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EXPERIMENTÁLNE STANOVENIE AMONIAKÁLNEJ EMISIE Z NÁDRŽE S ROŠTOM A BEZ ROŠTU

EXPERIMENTAL DETERMINATION OF AMMONIA EMISSION FROM THE TANK UNDER SLATS AND WITHOUT SLATS

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ABSTRACT
EXPERIMENTAL DETERMINATION OF AMMONIA EMISSION FROM THE TANK UNDER SLATS AND WITHOUT SLATS

Ammonia emission from slurry tank with slats and without slats was experimentally investigated. Experimental conditions was technological simulation in adapted Lindwall-box with defined air temperature 20 °C, 10 °C, and air velocity was 0.3 $m.s^{-1}$, 0.2 $m.s^{-1}$ and 0.1 $m.s^{-1}$; experiment without slat was only at 10 °C. Relative humidity was at constant value 70 %. Slats were not dirted. Effects of air flow velocity for the ammonia emission from tank with slats is significant. With increasing air flow velocity is increasing ammonia emission at both different temperatures. With different values of air flow from 0.1 $m.s^{-1}$, 0.2 $m.s^{-1}$ to 0.3 $m.s^{-1}$ were mean emissions 8.54 $mg.min^{-1}$- 9.57 $mg.min^{-1}$ and 10.72 $mg.min^{-1}$, that were 77.9%, 89.3% from emission at 0.3 $m.s^{-1}$ and at air temperature 20 °C. In experiments with 10 °C were increasing emissions of equal course from 4.99 $mg.min^{-1}$ - 75.7% to 5.27 $mg.min^{-1}$-80% and into 6.59 $mg.min^{-1}$ - 100% at 0.3 $m.s^{-1}$.

Ammonia emission from tank without slats has a different course than this one with slats. Ammonia emissions at 0.3 $m.s^{-1}$ was 8.21 $mg.min^{-1}$, at 0.2 $m.s^{-1}$ - 8.29 $mg.min^{-1}$ and at 0.1$m.s^{-1}$ 8.32 $mg.min^{-1}$ have opposite tendency than emission with slats. Its is possible to say that it probably changed circulation in comparison with slats. Then were changed physical conditions for ammonia releasing from slurry.

Air temperature has more important effects on the ammonia releasing. It is possible to compare exactly the result of experiments in this field and to say that in all cases were levels higher at 20°C than these at 10 °C. At 0.3 $m.s^{-1}$ were emission levels higher by 38.5%, at 0.2 $m.s^{-1}$ by 44.9% and at 0.1 $m.s^{-1}$ was higher by 41.6%, on the average was higher by 41.7%.

Determination of ammonia emission for slurry area in the tank was for 2 m^2. Primary tendencies in ammonia emission relating to the slurry area is according to the effect of air temperature and air speed. It was 143.1 - 334.2 $mg.m^{-2}.h^{-1}$ with slats and 237.3 - 256.2 $mg.m^{-2}.h^{-1}$ without slats.
Keywords: Slurry tank, Air temperature, Air velocity, Ammonia emission

INTRODUCTION

The emission of ammonia mainly coming from livestock buildings and slurry application. Technological solution of the building are an important part of releasing amount ammonia in stable and its technological element is important for releasing ammonia from slurry, too. Aim of the researches in these fields is oriented to define ammonia emission from the view of technological and physical ground releasing. It must result in important technological and processing reduction emission by animal housing systems, manure or slurry storage and at its applications technique too. It is important for reduction of the influence of agriculture or animal housing on environment.

Researches oriented to defining and reduction of ammonia emission on animal housing systems and its technological-build elements at IMAG-DLO is systematic.

Kroodsma W. et al. (1993) estimated monthly emission for a cow about 1kg NH_3; from unstirred slurry in the tank below slats was emission 300 $mg.m^{-2}.h^{-1}$, and from stirred slurry below slats was 280 $mg.m^{-2}.h^{-1}$.

De Boer-Keen and Monteny (1994) defined reference emission for a cow and month 1.2 kg NH_3.

