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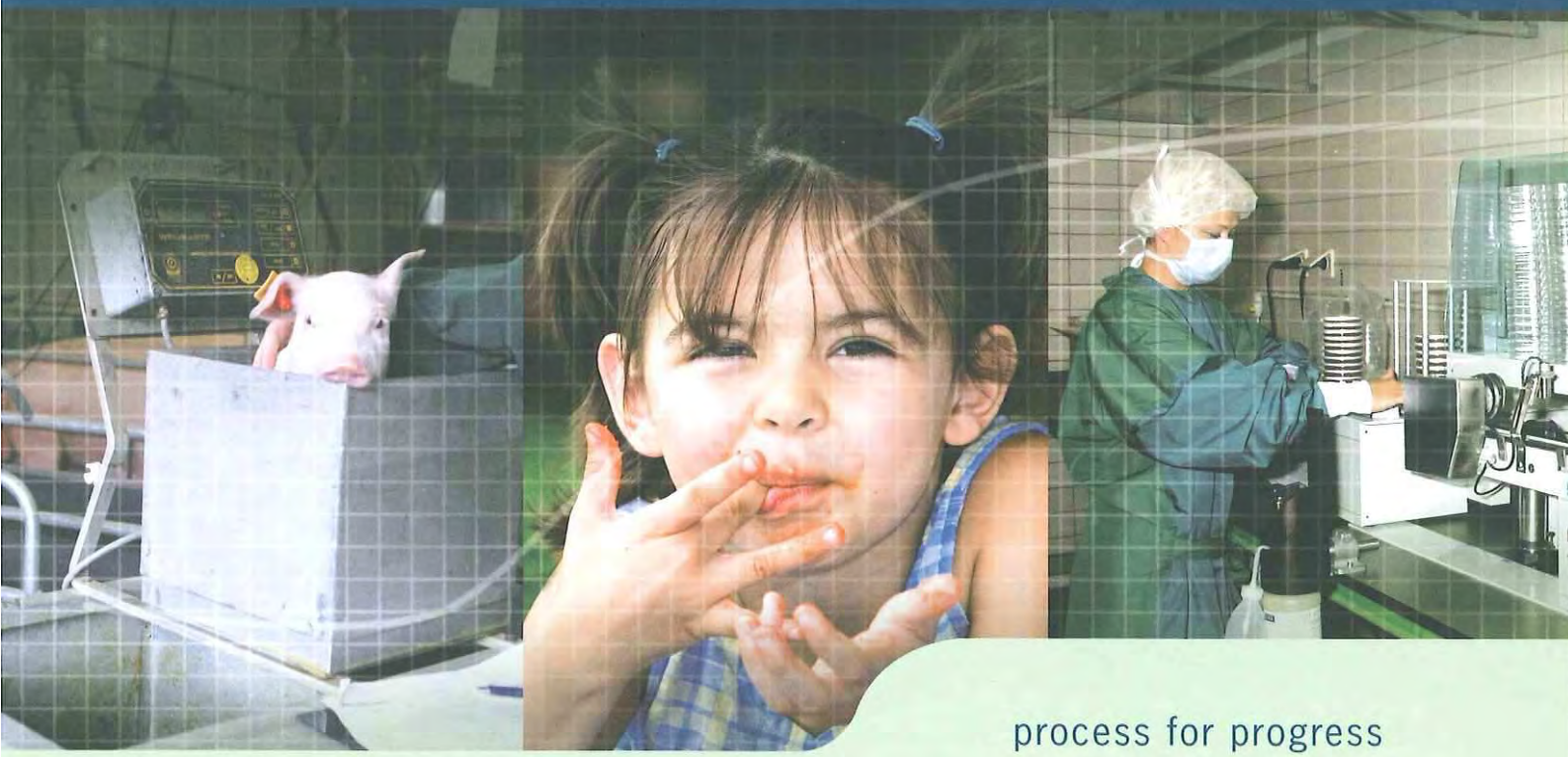

process for progress

Rapport 225

Oriënterende emissiemetingen aan de Comfort Slat Mats voor melkvee

Mei 2009

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De certificering volgens ISO 9001 door DNV onderstreept ons kwaliteitsniveau.
Op al onze onderzoeksopdrachten zijn de Algemene Voorwaarden van de Animal Sciences Group van toepassing. Deze zijn gedeponeerd bij de Arrondissementsrechtbank Zwolle.

