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DETERMINATION OF AMMONIA AND OTHER POLLUTANTS IN AIR AND IN THE AREA OF POULTRY KEEPING FARMS

OZNACZANIE AMONIAKU I INNYCH ZANIECZYSZCZEŃ NA TERENIE FERMY HODOWLI DROBIU

Abstract: Polluted air in a big farm of poultry keeping (~18 thousands of chickens) in Lodz province was sampled. The aim of the investigation was to determine odour pollutants, especially ammonia, in air and check the possibility of a catalytic method application in their removal. Gas samples were analyzed on the spot of sampling with an application of gases analyser Madur GA-20, as well as in a laboratory with an application of instrument and spectrophotometric methods. The intensity of odours was estimated using five-stage scale applied by local authorities in Japan for odorous protection of air quality. Within sampling period, poultry keeping in the farm was the source of variable in time ammonia emission ranging from 0.82 to 2.65 mg/m^3. Air inside in farm contained carbon dioxide (0÷0.3%) and oxygen (20.5÷20.9%). Carbon monoxide, sulphur dioxide, hydrogen sulphide (> 2.0 mg/m^3) and formaldehyde (> 0.25 mg/m^3) was not detected. The highest odour intensity inside the building of chicken keeping and at outlets of ventilators was at the third stage in odour scale applied in Japan (3.5), ie, clearly perceptible. However, it decreased significantly with the increase in a distance from the building.

Keywords: chicken farms, ammonia determination, odours in agricultural production

Poultry keeping farms, are the biggest sources emitting pollutants of all types, ie chemical - gases, mechanical - dusts and biological - microorganisms. Ammonia is the most noxious gas for the environment, produced by poultry keeping farms. Gases removed by ventilation contain also dimethylamine, carbon monoxide and dioxide, aldehydes, ketones, organic acids and many other organic compounds belonging to odours [1-5].

Ammonia is generated in poultry houses as a by-product during microbiological decomposition of organic compounds containing nitrogen in droppings and residual feed. The decomposition proceeds enzymaticly or with the participation of anaerobic bacteria [5-7]. The most important aim in the limitation of ammonia emission is maintenance of hygiene at the high level in the poultry house as well as equipment of efficient ventilation system. Well designed ventilation system prevents concentration of gases in the building and keeps temperature and humidity at the level which guarantees good mood and health of birds [5].

Experimental

Polluted air in a big farm of poultry keeping (~ 18 thousands of chickens) in the Lodz province was sampled. The aim of the investigation was to determine odour pollutants, especially ammonia, in air and check the possibility of a catalytic method application in their removal [1-3, 5]. Contents analysis of the gases carried away from their emission sources and estimation of their odour is a difficult task but possible to perform with the

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application of various methods of odour detection and odour level estimation [1, 4]. Gases sampling was carried out in the central part of the building (Fig. 1) and near outlets of ventilators at the height of 0.5 m [3, 8], in the period of poultry fattening - 5th and 6th week of the keeping, at various daytimes and seasons.

Fig. 1. Poultry house inside

Table 1

A dependence of odour intensity on concentration of selected odours applied by local authorities in Japan during determination of the highest allowable concentrations [1]

Odour intensity		**Odour concentration**				
		[ppm]				**[mg/m^3]**
		Methanethiol CH_3SH	**Acetaldehyde CH_3CHO**	**Styrene $C_6H_5CHCH_2$**	**Ammonia NH_3**	**Ammonia NH_3**
1	Detection threshold	0.0001	0.002	0.03	0.1	0.07
2	Recognition threshold	0.0007	0.01	0.2	0.5	0.36
2.5 3.0 3.5	Clear	0.002 0.004 0.01	0.05 0.1 0.5	0.4 0.8 2	1 2 5	0.71 1.42 3.55
4	Strong	0.03	1	4	10	7.10
5	Extreme strong	0.2	10	20	40	28.4

Gas samples were analyzed on the spot of sampling with an application of gases analyser Madur GA-20, as well as in a laboratory with an application of spectrophotometric methods and gas chromatography (GC-MS). Colorimetric or spectrophotometric analyses included the determination of ammonia [9, 10], hydrogen sulphide [11] and formaldehyde [12]. The intensity of odours was estimated using five-stage scale applied by local authorities in Japan for odorous protection of air quality. Table 1 presents concentration values of 4 among 8 obligatory air pollutants (ammonia, methanethiol, hydrogen sulphide,

dimethyl disulfide, trimethylamine, acetaldehyde and styrene), which determine potential harmfulness on five-stage scale applied by local authorities in Japan for determination of the highest allowable concentrations of odours in the environment [1]. The intensity of odour in air in work-places, as well as in air outside production buildings should not be higher than 3.5 stage (for ammonia 3.55 mg/m^3) which is the upper level (clear) of this stage.

Results and disscussion

Selected results of the pollutants investigation in air from the poultry keeping farm (poultry house) are presented in Tables 2-4.