Elzing A. et al. (1992) described in the model system experiments from livestock buildings with different floor material, manure treatment techniques and climate conditions on the ammonia emission. Floor surface was spreaded and emissions measured. Spreading was with mixing 5 kg urine-faeces dairy cattle over slatted floor or with 2 kg urine. Peak emission was after about 1 a› 2 hours after applying slurry mixture on a dirted surface 14.4 $mg.min^{-1}$; hereafter was slow decrease after 24 hours, till all the produced ammonia has been volatilized. The similar course have other experiments with full or empty cellar, after sprinkling only urine, with various temperature, air velocity and different concentration urine on the manure layer. Authors described result with the theoretical model in which rapid urea decomposition is followed by a relatively slow ammonia volatization.

If it is increasing environmental temperature from 9.5 to 19 °C its increased emission peak by 50%. If it is various air velocity from 0.12 $m.s^{-1}$ to 0.19 $m.s^{-1}$ is emission peak about 20% higher. Theoretical model predicts for both increasings a stronger effect on the ammonia emission than has been observed. Experiments with urine faeces mixtures in which the amount of nitrogen in the urine varies, show that the emission lineary depends on the nitrogen concentration of urine.

Air flow jet in the building is more important for the distribution of ammonia. Slatted floor allows free transfer of air between stall and manure pit. Exchanging air between building and manure pit have some effect on the manure temperature which is related to internal temperature in stall. Air flow has a distinct effect on the manure temperature, ammonia distribution and on the overall ammonia concentration, De Praetere and Van Der Biest (1989). Authors carried experiments to practically questions, orientation of building, air exchange, dimension manure pit housing building, its dividing etc.

In the IMAG-DLO were done more theoretical and practically oriented experiments to ammonia reduction. Our experiments realized during the study stay were oriented to define ammonia emission from the tank under slats and without slats.

METHOD AND EXPERIMENTAL CONDITIONS

Aim of the experiments was to determine the ammonia emission from tank for slurry with slats and without slats in the technological simulation on the adapted Lindwall-box, fig 1. Experiment was performed at the defined temperature and air velocity in the Lindwall - box simulator placed in the climatic chamber.

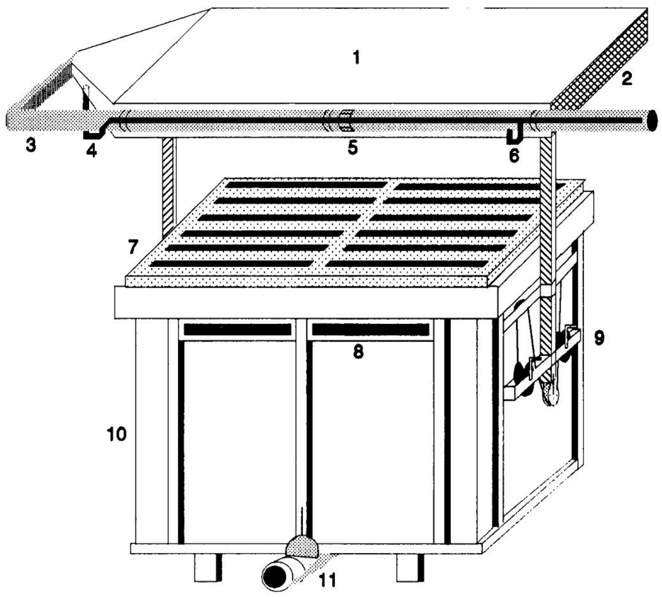

Figure 1. Experimental system to study the ammonia emission from floors (Elzing A. et al..1992).

1-Lindwal-box, 2-Air inlet, 3-Outlet air, 4,6-Place to taking stamp for measurement NH_3, 5-Anemometer, 7-Slats, 8-Windows, 9-Lifting gear, 10-Tank for slurry, 11 -Filling opening. Slats (7) are produced as block with measure dimension 2195x1060 mm, with 7 slats width 120 mm and space 35 mm, area slats of block is 2.33 m^2.