Abstract
Emissions of ammonia and methane from the comfort slat mats (a new floor type for dairy cattle) were measured with a dynamic box method. Emissions were reduced up to 50% for ammonia and for 75% for methane.

Keywords
Ammonia, methane, gaseous emission, dairy farming, floors.

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Samenvatting
De ammoniak- en methaanemissie van de 'comfort slat mats', een nieuw vloertype voor melkvee, zijn indicatief gemeten met een dynamische boxmethode. Ammoniakemissie wordt gereduceerd met circa 50% ten opzichte van een betonroostervloer. Methaanemissie reductie vanuit de mestkelder is circa 75%.

Trefwoorden:
Ammoniak emissie, methaan emissie, melkveehouderij, vloeren

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Oriënterende emissiemetingen aan de Comfort Slat Mats voor melkvee

Explorative emission measurements on Comfort Slat Mats for dairy cattle

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Summary

Introduction

Between May and July 2008 the Animal Sciences Group of Wageningen-UR (WUR-ASG) performed ammonia and methane volatilization measurements from walking floors in a dairy house equipped with the Comfort Slat Mats from ICE Comfort Slat Mats Ltd.. Ammonia is formed from urea (present in urine) by the enzyme urease (present in faeces and with faeces contaminated surfaces) . The urea is transformed into ammonia (NH_3) that is dissolved in water. The dissolved ammonia can emit to the air. Urease activity, urea concentration, urinate patterns and quantities, size of contaminated area, temperature and air velocity are factors in the ammonia forming and emission process. Because ammonia lead to acidification, Dutch legislation states maximum emission levels from dairy houses. New systems need to be developed to combine ammonia emission reduction with acceptable animal welfare.

Methane is a product of micro-biological activity in the slurry and of rumen activity. Rumen activity accounts for around 75% of total emissions on farm level and is not affected and measured in this project. Methane production rates from slurry are temperature dependant. There is no legislation regulating emissions on farm level.

The Comfort Slat Mats consists of two parts. A mat that is clipped onto the concrete slats and a valve can be attached to that mat to close the slots between the slats. The intention of the Comfort Slat Mats is to improve drainage of urine to the slurry pit (mat) and minimize the air exchange from the slurry pit by closing the slats (valve). The use of rubber also aims to improve animal welfare by providing a softer and more comfortable floor surface compared to concrete rubber slats.

The mats can be used in new built barns and can also be retrofitted to concrete slats in existing barns. At Waiboerhoeve Experimental Dairy Farm in Lelystad (part of WUR-ASG) a serie of experiments were carried out in which the ammonia volatilization from slatted floors with the Comfort Slat Mats was measured in order to get an impression of the NH_3 reduction perspective of these new floors. The project was financed by the Dutch Ministry of Agriculture, Nature and Food Quality (LNV), ICE Comfort Slat Mats Ltd. and HOLCIM betonproducten BV. This report summarizes the results.

Material

Table 1 gives an overview of the different floor types used for ammonia measurement. Codes in following figures refer to this table.

Table 1 Description of different floor types.

Code		Description
R	Reference	Concrete slatted floor
M	Mat	Concrete slatted floor with rubber mats on the slats
MV	Mat&Valve	Concrete slatted floors with mats on the slats and valves closing the slots

Table 2 gives an overview of the days that emission measurement were performed.

Table 2 Measuring dates

Date	Mat	Mat & Valve	Reference
6-5-2008	X		
8-5-2008		X	
9-5-2008			X
14-5-2008			X
23-5-2008		X	
26-5-2008	X		
30-6-2008			X
2-7-2008	X		
3-7-2008		X	
7-7-2008		X	
8-7-2008	X		
11-7-2008			X

