



PRODUCTION OF AMMONIA AND CARBON DIOXIDE IN CUBICLE HOUSING SYSTEM



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Abstract: *The aim of this study was to determine the changes of ammonia concentrations and carbon dioxide production during 48 hour in the summer time. The experiment was realized in cubicle loose housing system for 160 head of dairy cows with naturally ventilation. The barn was carried out extensive renovations. In the original object the cubicles were bedded by straw and after reconstruction they were bedded by solid parts of separated manure. The Photoacoustic Multi-gas Monitor system was used for measuring gas concentrations. The average ammonia concentrations has been 2,64 - 2,66 mg.m⁻³ (3,74-3,76 ppm) in dependence on measuring point and ranging from 1,26 mg.m⁻³ (1,78 ppm) to 3,30 mg.m⁻³ (4,67 ppm). After modifying dairy housing there was found increasing ammonia production but concentrations of carbon dioxide production was reduced.*

Key words: ammonia, carbon dioxide, dairy housing

Introduction

Air in the livestock environment also contains gases, dust and microorganisms that are a by-product of decomposition of animal waste due to the often inefficient conversion of nutrients. The animals are fed protein feed which contains surplus nitrogen, to ensure that the animals nutritional requirements are met. Nitrogen that is not metabolized into animal protein is excreted in urine and faeces of animals, which is followed by microbial activity breaks down and is released into the ambient air ammonia during manure storage (Jacobson, 2003). The basic function of air exchange technology in a housing (ventilation equipment), should not only maintain the optimal temperature, but also removing harmful gases from the air of stable. Adequate ventilation of indoor air removes excess carbon dioxide, but also harmful ammonia gas, odor and humidity. Reduce harmful emissions from intensive livestock farming is currently a major challenge in Slovak agriculture (Kováč et al., 2006).

Material amethods

For measuring of gas concentrations was used the device 1312 Photo-acoustic Multi-gas Monitor of firm INNOVA Air Tech Instruments with multi-channel sampling system 1309. This equipment was installed in the cubicle loose housing system before and after reconstruction of housing for 160 head of dairy cows with naturally ventilation. In origin object, dairy were housing in four rows of cubicle with straw bedding. Excrements from manure surface were removed once a day by universal loader and collected on solid concrete floor outside the building. Currently, after construction-technological transformation of the barn, cubicles are bedded by solid part of separated manure, surface of each cubicle is increased, length 2,5 m and width 1,2 m. The manure surface is reduced from 1013 m² to 779,8 m² with width 2,2 m (in origin was 2,6 m). Manure removal is handled by the hydraulic blades with intensity every 2 hours. The concentrations of gases NH₃ and CO₂ were measured at ten sampling points; nine spots (1 - 9) inside and one measuring spot (10).

Results

Measurements of the ammonia concentrations ammonia and carbon dioxide were realized in the original housing and also after reconstruction of the object. Both experiments were carried out within 48 hours of summer season in the same climatic conditions. On the basis of observed values of gases in the reconstructed housing system it is possible to establish, that mean ammonia concentrations not varied significantly in dependence on the measuring place (table1; 2,64 - 2,66 mg.m⁻³, or 3,74 - 3,76 ppm). The ammonia concentrations were below the general threshold limit of 20 ppm for living environment of men and animals. The minimum recorded ammonia concentration value was outside at 14.00 hour (1,26 mg.m⁻³, or 1,78 ppm) and the highest in the feeding area at 19:44 hour (3,30 mg.m⁻³, or 4,67 ppm). Inside air temperature in the measuring time was ranged from

19,5°C to 30,8°C, whereas the outside air temperature reached 35,3°C at midday and relative humidity inside air ranged from 41,5% to 77,7 %. The mean concentrations of CO₂ were almost the same, without significant deviations on the all measuring places. The minimum value of carbon dioxide 821,48 mg.m⁻³ (448,16 ppm) was recorded on the measuring point 6 – in cubicle lying at 14:00 hour and the highest 2573,5 mg.m⁻³ (1403,99 ppm) outside at 19:52 hour. The average values did not exceed of the suggested limits of 2000 - 3000 ppm for CO₂.

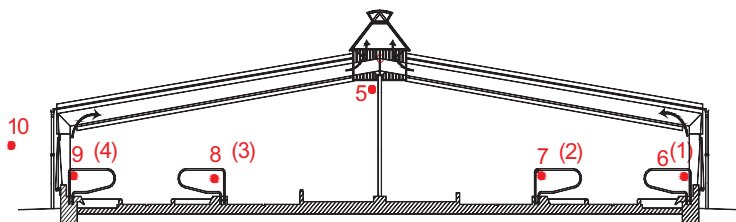


Figure 1 Cross-section of dairy housing and measuring points of air sampling after housing reconstruction

Legend: a - cubicle lying; b - manure area; c - feeding area; d - through corridor; 1, 4, 6, 9 - measuring points in cubicle lying; 2, 3, 7, 8 - measuring points in feeding area; 5 - measuring points in roof ridge; 10 - outside measuring point