The planned experimental condition was as follows

Temperature air /°C/	Air velocity /$m.s^{-1}$/	Ventilation rate /$m^3.h^{-1}$/	Type of the floor
20	0.3	270.6	Slatted
	0.2	188.0	
	0.1	71.6	
10	0.3	270.6	Slatted
	0.2	188.0	
	0.1	71.6	
10	0.3	270.6	Without
	0.2	188.0	
	0.1	71.6	

Relative humidity was regulated on constant value 70 %. Experiments with slats were realized at 20 °C, 10 °C, without slats were realized only at 10 °C.

Tank in the Lindwall-box was filled up with 2 m^3 slurry of the dairy cows with 11.4 % dry matter, 5.54 $g.kg^{-1}$ N_{kj}, 7.2 pH in the slurry, 8.5-8.6 pH on the surface slurry, 2.84 $g.kg^{-1}$ NH_4-N, slats area was 2.33 m^2, and slurry surface was 2 m^2.
Experiments with slats - this one was not dirted with slurry. Proceedings measur-ment is standard method in the IMAG - DLO Wageningen, according to Scholtens

(1990). It is measured in the air outlet flow, speed for definition rate flowed air, concentration of ammonia. Principle measurement concentration NH_3 it is based on conversion NH_3 to NO_x. Regulation process measurement and dates registration were with the Data-Loggin system processed by computer.

RESULTS

Ammonia emission at individual experiments

In the table 1 are presented resultant ammonia emissions at individual exactly defined experiments with different air temperature and air velocity or ventilation rate.

Technological simulation was realised in climatic chamber. Realised were experiments with standard defined condition for the cattle barns, slurry tank with slatted floor and without slats. Slurry was unstirred and slat was clear, not dirty. There were defined ammonia emissions only from the tank. Documented was the influence of ground climatic parameters on it. It is a part of researches oriented to defining and reductions ammonia emission from cattle housing systems at researches on IMAG-DLO. Tested parameters of air velocity and temperature of air was likewise in the cattle stable.

Table 1. Ammonia emission in individual experiments / $mg.min^{-1}$/

Experiments		With slats		Without slats
Air temperature		20 °C	10 °C	10 °C
Air flow velocity	Emission		/ $mg.min^{-1}$ /	
	Maximum	11.14	7.04	8.54
0.3 $m.s^{-1}$	Mean	10.72	6.59	8.21
Minimun	10.41	6.00	7.36	
	Maximum	10.77	5.60	8.65
0.2 $m.s^{-1}$	Mean	9.57	5.27	8.29
Minimum	8,66	4,84	7,92	
	Maximum	8.58	5.25	8.54
0.1 $m.s^{-1}$	Mean	8.54	4.99	8.32
	Minimum	8.01	4.77	7.91

Effect of air flow velocity on amonnia emission

Tank with slat

Emission from slurry tank with slat placed in the Lindwall-box depended on air velocity progressively. Amount released amonnia with slats increased with increasing of air velocity and temperature of air, table 1. It was the higher the higher air moving was, it depended proportionately on air velocity.

If you put the reference emissions value results with air velocity 0.3 $m.s^{-1}$ at both temperature variarants there were:

- With 20 °C were 10.7 $mg.min^{-1}$, its higher than at air velocity 0.2 $m.s^{-1}$ it was 89.3% and at 0.1 $m.s^{-1}$ were 77.9 % from referece value emission at 0.3 $m.s^{-1}$.
- With 10°C were 6.6 $mg.min^{-1}$, at 0.2 $m.s^{-1}$ it was 80% and at 0.1 $m.s^{-1}$ were 75.7 % from referece value emission at 0.3 $m.s^{-1}$.

At smaller air velocity is amonnia emission lower, fig. 2.

