ENVIRONMENTAL TECHNOLOGY VERIFICATION

DANETV

DANISH TECHNOLOGICAL INSTITUTE

ETV Verification Statement

TECHNOLOGY TYPE:	**Chemical treatment of biomass**
APPLICATION:	**Manure on farms (substrate for biogas production).**
PRODUCT NAME:	**INFARM NH4+ Acidification System**
COMPANY:	**Grundfos New Business A/S**
ADDRESS:	**Poul Due Jensens Vej 7, 8850 Bjerringbro**
PHONE:	**+45 47501400**
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Biogas yield of fibers from manure treated with sulphuric acid

J.no.1002
Test no.1 Swine manure

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 Grundfos New Business 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, Grundfos New business A/S and the company INFARM A/S.

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

INFARM and/or farmer personnel operated the acidification plant and assisted with all tasks described as necessary for verification according to the contract.

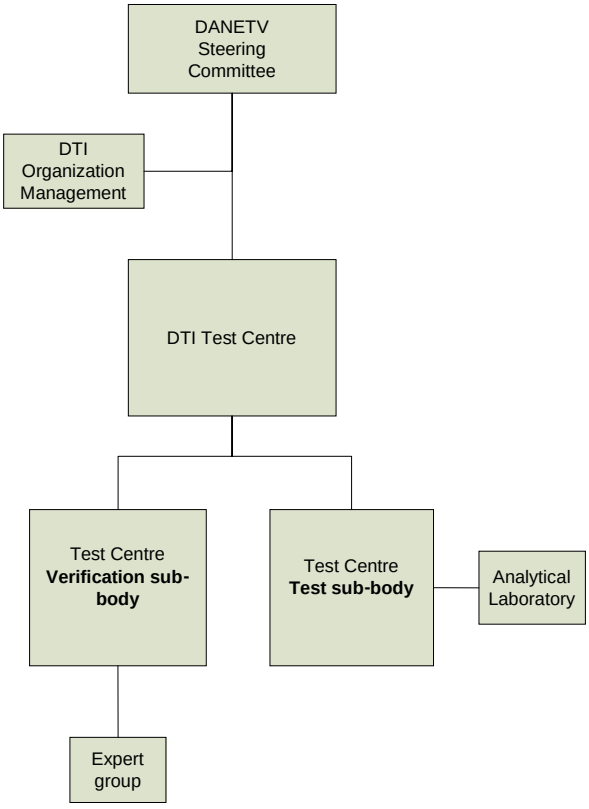

Figure 1 Verification organization

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 on a farm and operated at normal conditions during the testing period. Samples of manure were mechanically separated in laboratory prior to incubation under mesophilic conditions (35˚C) at Danish Technological Institute. Microbial methane production was followed in repeated batch incubation tests with 5, 10 and 20 % acidified fibers. 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.

The manure treatment equipment consists of a number of techniques (unit operations) combined together. All unit operations of the equipment have been described but in this verification the system was considered as a black box and the different unit operations have not been verified separately.

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. Parallel tests at Aarhus University laboratory were conducted to check and evaluate the method used to determine biogas potential in the biomass.

Technology and product description

This document is a short description and verification statement on the manure treatment system "INFARM NH4+" in terms of impact on biogas potential using fibers derived from treated manure. The primary purpose of the acidification is to reduce ammonia emission from manure in animal housing, storage and land application. The pH of manure is reduced to approximately 5.5. Acidified manure or fiber fraction from separation is often used as substrate for methane production at biogas plants. This verification describes the effect of using proportions of acidified manure fibers as substrate in anaerobic biogas production.

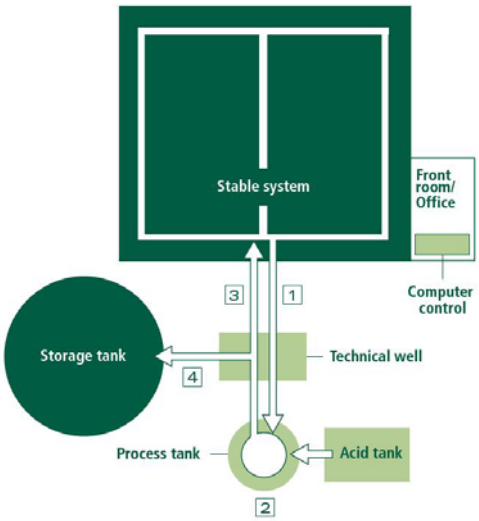

Figure1. Principle of INFARM NH4+ manure acidification system. Sulfuric acid is added in process tank and acidified manure is pumped back to manure pit in stable in order to reduce ammonia emissions. Samples of manure for biogas laboratory tests were taken before storage tank.

VERIFICATION RESULTS

Table 2. Target and measured values of tested parameters.