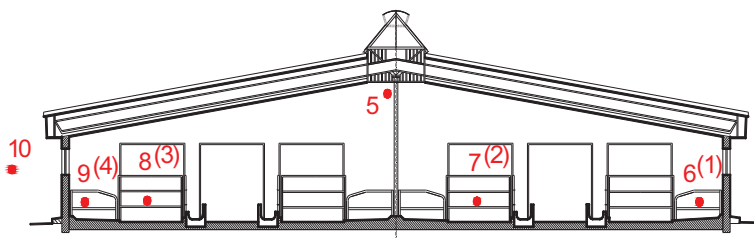


Figure 2 Cross-section of dairy housing and measuring points of air sampling - origin housing system

Legend: a - cubicle lying; b - feeding area with manure area; c - feeding manger; d - through corridor; 1, 4, 6, 9 - measuring points in cubicle lying; 2, 3, 7, 8 - measuring points in feeding and manure area; 5 - measuring points in roof ridge; 10 - outside measuring point

In comparison with measured out concentrations of gases before structural-technology modification we can say that obtained dates were lower in original object despite comparable climatic conditions. There mean concentrations of ammonia ranged 0,39 - 1,61 mg.m⁻³, maximum inside air temperature rose up 30,6 °C and maximum outside temperature was 34,3 °C. Relative humidity of inside air was in a range from 34,6 to 80 % during measuring time. The concentrations of CO₂ reached mean values from 1466,4 mg.m⁻³ to 1799,6 mg.m⁻³ (800 - 981 ppm) in depend on the measuring point. This means, that the carbon dioxide production was bigger in origin housing system, which was caused by the insufficient ventilation of the barn.

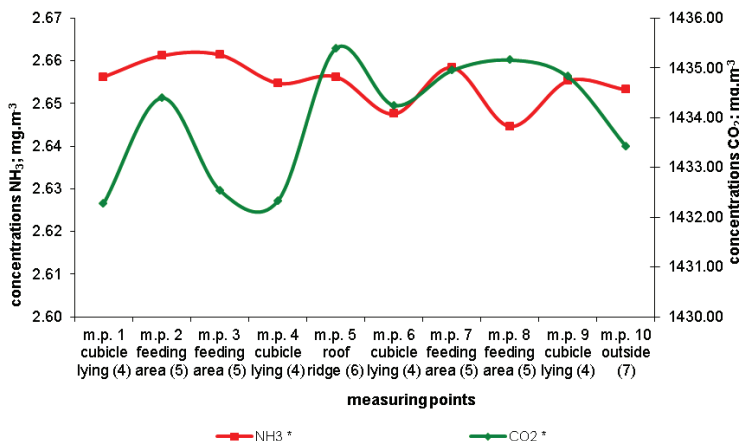


Figure 3 Mean concentrations of ammonia and carbon dioxide - after housing reconstruction, mg.m⁻³

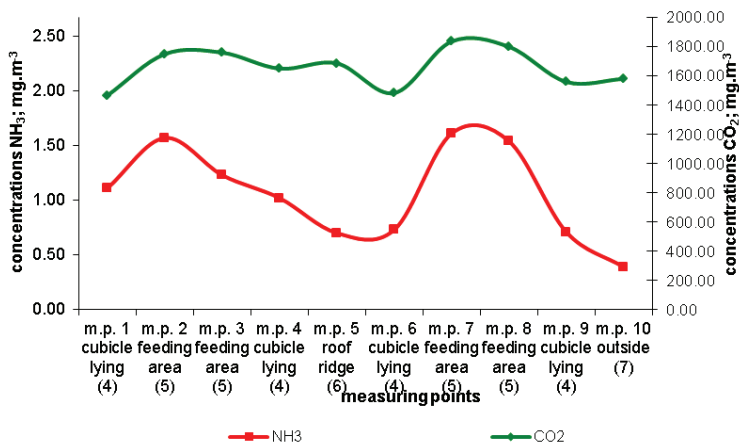


Figure 4 Mean concentrations of ammonia and carbon dioxide – in origin housing, mg.m⁻³

Conclusion

The original dairy housing was renovated to improve conditions for livestock, improve ventilation and microclimate parameters of the indoor environment. The litter from a separated manure, rubber mats on the manure area and removal manure by the blades every 2 hours are used to ensure animal welfare. After reconstruction the building it was found out that ammonia production increased in comparison with production before reconstruction, despite to the fact that the total surface covered with manure diminished. There are several reasons. According to that separate manure is used to the cubicle lying as a litter, the total emitting surface is higher and increased amount of ammonia is probably also due to cross uncovered slurry collection channel. However, concentrations of carbon dioxide were lower than before reconstruction, which means that air quality in terms of CO₂ production in dairy housing has been improved by removing the side walls of buildings and their replacement with tape sheet and anti air draft netting.

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Докладът е рецензиран.