Table 2

Analysis results of air sampled in a large building of the poultry keeping farm

Analysed component	**Measurements - 24.09.2009 (midday). Air temperature inside the building 24°C and outside the building 19°C**		**Measurements - 01.10.2010 (evening). Air temperature inside the building 22°C and outside the building 9°C**	
	Air in the central part of the building at the height of 0.5 m	**Air at the outlet of a ventilator**	**Air in the central part of the building at the height of 0.5 m**	**Air at the outlet of a ventilator**
O_2 [%]	20.5	20.9	20.9	20.9
CO_2 [%]	0.3	0	0	0
CO [ppm]	0	0	0	0
NH_3 [mg/m^3]	1.45÷2.59	N.d.*	0.82÷1.37	N.d.
Formaldehyde [mg/m^3]	< 0.25	< 0.25	< 0.25	< 0.25
Odour intensity: stage; description	3.0; clear	3.5; clear	2.5; clear	3.0; clear

* N.d. - not determined

Table 3

Analysis results of air sampled inside the poultry house on November 30, 2009 (midday). Air temperature in the poultry house 22°C and outside 6°C

Analysed component	**Air in the central part of the building at the height of 0.5 m**	**Air at the outlet of a ventilator**	**Air in a distance of 10 m from the outlet of a ventilator**
O_2 [%]	20.5	20.5	20.9
CO_2 [%]	0.3	0.3	0
CO [ppm]	0	0	0
SO_2 [ppm]	0	0	0
TOC in a solution in a gas washer [mg C/dm^3]	2.493	-	-
NH_3 [mg/m^3]	1.97÷2.65	N.d.	N.d.
Formaldehyde [mg/m^3]	N.d.	< 0.25	N.d.
Hydrogen sulphide [mg/m^3]	N.d.	< 2.0	N.d.
Odour intensity: stage; description	-	3.5; clear	2.0÷2.5; recognition threshold - clear

The presence of ammonia was found inside the poultry house at varying concentrations in the range from 0.82 to 2.65 mg/m^3 (Tables 2-4). Results of the analyses show that the ammonia concentration inside the building was a little bit higher at noon and in the

evening. The ammonia concentration was only 0.26 mg/m^3 (Table 4) in the air removed from the poultry house by the outlet of the side ventilator. Chromatographic analyses in the GC-MS system did not show ammonia content higher than 0.1% or organic compounds concentrations higher than 1 mg/m^3 possible for the detection in this system. Carbon monoxide, sulphur dioxide, hydrogen sulphide (> 2.0 mg/m^3) and formaldehyde (> 0.25 mg/m^3) was not detected. Traces of dust (not detected) arising from the building and covering ventilators casing or plants below their outlets, were observed.

Table 4

Analysis results of air from the poultry keeping farm on May 25, 2010 (morning). Air temperature inside the building 22°C and outside 20°C [3]

Analysed component	**Air sampled inside the poultry house at the height of 0.5 m from the ground**	**Air removed from the inside of the poultry house and sampled at the side ventilator outlet**
O_2 [%]	20.9	20.9
CO_2 [%]	0	0
CO [ppm]	0	0
SO_2 [ppm]	0	0
CH_4 [ppm]	1.0	0
NH_3 [mg/m^3]	0.84÷1.19	0.26
Formaldehyde [mg/m^3]	< 0.25	< 0.25
Hydrogen sulphide [mg/m^3]	< 2.0	< 2.0
Odour intensity: degree; description	3.0÷3.5; clear	2.5÷3.0; clear

Odour intensity was estimated using five-stage scale developed in Japan with the third stage splitted for three levels labelled as: 2.5, 3.0 and 3.5 (clear). The measurements proved that odour intensity in the air inside the poultry house and removed by the ventillators was the highest in the third stage, ie, clear, and reached the value of, 3.5. The odour intensity decreased quickly with an increase in the distance from the ventilator in spite of air flow in the same direction (2÷3 m/s), because in the distance of about 10 m, this intensity was only at the level of the stage limit - recognition threshold and clear, ie 2.0÷2.5. The odour intensity was significant only in the distance of a few meters from the ventilator.

Conclusions

Within sampling period, poultry keeping in the farm was the source of variable in time ammonia emission ranging from 0.82 to 2.65 mg/m^3. Air inside in farm contained carbon dioxide (0÷0.3%) and oxygen (20.5÷20.9%). Concentrations of ammonia determined in the poultry house in the evening were lower than in the morning and at noon. Carbon monoxide, sulphur dioxide, hydrogen sulphide (> 2.0 mg/m^3) and formaldehyde (> 0.25 mg/m^3) was not detected. The highest odour intensity inside the building of chicken keeping and at outlets of ventilators was at the third stage in odour scale applied in Japan (3.5), ie, clearly perceptible. However, it decreased significantly with the increase in a distance from the building.

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Abstrakt: Próbki zanieczyszczonego powietrza z dużej fermy drobiu rzeźnego (~18 tys. kurcząt) pobrano w województwie łódzkim. Celem badań było wykonanie analiz powietrza na zawartość zanieczyszczeń odorowych, zwłaszcza amoniaku, a w perspektywie zbadanie możliwości zastosowania metody katalitycznego utleniania do ich usuwania. Próbki gazów były analizowane na miejscu pobrania za pomocą automatycznego analizatora gazów Madur GA-20, a także w laboratorium metodami instrumentalnymi i spektrofotometrycznymi. Do oceny intensywności zapachu stosowano pięciostopniową skalę wykorzystywaną przez władze lokalne w Japonii do ochrony zapachowej jakości powietrza. Hodowla drobiu w badanej fermie była w okresie pobrania próbek źródłem zmiennej w czasie emisji amoniaku w granicach 0,82÷2,65 mg/m^3. W powietrzu obiektu stwierdzono 0÷0,3% ditlenku węgla i 20,5÷20,9% tlenu, natomiast nie wykryto tlenku węgla, ditlenku siarki, siarkowodoru (> 2,0 mg/m^3) ani formaldehydu (> 0,25 mg/m^3). Najwyższa intensywność odorowa wewnątrz budynku hodowli kurcząt, a także na wylotach wentylatorów mieściła się w trzecim stopniu skali zapachu stosowanej w Japonii (3,5), tj. wyraźny, jednak znacznie obniżała się wraz z oddalaniem się od obiektu.

Słowa kluczowe: fermy drobiu, oznaczanie amoniaku, odory w produkcji rolnej