# Measurement of Ammonia Volatilisation from Naturally Ventilated Mink Houses – Effect of Frequent Removal of Mink Slurry

**Hansen Martin N., Madsen Bo E.**
*AgroTech Institute for Agri Technology and Food Innovation, Agro Food Park 15, 8200 Aarhus N, Dk,* mno@agrotech.dk

**Abstract**
To document the ammonia abatement by frequent slurry removal in mink houses, a comparative study of the ammonia emission from mink houses with daily, twice weekly, and weekly removal of slurry was performed at two commercial mink farms. The study was conducted in accordance to the prescriptions of the VERA test protocol for Livestock Housing and Management systems. The ammonia emission effect of the different slurry removal frequencies was studied in six measurement periods distributed as evenly as possible throughout a production year. Each measurement period lasted seven days. A considerably variation of emission levels throughout the production year was found, mainly due to changes in temperature and number and weight of animals. Frequent removal of slurry was found to reduce ammonia emission from the housing system. Daily slurry removal significantly reduced ammonia emission by 26 % compared to weekly removal, while twice weekly removal was found to result in a significant reduction of ammonia emission by 31 %.

**Introduction**
Denmark has a large mink production and the total emission of ammonia ($NH_3$) from mink houses has been estimated to account for approximately 10 % of the national $NH_3$ emission from animal housing systems [1]. The national environmental authorities therefore introduce new and stricter regulations when mink producers want to increase or modify their present production. Development and documentation of new ammonia abatement technologies are therefore requested by mink farmers. The present study was conducted to document the $NH_3$ reduction of frequent removal of mink slurry from mink houses.

Mink production takes place in naturally ventilated mink houses. The mink are held in cages (W = 0.3m, l = 0.6m, h = 0.45m) attached a nest. Mink allocates their urine and faeces in a restricted area as far away from the nest as possible. This allows that the majority of excreted manure can be collected as slurry in slurry pits situated below the mink cages (Fig. 1). The slurry collected in the slurry pits is removed by either manual or mechanical propelled scraper systems to an outdoor storage tank at daily or weekly intervals.

**Figure 1. Picture of the slurry pits situated below the mink cages. Mink allocates urine and faeces in a restricted area as far away from their nest as possible, which means that the majority of the excreted manure is collected in the slurry pits. The slurry pits were 0.34 m wide and 82.4 m long.**

## Material and Methods

The study took place at two commercial mink farms and included emission studies of two different manure-handling systems. At each farm two equal housing sections having capacity for approximately 3500 mink were chosen as respectively case and control test sections. All test sections were naturally ventilated through side wall and ridge openings. The majority of produced manure was sampled as slurry in slurry pits situated below the mink gages. The produced slurry was removed once weekly in the control sections (corresponding to standard management practice in Denmark) and twice weekly or daily in the case test sections.

The $NH_3$ emission from case and control sections was simultaneously measured in six measuring periods evenly distributed throughout a production year. Each measuring period lasted seven days, where the $NH_3$ emission was continuously measured by quantification of the air exchange rate, and the $NH_3$ concentration in incoming and outgoing air. The air exchange was measured by a tracer gas dilution model based on the estimated $CO_2$ production of housed mink. The concentrations of gasses were continuously online measured by use of a photo-acoustic multigas monitor (INNOVA 1412) connected to a multiplexer (INNOVA 1309).