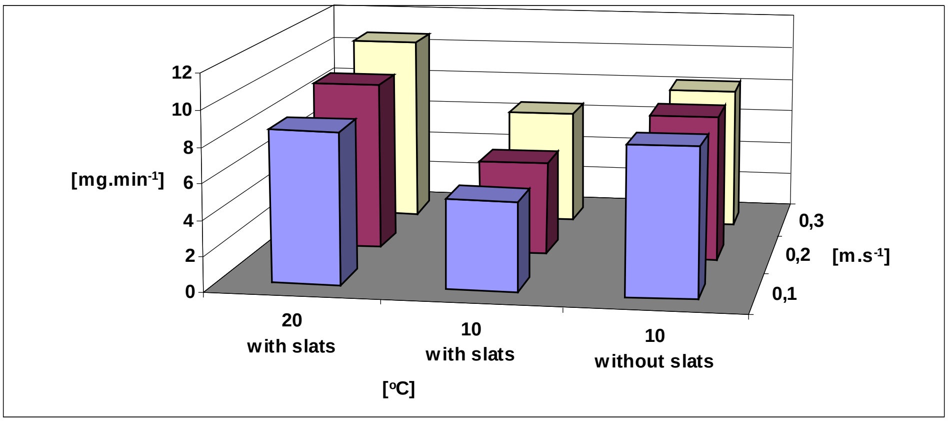

Figure 2 Mean NH_3 emission from slurry tank with and without slats at different air velocity and air temperature

Tank without slat

Investigation of ammonia emission from tank without slatt have different course than emission with slatted floor the tank. It is more leveling than at slatted floor. Its average level was 8.21-8.32 mg.s^{-1} , with maximum average 8.32 mg.s^{-1} , it was at 0.1 m.s^{-1} , table 1, fig. 2. .It is possible to say that air circulation changed in comparison with experiments with slats. Then were changed physical conditions for releasing of ammonia from surface layer of slurry.

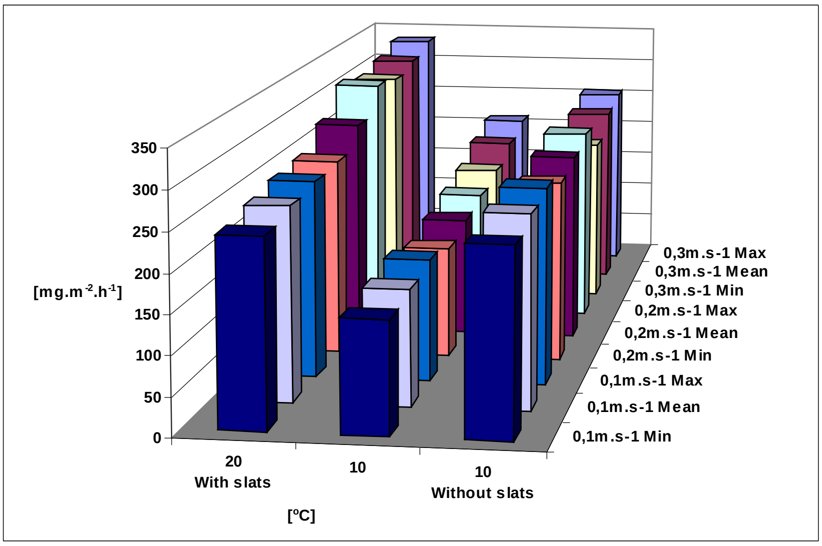

Figure 3 Results of NH_3 emission from slurry tank with and without slats at different air velocity and temperature

EFFECT OF AIR TEMPERATURE ON AMMONIA EMISSION

Temperature of air has more important influence on ammonia emission. If it is possible to compare different experiments air temperature 20.0°C and 10°C with slatt floor on ammonia emission. It was less at smaller value of air temperature 10°C :

- At air velocity 0.3 $m.s^{-1}$ was less emission about 38.5 %, with level 61.5 % from reference value by 20°C;
- At air velocity 0.2 $m.s^{-1}$ was level ammonia emission 55.1 %, smaller about 44.9 %;
- At air velocity 0.1 $m.s^{-1}$ was ammonia emission 58.4% from reference value, smaller about 41.6%.

On average was level of ammonia emission less - 41.67 %, about 58.33 % at 10°C air temperature from emission at 20.0°C.

