INNOVATIVE AND CLEANER INORGANIC TECHNOLOGIES
Module supervisor: dr hab. inz. Marcin Banach
Laboratory Instruction No 5
NEUTRALIZATION OF AMMONIA

REPORT:
ONE WEEK AFTER THE END OF THE CLASS

Author: Jolanta Pulit-Prociak

Projekt „Międzynarodowy program kształcenia Innowacyjne Technologie Chemiczne”
dofinansowywany z Funduszy Europejskich
nr POWR.03.03.00-00-M070/16

Wydział Inżynierii i Technologii Chemicznej
Politechniki Krakowskiej im. Tadeusza Kościuszki
Ul. Warszawska 24
31-155 Kraków

tel/faks 12 628 20 35
tel. 12 628 27 01
www.chemia.pk.edu.pl

1. Introduction

In countries with well-developed agriculture, there is a risk of increased environmental pollution due to the over-exploitation of the soil and eutrophication of surface water. Also, industrial livestock farming and breeding has negative effects on nature. As a result of the emission of foul odors from livestock premises, atmospheric air pollution may be problematic, while the improper handling of natural fertilizers of animal origin (e.g. excessive fertilization of the soil) contributes to the contamination of surface and ground water as well as soil. In the case of breeding pigs, the biggest environmental nuisance is porcine slurry, which contains about 400 malodorous compounds, including large amounts of ammonia.

Unpleasant odors are produced by volatile organic and inorganic compounds. They are formed in the body during digestive processes and as a result of microbiological changes occurring in faeces during its collection in tanks, and its utilization through the fertilization and application of slurry to the soil. Neutralization of odoriferous substances is difficult, however, in terms of sustainable development, it is an important element of green chemistry. According to the literature, the reduction of odor emissions will be one of the most important directions in the development of animal systems and technologies in the future.

1.1. Methods of deodorization of malodorous substances

1.1.1. Direct methods

Direct methods consist of modifying animal feeds by using additives that limit nitrogen excretion (humic preparations) as well as modifying the composition of proteins and reducing the amount of proteins and substances containing sulfur in the feed. The feed is often supplemented with exogenic amino acids, probiotics, prebiotics, organic acids and plant extracts. Bismuth compounds such (bismuth subgalat, BiG), chlorophyllin copper complexes (CCC) and powdered activated charcoal (PAC) are also added.

Wydział Inżynierii i Technologii Chemicznej
Politechniki Krakowskiej im. Tadeusza Kościuszki
Ul. Warszawska 24
31-155 Kraków
tel/faks 12 628 20 35
tel. 12 628 27 01
www.chemia.pk.edu.pl

1.1.2. Indirect methods

Indirect methods consist of reducing odor emissions by processing the source material and modifying the composition of the floor and drainage pipes in the rooms in which animals are located. Chemical substances such as superphosphate, phosphoric acid, aluminosilicates, saponins and preparations containing live bacterial cultures are also added to the mulch. The use of biofilters consisting of coarse peat, peat fibre, compost from a treatment plant, fermented horse manure and wheat straw also produces satisfactory results. The use of low-temperature plasma reactors is also of importance, which, according to Mielcarek and colleagues is far more cost-effective than combustion methods and adsorption technologies. In order to deodorize the air, ozone is also used. It is also possible to use ionic liquids because of their ability to dissolve volatile organic and inorganic compounds. Odor oxidation methods using heterogeneous catalysts are also well known.

Indirect methods of deodorization are based on different techniques of removing volatile compounds, such as adsorption and absorption, biological methods (e.g. biofiltration), thermal oxidation, and chemical methods. Chemical neutralization usually takes place via a chemical reaction with neutralizing reagents. The reaction products are compounds that do not have volatile properties and do not have an odor, hence, fragrance deactivation occurs. Sulfuric acid (VI) and phosphoric acid (V) may be considered as neutralizing substances due to their high reactivity with chemicals.

2. Aim of experiment

The purpose of the experiment is to neutralize ammonia by means of a chemical method and to evaluate its effectiveness.

Wydział Inżynierii i Technologii Chemicznej
Politechniki Krakowskiej im. Tadeusza Kościuszki
Ul. Warszawska 24
31-155 Kraków
tel/faks 12 628 20 35
tel. 12 628 27 01
www.chemia.pk.edu.pl

3. Chemical reagents and laboratory equipment

3.1. Chemical reagents

- redistilled water

- phenol reagent

Volumetric flask 100 ml Dark bottle 100 ml
H_2O Phenol 5.0 g Sodium nitroprusside 0.025 g Salicylic acid 0.1 g
Pour around 50 ml of water into a volumetric flask, add phenol, sodium nitroprusside and salicylic acid and fill the flask with water. Durability: 6 months

- sodium hypochlorite reagent

Glass bottle 50 ml
Sodium hypochlorite Aqueous solution of NaOH, 10%
Mix sodium hypochlorite with an aqueous solution of NaOH (10%) in a volumetric proportion 5 ml (sodium hypochlorite) : 5.5 ml (NaOH)