Parameters	Target	Measured value	Method
Overall performance			
pH regulation	5.5	5.68	Calibrated pH meter
Chemicals			
Sulphuric acid liter/stable/day		64	Calculated from log file weighing cells
Fiber quality			
Sulphur content mg/kg DM		32333	Analysis
DM %		12.2	Analysis
Effect			
Biogas production in laboratory test using *5 % acidified* manure fibers in mixture with non-acidified fibers	No inhibition	**No inhibition**	Biogas potential (mesophilic 35˚C)
Biogas production in laboratory test using *10 % acidified* manure fibers in mixture with non-acidified fibers	No inhibition	**No inhibition**	Biogas potential (mesophilic 35˚C)
Biogas production in laboratory test using *20 % acidified* manure fibers in mixture with non-acidified fibers	No inhibition	**Beginning inhibition (Delay)**	Biogas potential (mesophilic 35˚C)

Biogas tests with addition of different amounts of acidified fibers to reference fibers showed the same amount of produced methane at 5 and 10% addition of acidified fibers when compared with the reference fibers after 30 days of bio gasification under mesophilic conditions. The test showed that acidification had no negative effect on the biogas production when concentrations of acidified fibers where below 10 %. A moderate inhibition (delay in gas production) was measured when the proportion of acidified fibers was raised to 20%. However the same accumulated methane production is obtained after 30-35 days of active growth (when correcting for 10 days initial lag phase). The tendency for faster production in early stage of incubation (<30 days) can be explained as result of different lag periods and therefore of no practical importance.

Main results from biogas test is depicted in figure a7.7 from test report (repeated in figure 2 below)

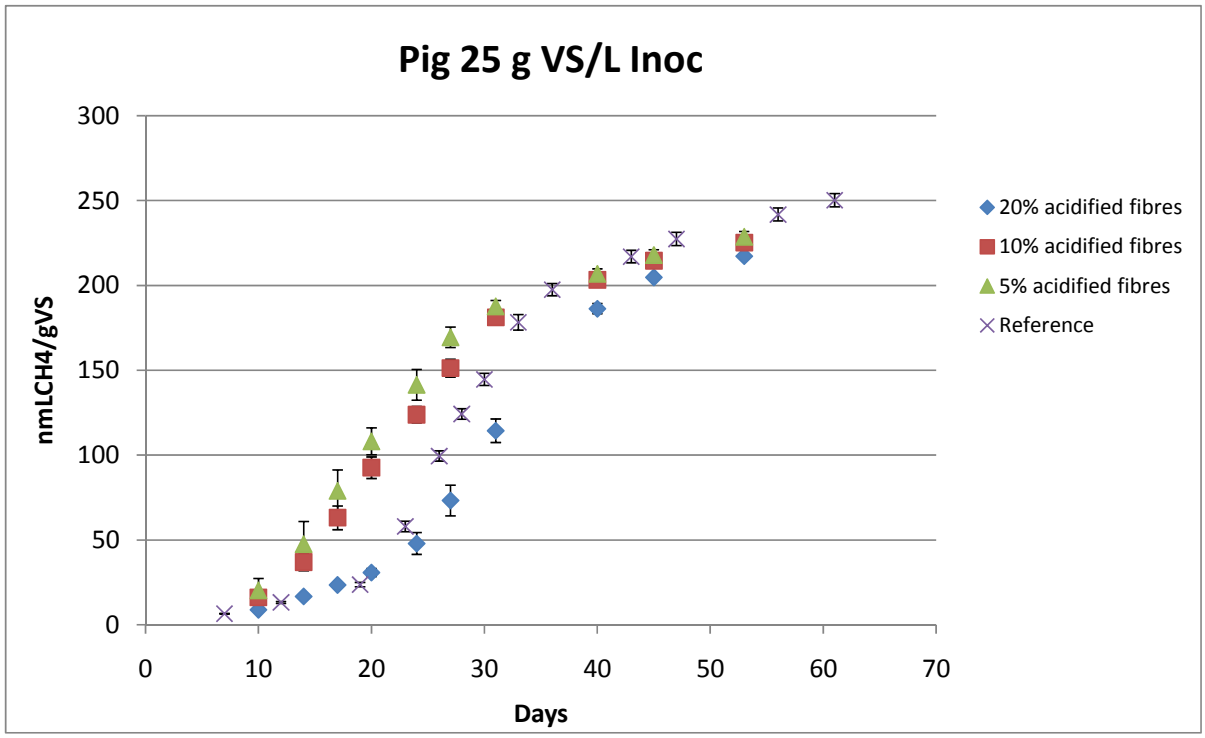

Figure 2 Accumulated methane production for 25 g VS/l (average of a triple analysis) 5, 10, 20 % was measured from 20/11-2009 until 12/1-2010 whereas the reference (0%) was measured from 4/11-2009 to 4/1-2010. Standard deviations for each triple measurement are shown in the figure.

It is concluded for the INFARM NH4+ system that:

- there is no significant inhibition in biogas production with addition of 10% acidified separated fibers with a dry matter content (DM) of 12% in mix with non acidified fibers
- inhibition may occur when there is more than 20% acidified fibers (DM=12%) in substrate for mesophilic methane production.
- there is a significant risk of inhibition of methane production when a substrate with 100 % acidified fibers is used and a high H_2S concentration in the gas phase must be expected.

Responsible for this verification is:

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DTI - Life Science Environment Technology Verification

Original signed 01/05/10 by
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