Method

Two walking alleys in one of four sections of the dairy research farm Waiboerhoeve were equipped with the Mat&Valve system. Roughly half of both alleys with the Mat and the Valve, and the other half of both alleys with only the mat. This results in four measuring location in two alleys. On all four locations two measurements were performed. The concrete slatted floor of another section was used as a reference. Two measuring locations in similar alleys of this section were chosen. Both sections are identical apart from the floor type. Also these two locations were measured twice. One series of measurements took one day. Each series of measurements consisted of three treatments (see Table 3). In treatment one the floor was measured as it was found that day. That measurement lasted for around 1 hour. In treatment 2 and 3 a sample of N-solution resembling dairy cow urine was applied in the floor. In treatment 2 it was applied on the floor before scraping and in treatment 3 on the floor after scarping. In all three treatments the ammonia emission was measured using the dynamic box method (Mosquera *et al.*, 2008.) . A laminar airflow is created in the box that is placed on the floor. The section of the slurry pit right below the box is separated from the rest of the pit by sheets of polycarbonate. Air temperature and relative humidity is monitored during measurements. The concentration of ammonia and methane and the airflow is measured in the outgoing air in ppm and m^3/h respectively. Before and after the background concentrations for both ammonia and methane were measured. For gas measurement a photo-acoustic gas monitor was used (Innova 1312). A typical ammonia volatilization pattern shows a rapidly increasing ammonia concentration in outgoing air that after a peak dies out slowly. Measurements on a floor section are continued at least until a certain peak in ammonia concentration is noticed and lasted approximately 3 hours.

Table 3 Overview of different treatments

Treatment code	Treatment description
1	Floor as it is without further treatment
2	Applying urine like N-solution
3	Scraping and applying second urine like N-solution

Figure 1 Measuring box on slatted floor

Figure 2 Separating a part of the slurry pit

Results

Ammonia and methane concentrations were measure about twice per minute and combined in 5 minutes averages. Each measurement was corrected for background concentration. Concentrations of ammonia measured in ppm were calculated to mg/m^3. Ventilation rate and temperature were measured every 5 minutes. Outgoing air volume was constant throughout the day. Ammonia emission in mg/h was calculated by multiplying concentrations and ventilation rate. This concentration was corrected for temperature differences between and within the measuring days standardizing the emission for a temperature of 15 °C. Emission was corrected using the method described in Duinkerken *et al.* (2003). Finally results were synchronized on start of measurements for reason of comparison. Figure 3 gives the ambient temperature during all measurements. In Table 4 and figure 4 the emission results are expressed as absolute levels and as a percentage of the reference (=concrete slats). Reference is 100% and emission of Mat and Mat&Valve can only be compared with the reference *within* one treatment.

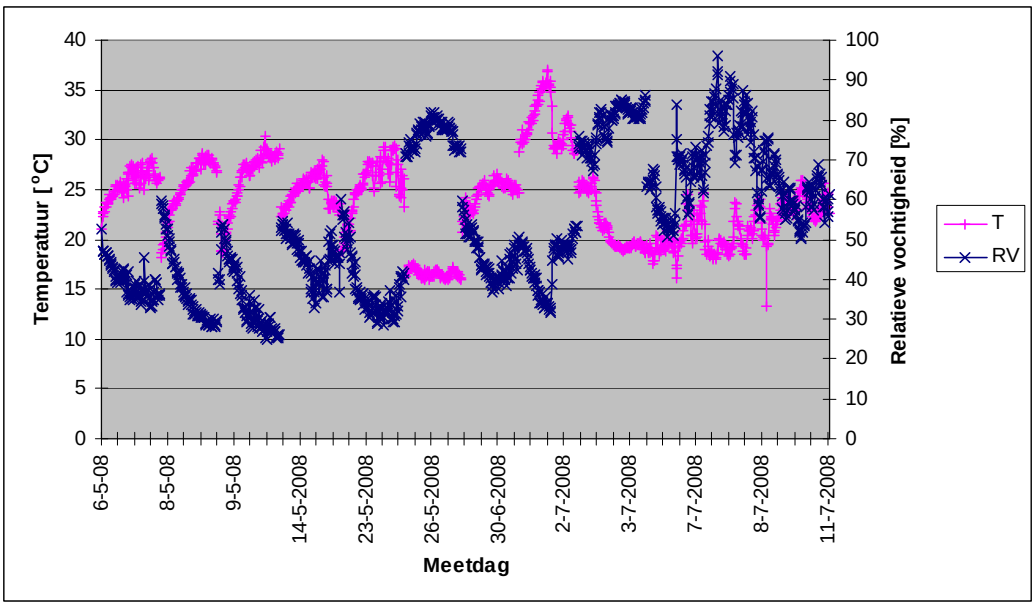

Figure 3 Development of ambient temperature (T in °C) and relative Humidity (RV, in %) during the measuring days