- stock standard solution

Volumetric flask 1000 ml
Ammonium chloride 0.3141 g H_2O

Wydział Inżynierii i Technologii Chemicznej
Politechniki Krakowskiej im. Tadeusza Kościuszki
Ul. Warszawska 24
31-155 Kraków
tel/faks 12 628 20 35
tel. 12 628 27 01
www.chemia.pk.edu.pl

Dissolve ammonium chloride in around 200 ml of water and fill the flask to the mark with water. Durability: 2 months

- adsorbing solution

Volumetric flask 1000 ml
Sulphuric acid 95% 0.5 ml H_2O
Add 0,5 ml of sulphuric acid to the volumetric flask and fill the flask with water to the mark.

- standard working solution - corresponding to 1 µg of ammonia in 1 ml

Volumetric flask 100 ml
Adsorbing solution Stock standard solution
Dilute the stock standard solution with the adsorbing solution in volumetric ratio 1:10.

- neutralizing sulphuric acid, 10%

Beaker
Sulphuric acid 95% H_2O
Calculate the appropriate dilution and prepare 30 ml of sulphuric acid at a concentration of 10%. The preparation should be carried out in a fume hood.

3.2. Laboratory equipment

- 3 Poleżajew's scrubbers
- pump

Wydział Inżynierii i Technologii Chemicznej
Politechniki Krakowskiej im. Tadeusza Kościuszki
Ul. Warszawska 24
31-155 Kraków
tel/faks 12 628 20 35
tel. 12 628 27 01
www.chemia.pk.edu.pl

- teflon wires
- 3 stands
- 3 clamps

4. The course of the exercise

4.1. Calibration curve

Add 0.0; 0.4; 0.6; 0.8; 1.2; 1.6; 2.0 ml of standard working solution and fill up the mark with absorbing solution so that the whole volume of the mixture was equal to 5 ml. The content of ammonia in the tubes is: 0.0; 0.4; 0.6; 0.8; 1.2; 1.6; 2.0 µg. Add 1 ml of phenol reagent and 0.5 ml of sodium hypochlorite to each tube. Mix thoroughly and place tubes in a dark place for 20 minutes. Measure their absorbance at λ=630 nm.

4.2. Measurement of ammonia content in environment sample

The environment sample is provided by your tutor. Introduce 10 ml of absorbing solution to each scrubber. Seal their joints thoroughly and connect with pump. The second wire is introduced to the container with the environment sample (of known volume) which should be covered with parafilm sheet. The flow parameters will be set by your tutor. Turn on the pump and let the air pass through all scrubbers for a known time. Note the air flowrate. When absorption is complete, proceed to the analysis of ammonia in the absorbing solutions.

Wydział Inżynierii i Technologii Chemicznej
Politechniki Krakowskiej im. Tadeusza Kościuszki
Ul. Warszawska 24
31-155 Kraków
tel/faks 12 628 20 35
tel. 12 628 27 01
www.chemia.pk.edu.pl

4.3. Determination of ammonia by spectrophotometric indophenol method

The analysis concerns the reaction of ammonia to produce indophenol. Transfer 5 ml of each solution from the scrubbers to separate tubes. To each tube add 1 ml of phenol reagent and 0.5 ml of sodium hypochlorite reagent. Mix thoroughly and place the tubes in a dark place for 20 minutes. After that time, analyse the ammonia content based on the calibration curve.

4.4. Neutralization of ammonia

Add 20 ml of sulphuric acid (10%) to the environment sample. Mix the pulp with baguette. Determine the ammonia concentration according to p. 4.3.

4.5. Calculation

Calculate the ammonia concentration in the air according to the formula:

$$X = \frac{m \cdot V_1}{V_2 \cdot V},$$

Where:

X – ammonia concentration in the air [mg/m^3]

m – ammonia mass in the sample [µg]

V_1 – total volume of tested sample [ml]

V_2 – volume of tested sample analysed [ml]

V – volume of air passing through the scrubbers [dm^3]

Wydział Inżynierii i Technologii Chemicznej
Politechniki Krakowskiej im. Tadeusza Kościuszki
Ul. Warszawska 24
31-155 Kraków
tel/faks 12 628 20 35
tel. 12 628 27 01
www.chemia.pk.edu.pl

5. Report

The report should include: introduction (from 0.5 to 1 pages with citations), course of work, results and their analysis, summary with conclusions and a list of references.

Projekt „Międzynarodowy program kształcenia Innowacyjne Technologie Chemiczne”
dofinansowywany z Funduszy Europejskich
nr POWR.03.03.00-00-M070/16

Wydział Inżynierii i Technologii Chemicznej
Politechniki Krakowskiej im. Tadeusza Kościuszki
Ul. Warszawska 24
31-155 Kraków

tel/faks 12 628 20 35
tel. 12 628 27 01
www.chemia.pk.edu.pl