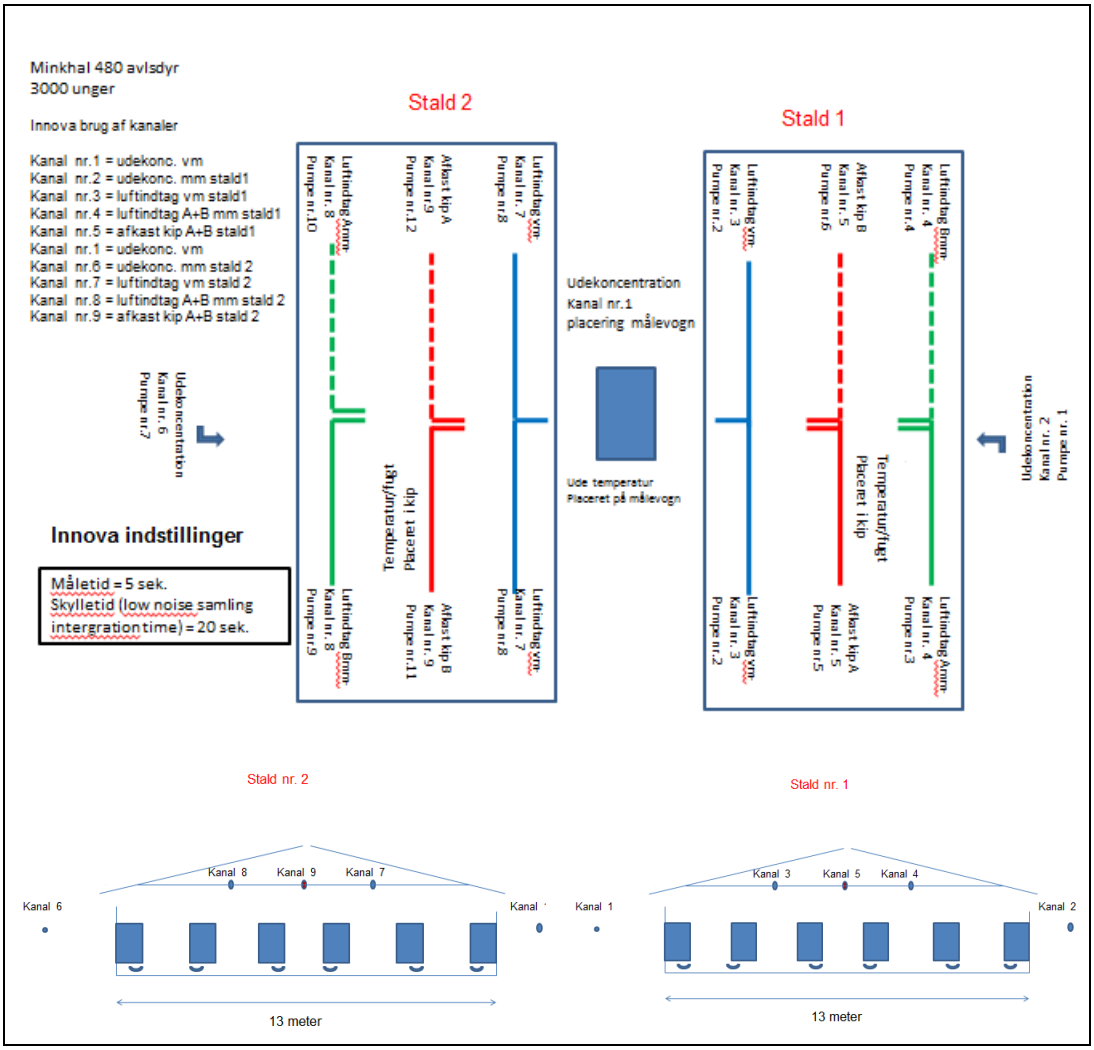


**Figure 2. A schematic overview of the test sections and placement of air sampling equipment inside and outside the case and control test sections. The red, green, and blue lines inside the mink houses represent the three in-house air sampling systems. The blue arrow and the blue rectangle outside the houses represent out-door sampling points.**

Outside air was automatically sampled by outdoor samplers situated outside the test sections, and in-house air was sampled by three 20 m perforated sampling tubes situated inside each test section (Fig.

2). Sampled air was sucked to the gas monitoring system by insulated and heated Teflon tubes to avoid condensation of vapor and $NH_3$ inside the tube system.

## Results and discussion

The daily $NH_3$ emission per adult female was found to be influenced by course of the year. Mink produce offspring in early May, which grow up during summer and autumn before taken out of production in November - December. The daily $NH_3$ emissions per adult female (female mink + 6.4 offspring) were found to be highest during warm season and when the weight and number of offspring were high (Fig. 3). Frequent removal of the mink slurry was found to reduce ammonia emission during all measuring periods. The highest effect was observed in the period between May and November, while lower effect of frequent removal was observed during winter periods, when temperatures were low and only adult females and males requested for mating were housed in the test sections.

