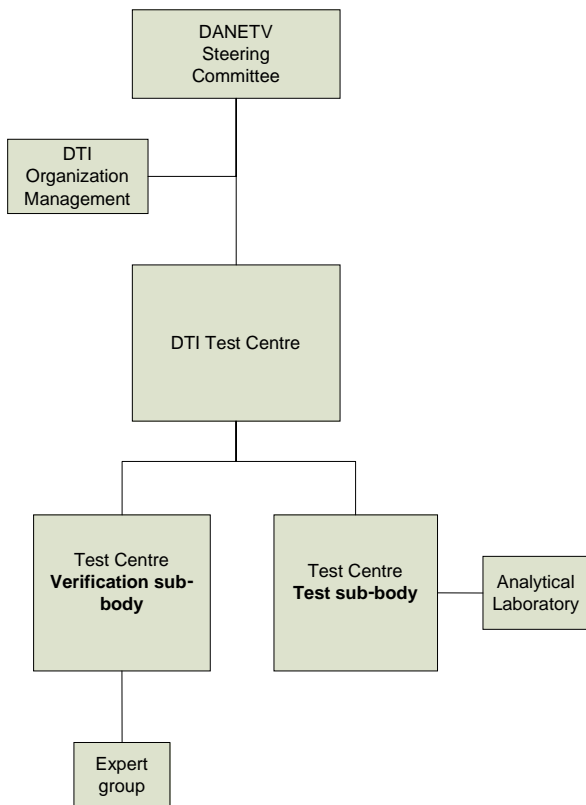


Figure 1 Verification organization

Table 1. Responsible personnel in the test organization.

Test and Verification Center	Danish Technological Institute (DTI) Verification Centre Life Science Division
Verification responsible	Arne Grønkjær Hansen
Test responsible	Bjørn Malmgren-Hansen
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Test plan

The treatment equipment was installed at GFE biogasplant in Langaa and was operated at normal operating conditions (temperature, treatment period) during the testing period. However, it was necessary to perform some operation steps manually like feeding of fibres and outlet of treated fibres to obtain samples for analysis and to avoid noise in weighing cells. Samples of hen manure were incubated under mesophilic conditions (35°C) at Danish Technological Institute. Microbial methane production was followed in repeated batch incubation tests. The test followed the measurement protocol for biogas potential measurements for ETV tests.

In all tests the methane yield was followed using micro-GC in a period of 15-30 days which is the period of interest at biogas plants.

Quality assurance

The quality assurance includes control of the data quality and integrity. The test plan, test report, verification protocol and verification report have been reviewed by experts at DTI and by external members of the expert group as described in quality manual and DAN-ETV standard procedures.

Technology and product description

This document is a short description and verification statement on the biomass “NIX” (nitrogen extraction) pretreatment concept from GFE/Xergi. The impact on biogas potential using fibers derived from treated manure is evaluated and compared to the company claim.

This verification describes the effect on ammonia removal and methane production when using the NIX concept as pretreatment in a mesophilic biogas process. The biogas potential is evaluated using laboratory methods only.

The product verified is a pressure cooker which can treat biomass at pressures up to 6 bar (160 °C) In the treatment additives can be added such as lime (CaO) for increasing pH. The addition has two purposes. It helps degrading the biomass by alkaline hydrolysis and improves the removal efficiency of ammonia.

A simple PI diagram of the boiler and input/outputs is shown in Figure 2.

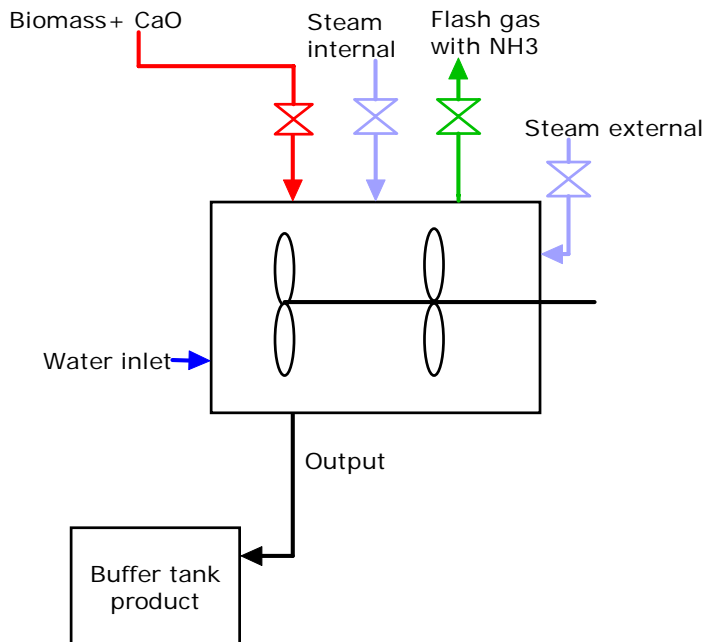


Figure 2 GFE pre-treatment/ NIX concept (pressure cooker).