Table 4 Ammonia emission in emission related to reference floor type

Treatment	1			2			3		
Floor type	R	M	MV	R	M	MV	R	M	MV
Emission [mg NH_3*h^{-1}*m^{-2}]	938,6	597,3	513,4	4812,6	3346,8	2297,7	6191,8	4861,9	3657,7
Relative emission	100%	64%	55%	100%	70%	48%	100%	79%	59%
Emission [mg CH_4*h^{-1}*m^{-2}]	11019	5846	2632	12198	7004	3157	15581	6139	6851
Relative emission	100%	53%	24%	100%	57%	26%	100%	39%	44%

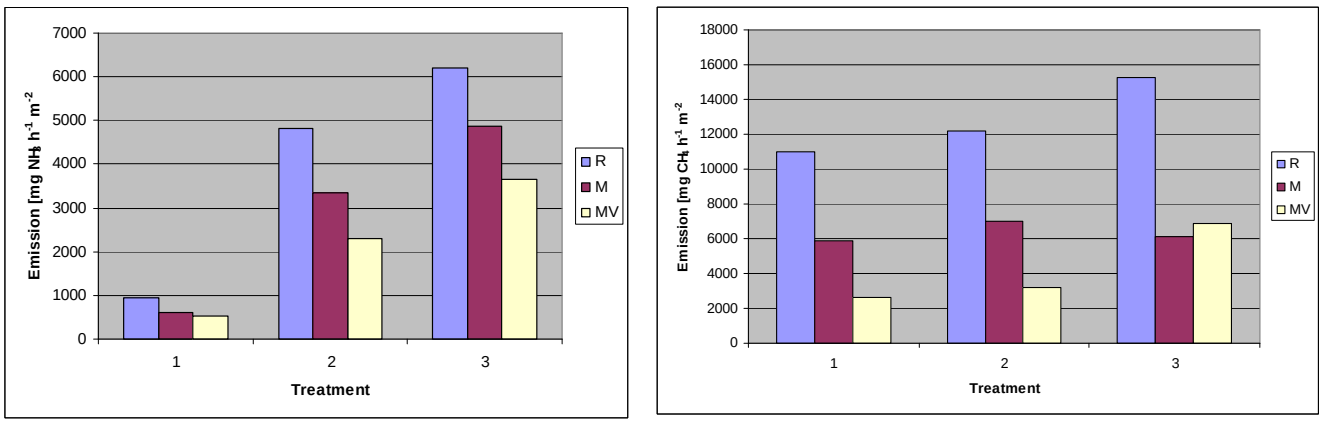

Figure 4 Emission of ammonia and methane in mg h^{-1} m^{-2}

Figure 5 and 6 gives the emission pattern after the treatment 1 and treatments 2 and 3 for ammonia and methane respectively when averaged over all measurements.