TEMPERATURE OF THE SLURRY

Temperature of the slurry in surface layer was lower than set-up air temperature in different experiments:

Experiments	Temperature [°C]	With slat	Without slat
Air - t_{ai}	20.0	10.0	10.0
Slurry - t_{sl}	18.6	9.6	9.6

EMISSION FROM AREA OF THE TANK

Amonnia emission for individual experiments is defined for slurry surface, too.
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Primary tendencies of the ammonia emission related to the slurry area according to the effect of air temperature and air speed are equal to results in the tab.2, fig. 3

Table 2.
Determination of ammonia emission for slurry area in the tank / $mg.m^{-2}.h^{-1}$/

Experiments slats		With slats		Without
Air temperature		20° C	10 °C	10 °C
Air flow	Emission velocity		$mg.m^{-2}.h^{-1}$	
0.3 $m.s^{-1}$	Maximum	334.2	211.2	256.2
	Mean	321.6	197.7	246.3
	Minimum	312.3	180.0	220.8
0.2 $m.s^{-1}$	Maximum	323.1	168.0	259.5
	Mean	287.1	158.1	248.7
	Minimum	259.8	145.2	237.6
0,1 $m.s^{-1}$	Maximum	257.4	157.5	256.2
	Mean	250.5	149.7	249.6
	Minimum	240.3	143.1	237.3

Determination of ammonia emission for slurry area in the tank was for 2 m^2.

Definition of ammonia emission for slurry area in the tank and individual experiments was estimated for possibility of technological comparison of results, and of results by other authors.

Ammonia emission for unit area in the experiments without slats were of very equal course, too. It has opposite tendency than emission with slats. It is possible to say that it probably changed circulation in comparison with slats. Then were changed physical conditions for releasing of ammonium from slurry.

DISCUSSION AND CONCLUSIONS

Defining ammonia emission from slurry tank with slat and without slat were realised on exact experimental conditions in Lindwal-box. Controlled air temperature and air velocity by constantly relative humidity, ground climatic condition, unable defining its significant influence on ammonia emission. Microclimatical conditions were defined similar to stable. Then it is possible to compare emmision from technological part, slurry tank with slatt with other building technological elements or from whole the stable.

Significant influence of different air temperature and air velocity was provided. At experiments with slats, by 20 °C were released 11.14 - 8.01 mg.min-1 - difference 39%; by 10 °C were released 7.04 - 4.77 mg.min-1- difference 48%; without slatt were released by 10 °C 8.65 - 7.91 mg.min-1 difference only 9.4% .

From results is important that influence of air temperature on releasing ammonia is different. More important is on condition from view point of solution tank without slatt. At 10 °C were on average more releasing ammonia about 47.3% than in experiments with slats.

If we are estimating monthly production of ammonia it was at 20 °C - 0.415 kg.month-1, by 10 °C - 0.243 kg.month-1 with slats; if it is without slats, were by 10°C released 0.357 kg.month-1. Production from slurry area was different by climatically parameter too. With slatts at 20 °C were 334.2-240.3 mg.m-2.h-1, by 10 °C were 211.2 - 143.1 mg.m-2.h-1; without slats by 10 °C were 256.2 - 237.3 mg.m-2.h-1. Monthly production amounts of ammonia for m2 slurry area were half from the value mentioned above.

Estimated level of ammonia emission coresponding with autors (Krodsma W. at al .1993). Authors estimated unstirred slurry below slats 300 mg.m-2.h-1, and stirred slurry below slats 280 mg.m-2.h-1. These results partly correspond with our results estimated in the exact experiments with defined temperature and air speed.

Partly it is possible to compare our results with research of Elzing A. et al. (1992). Authors realised more experiments with differently treatment floor. They estimated that peak emission was after about 1 a, 2 hours after applying slurry mixture on a dirted surface 14.4 mg.min-1; hereafter was slow decrease after 24 hours, till all the produced ammonia has been volatilized.

For a possibility of reduction ammonia emission in stable with regulated climatical parameters take into consideration Krause (1997).

Estimated results are possible to be used for a new technological study about ammonia emission and its possible ways to their reductions.

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