The pressure cooker operates as a batch process. The cooker is mounted with weighing cells which makes it possible to register all added and removed masses within a given uncertainty. Added biomass is continuously mixed inside the cooker with a rotating mixer

A processing cycle is described below:

- Biomass is fed to the pressure cooker together with CaO.
- A given amount of water is added
- The pressure is increased by adding steam in the external chamber of the pressure cooker and by adding steam directly into the process.
- After a given treatment period at selected temperature the pressure is released in a controlled way to a gas collection system which leads the gas to a scrubber.
- In this period the hot gas with a high content of ammonia and steam is removed from the process.
- When the temperature is below 100°C, water is added for cooling.
- Finally the treated biomass water mixture is lead to a closed storage tank before being added to the biogas plant.

VERIFICATION RESULTS

The average figures of performance parameters are shown in below:

Table 2 Target and measured values of tested parameters

Parameters	Target	Measured value	Method/comment
Overall performance			
Capacity		9-10 ton fibres calculated as dry matter (DM) /day corresponding to 15 batches pr. day. Capacity for fibres separated from swine manure with 33% DM is calculated to: 30 ton/day. The capacity for hen fibres with 52 %DM is calculated to approx. 18 ton/day	Calculation from Log files and tests The capacity depends on chosen treatment time and temperature.
Chemicals			
CaO		2.9%	Weighed amount out of added wet hen fibres
Water for wetting in test (kg)		1246	Weighed amount. In normal operation manure is added
Water addition normal operation		None	In normal operation manure is added for wetting and dilution of fibres
Steam (kg) for treatment of 890 kg hen fibres with DM 52-62%		383	Weighed amount. The used amount in test may be reduced. The amount of added steam depends on the added amount of water/manure for wetting of fibres.
Energi			
Energy consumption as steam		Not calculated	The energy consumption was not calculated as it was not possible to measure the steam consumption in the external heater during the experiment
Electricity consumption		Estimate: 34 kW pr loading or 54 kW/ton Dry matter	Based on estimate for stirrer which consumes the major part of electricity
Treatment effects			
Removal of NH ₄ -N %	50	60	Mass balance and measured NH ₄ -N content in input and output
Increase in Methane production per gVS in %	25	30	Methane potential (mesophilic 35°C) after 30 days active methane production
Other demonstrated effects			
Loss of carbon in flashed steam		<0.35%	Analysis on sampled flashed steam

Figure 1 shows the accumulated methane production in laboratory test at mesophilic conditions during the test period of 55 days. There is a lag phase of approximately 10-12 days in methane production. The major production was finished after 40 days corresponding to 30 days production when correcting for the lag phase.

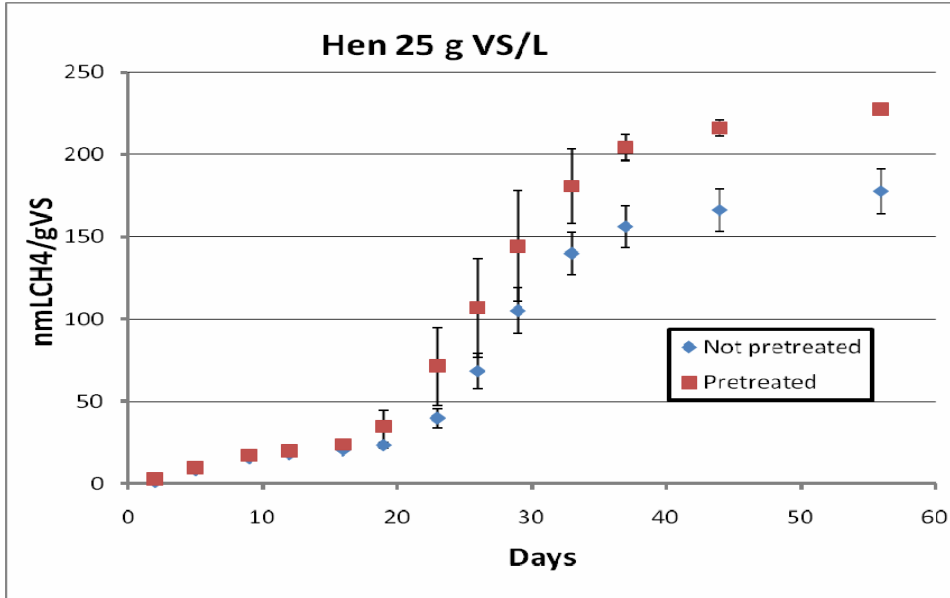


Figure 1. Accumulated methane production for 25 g VS/l (6-double) Standard deviations of the summarized methane production for each 6-double measurement point are shown in the figure.

Conclusion

It is concluded from the tests of the NIX Concept with Hen Manure that:

- The target of 50% NH₄-N removal is achieved (60 % reached in this test)
- The target of 25% increase in methane production is achieved (30 % reached in this test)

It is further demonstrated that

- The carbon loss with flashed out steam is insignificant.
- The pressure cooker homogenizes the fibre material seen in smaller standard deviations for accumulated methane production after 40-55 days.

Other effects

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Comments

It must be emphasized that:

- This verification is a result of a test of the pretreatment running under a certain pre-defined set of parameters (temperature, CaO dosis, treatment time and steam flashing).

A potential for higher increase in methane production after optimization of these parameters is expected.

The obtained ammonium removal might be optimized further by changing the pre-defined set of parameters mentioned above and the result might have been affected by the manual flashing of steam during the test period

Responsible for this verification is:

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DTI - Life Science Environment Technology
Verification



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