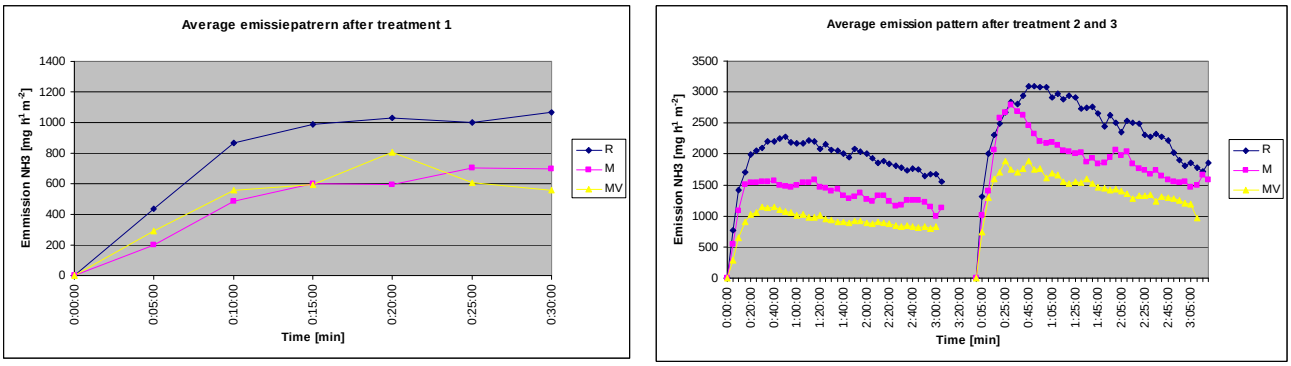

Figure 5 Ammonia emission pattern after treatment 1 (left) and treatments 2 and 3 (right)

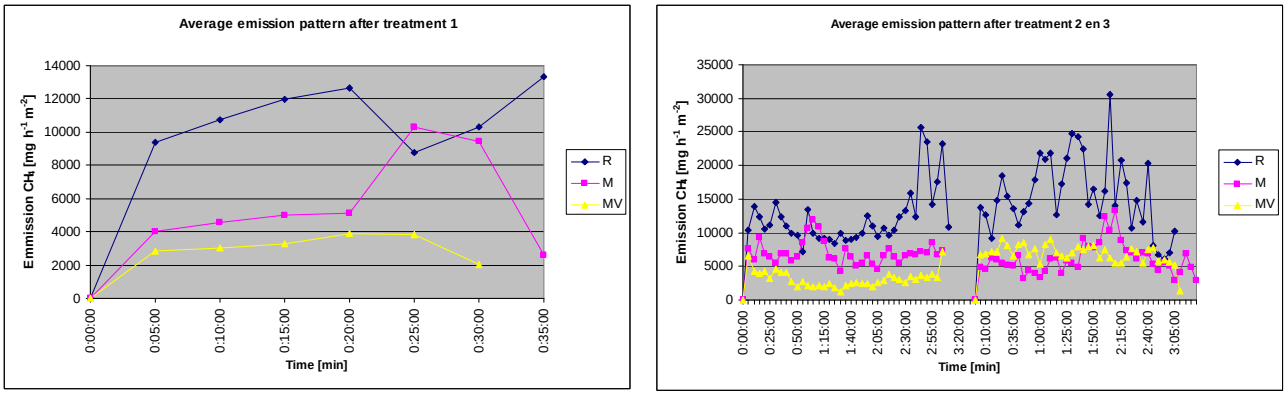

Figure 6 Methane emission pattern after treatment 1 (left) and treatments 2 and 3 (right)

There is a clear reaction of the ammonia emission on treatments 2 and 3 (application of urea). This reaction is as could be expected. Such reaction was not measured for the methane emission.
Analyses of different methods for correction of background concentrations of ammonia en methane did not affect the general results.

Conclusion

- Ammonia emission patterns during measurements are in accordance with expected.
- The ammonia emission pattern is consistent over the several measuring days, floor types and treatments.
- There is reason to belief that the Mat has a reducing effect on ammonia emission from slatted floors in dairy housing in reference to a concrete slatted floor. Average NH_3-reduction of the Mat after treatments 2 and 3 was 20-40%.
- The valve adds an additional emission reducing effect. Average NH_3-reduction of the Mat&Valve after treatment 2 and 3 was 40%-50%.
- The higher levels of emission after treatment 3 are probably caused by changing circumstances in the slurry pit after application of the urine in the second treatment and not necessarily caused by the treatment itself.
- Using the reduction percentages calculated above and taking the emission values from the RAV annex 1 for concrete slats of 11 kg NH_3 per year per animal place as a reference, the emission values for the Mat and Mat&Valve will range between 7,0-8,7 and 6,0-6,6 kg NH_3 per year per animal place respectively.
- However, these results at the level of a whole building need to be validated by full scale measurments.
- Mats reduced the methane emission to 61% of the emissions of reference floor (concrete slats).
- Mats and Valves reduced the methane emission to 76% of the emissions of reference floor (concrete slats).
- However the comfort slat mats only affect the 25% share from slurry of the of the total methane emission of form a barn.