Environmental Technology Verification

Statement of Verification

Technology type	Slurry acidification technologies	
Application	Acidification of cattle slurry for reduced ammonia emission	
Technology name	JH-Acidification NH_4^+	
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This verification statement summarizes the results from verification of the *JH-Acidification NH4*$^+$ system used for acidification of cattle slurry.

Description of technology

Jørgen Hyldgaard Staldservice A/S has developed a new technique called JH-Acidification NH4$^+$, which is an acidification system for both cattle and pig manure. The current acidification system has been optimized for dairy cow barns with a recirculating manure pit system.

The manure acidification system for cattle farms includes the following key elements:

- Acid tank, where 96 % technical grade sulphuric acid is stored until it is added to the manure.
- Mixing tank in which manure stirring, acid addition and pumping take place. The mixing tank is generally an existing tank.
- Following mixing and acidification the manure is pumped to the recirculation manure pit in the barn.
- Storage tank, where acidified manure is stored after the pumping process from the mixing tank.
- Control cabinet and PC controller, which are used for control, configuration, data logging and alarms.

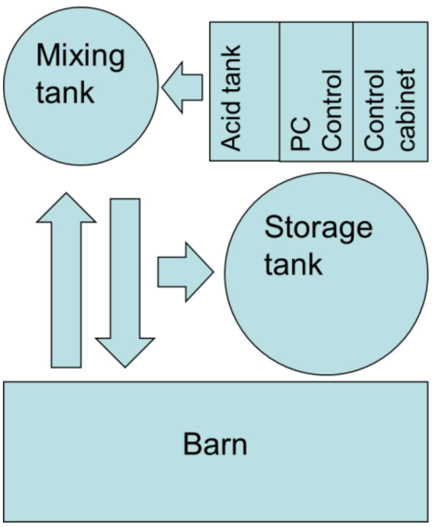

Figure 1. Flow diagram of the JH-Acidification system for a cattle barn.

The acidification system works as follows:
At the present time every day of the year (normally at night) the acidification process is executed in the following chronological order:

1. The two pH electrodes which are placed in the mixer tank are flushed with water.
2. Stirring of the manure in the mixing tank begins and manure from the mixing tank is pumped into the circular pit in the stable.
3. After 10-20 minutes of stirring, sulphuric acid (96 % technical grade) is added from the acid tank to the manure in the mixing tank. A metering pump is used for this purpose.
4. The stirring stops after 30-60 minutes. At this time the pH value has reached its set point at pH 5.5.
5. After 10 minutes break the pH is measured in the mixing tank and the value is logged.

Depending on the time when the daily acidification is initiated, manure is pumped into the storage tank. The manure is pumped to the storage tank until a pre-set minimum level in the mixing tank is reached.

All processes such as stirring, pumping, addition of sulphuric acid and pumping to the storage tank are controlled automatically. The control cabinet manages the acidification. Logging of all measured pH values are uploaded to a web server, which can be accessed from everywhere. This gives an opportunity to continuously monitor and verify that the installation works properly.

Application of technology
The intended application of the JH-Acidification NH_4^+ system is defined in terms of the matrix, the target and the effect of the slurry acidification system. The matrix is the type of material that the technology is intended for. Targets are the measurable properties that are affected by the technology. The effects describe how the targets are affected by the technology.

Matrix	The JH-Acidification NH_4^+ system was verified for cattle slurry in recirculation pits in dairy farm buildings without active floor cleaning system.
Target	The target of the application was ammonia emission from dairy farm buildings.
Effect	Controlled ammonia emission following installation of JH-Acidification NH_4^+ system in dairy farm buildings. Claimed performance: • Emission less than 10 kg NH_3 per year per animal.
Exclusions	The effect on odour and dust emission from dairy farm buildings after addition of sulphuric acid was not evaluated as part of this verification.

Description of test
The primary measurement parameter was ammonia emission. Secondary measurement parameters included CO_2, H_2S, CH_4, N_2O, ventilation rate, temperature, relative humidity, noise, wind direction and speed, electricity consumption, acid consumption, pH in slurry, slurry production, nutrient content of slurry, milk production and composition, feed composition and more.

All measurement parameters were measured at four different dairy farms with JH-Acidification NH_4^+ system installed during a period of one year. The ammonia concentration was measured with a photoacoustic gas detector in six periods evenly distributed throughout the year at all four farms. Each period consisted of minimum four days after another. The ventilation rates were required to calculate the ammonia emission from a dairy building. In this verification CO_2-balance was used for calculation of the ventilation rate. The CO_2-balance method uses the CO_2 produced metabolically by the cows as a tracer gas. By measuring the CO_2 concentration difference between the air inlet and air outlet, the ventilation rate can be calculated. Three of the test sites had Holstein-Friesian dairy cattle and one had Jersey dairy cattle. The capacity of the livestock buildings was in full use the whole year around. The flooring systems of all the dairy farms were slatted floor. The manure from the cattle was collected in a recirculation pit under the slatted floor. The ventilation system was natural ventilation with regulated curtains or lamella openings in the sides of the barns. The number of cattle heads indicated in table 2 is an average over one year. The bedding material was either straw or sawdust. The cows were all fed with a mix of corn silage and grass silage balanced with soybean meal and wheat.

Verification results

This section summarizes the results of the test and verification as described in the test report and verification report respectively. Measured emissions are normalized in a way that the found N-emission in percent of TAN (Total Ammonia Nitrogen)-excreted is fitted to the normative standards for TAN-excretion in Denmark in the year 2011. The N-emission in percent of N-excreted was found to be 6.8 % and the N-emission in percent of TAN-excreted was found to be 13.2 % on an average, see Table 2.