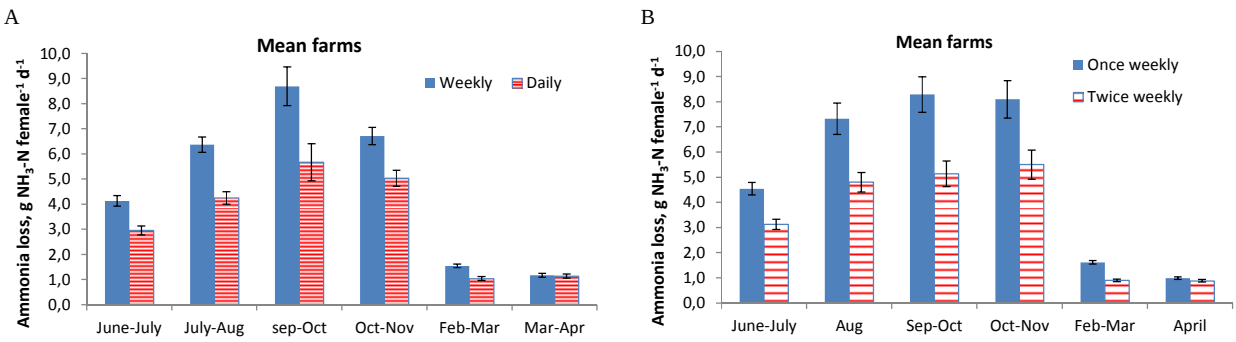


**Figure 3. Mean measured ammonia emission in g ammonia nitrogen per hour and adult female mink when the produced slurry was removed weekly, twice weekly, and daily. A shows the measured ammonia emission for weekly and daily removal of slurry. B shows the measured ammonia emission for weekly and twice weekly removal. Error bars represent 95 % confidence intervals of the estimates.**

The mean daily $NH_3$ emission per adult female mink was found to be between 4.8 and 5.1 g $NH_3$-N when the slurry was removed once weekly. Daily slurry removal reduced on average the $NH_3$ emission by 26 % to 3.4 g $NH_3$-N adult female$^{-1}$ day$^{-1}$ (Table 1), while twice weekly slurry removal was found to reduce ammonia emission by 31 % to 3.4 g $NH_3$-N per adult female per day (Table 2).

**Table 1. Calculated reduction of ammonia emission when the slurry was removed daily. All values are per cent reduction in ammonia emission compared to the measured emission from weekly slurry removal.**

| Farm | Slurry removal | June | July-Aug | Sep | Oct | Feb | Mar | Mean |
|---|---|---|---|---|---|---|---|---|
| 1 | Daily | -7.6 | 32.6 | 24.1 | 10.1 | 26.3 | 13.2 | **21.3** |
| 2 | Daily | 41.0 | 34.0 | 45.9 | 36.9 | 39.5 | -14.5 | **30.5** |
| Mean | Daily | 16.7 | 33.3 | 35.0 | 23.5 | 32.9 | -0.6 | **25.9** |

**Table 2. Calculated reduction of ammonia emission when the slurry was removed twice weekly. All values are per cent reduction in ammonia emission compared to the measured emission from weekly slurry removal.**

| Farm | Slurry removal | June-July | Aug | Sep | Oct-Nov | Feb-Marts | April | Mean |
|---|---|---|---|---|---|---|---|---|
| 1 | Twice weekly | 9.5 | 32.2 | 38.4 | 27.2 | 29.9 | 10.6 | **25.1** |
| 2 | Twice weekly | 42.7 | 33.4 | 37.6 | 25.8 | 55.1 | 11.1 | **36.0** |
| Mean | Twice weekly | 26.1 | 32,8 | 38.0 | 26,5 | 42.5 | 10.9 | **30.6** |

## Conclusion and perspectives

To verify the ammonia abatement effect of frequent slurry removal in mink houses a comparative study of ammonia emission from mink houses with daily, twice weekly, and weekly removal of slurry was performed at two commercial mink farms. The study was conducted in accordance to the prescriptions of the VERA (Verification of Environmental Technologies for Agricultural Production) test protocol for Livestock Housing and Management systems version 1 (2009-12-09) [2]. The emission effect of different slurry removal frequencies was studied in six measurement periods distributed as evenly as possible throughout a production year running from May to April. Each measurement period included continuously emission studies running for seven days. A considerably variation of emission levels through the production year was found, mainly due to changes in temperature and number and weight of animals. Frequent removal of slurry was found to reduce ammonia emission. The highest reduction effect was observed in periods of summer and autumn when number and weight of housed mink were high. Daily slurry removal significantly reduced ammonia emission by 26 % compared to weekly removal, while twice weekly removal was found to result in a significant reduction of ammonia emission by 31 %. Both technologies were found to have high operation stability. The technologies were not found to have negative effects on animal welfare and occupational health and safety.

## References

[1] Pedersen S., Sandbol P. 2002. Ammonia emission and nitrogen balances in mink houses. Biosystems Engineering, **82:**(4), 469-477.

[2]VERA protocol, 2012. Verification of Environmental Technologies for Agricultural Production. Test protocol for Livestock Housing and Management systems. The Danish Environmental Protection Agency (EPA).
http://www.veracert.eu/da/teknologiproducenter/testprotokoller/~/media/DS/Files/Downloads/Artikler/VERA/VERA_protokol_online_02.ashx