Evaluation of performance test parameters

Table 1. Measured ammonia emissions at the four normalized farms during one year including mean value, estimated 95% confidence intervals (shown in square brackets) and standard variation. Results are presented as emission per heat producing unit (1 HPU = amount of animals producing 1000 W of heat at 20 ºC), emission per animal and emission per livestock unit (1 LU = 500 kg of animal weight).

Ammonia Norm. emission from Acidified farms	Emission, HPU Kg NH_3/HPU/year	Emission, animal kg NH_3/year/animal	Emission, LU Kg NH_3/year/LU	Mean indoor temp. ºC
Farm 1	8.29	9.10	8.15	12.7
Farm 2	7.38	9.72	7.78	11.3
Farm 3	9.55	9.36	9.09	11.9
Farm 4 (Jersey)	7.46	8.86	8.77	11.4
Mean year 95 % conf.	8.17 [7.18; 9.16]	9.26 [9.05; 9.47]	8.45 [8.11; 8.78]	11.8 [11.44; 12.19]
Std. variation	1.01	0.37	0.59	0.66

It is seen in table 1 that the ammonia emission per animal expressed as a mean value for four cattle farms over one year was calculated to 9.26 kg per animal in this verification.

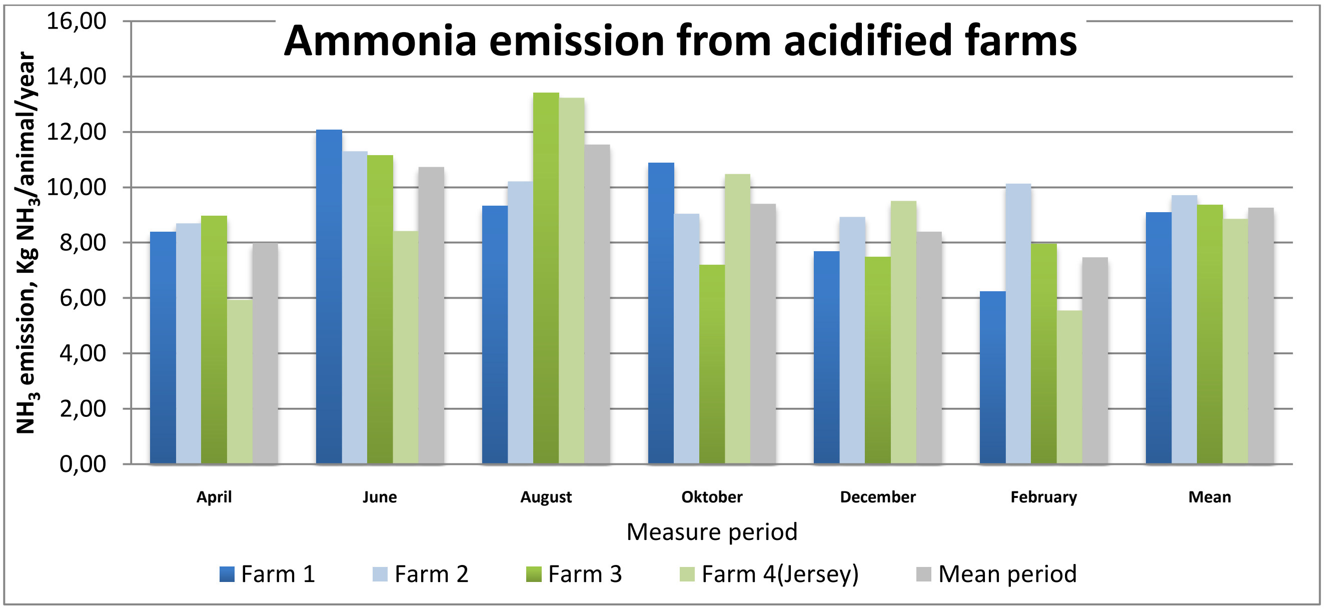

Figure 2. Emission of ammonia from the acidified and normalized dairy farms. The values are given for the four different farms and the mean in all 6 periods. The measured emission values are normalized and given in Kg NH_3/animal/year. The first measuring period was in April 2011 and the last measuring period was in February 2012.

Figure 2 shows the variation in ammonia emission per animal over the year. Highest emissions were measured in June and August when temperatures were highest.

Table 2. Herd composition, the consumption of sulphuric acid and N-emission in % og N-excretion at the four farms including mean value, estimated 95% confidence intervals (shown in square brackets) and standard variations are given.

Farm number	Herd composition no. Cows/Heifers	Acid consumption Kg/m3 slurry	N-emission % of N-excretion	N-emission % of TAN excretion
Farm 1	175/66	5.7	7.0	13.3
Farm 2	217/0	5.4	5.9	12.2
Farm 3	233/177	6.3	7.7	14.9
Farm 4 (Jersey)	541/0	5.5	6.6	12.5
Mean values 95 % confidence intervals		5.7 [5.50; 5.97]	6.8 [6.38; 7.27]	13.2 [12.55; 13.89]
Standard variation		0.4	0.8	1.2

Table 2 shows the variation in herd composition, acid consumption and ammonia emission in percent of N- excretion. There is a positive correlation between the percentage of heifers on the farm, the emission of ammonia in percent of N-excretion/TAN-excretion and the acid consumption. This can be explained by heifers having a higher ratio of ammonia nitrogen in N-excreted, and this takes more acid to neutralize.

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

Original signed 8th of March 2012		Original signed 8th of March 2012	
Signed by Gunnar Hald Mikkelsen Management representative	Date	Signed by Amparo Gómez Cortina Verification responsible, AgroTech	Date