Optimal Litter Composition for Industrial Poultry Houses

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Abstract – The objective was to determine optimal litter composition parameters for industrial poultry houses. The most preferable ratio of natural mineral sorbents to manure was found. We studied the technologies of processing poultry manure into a formed product contributing to soil structuring and providing plants with balanced fertilization with microelements (nitrogen, phosphorous and potassium).

Key words – environment pollution, ammonia, adsorption, poultry farming, manure, natural sorbents, composting.

I. Introduction

Poultry farming is a well-developed field of the livestock production, the primary targets of which include raising, keeping and feeding selective-breeding poultry, application of fully automated and mechanized processes, strict observance of process parameters and taking veterinary preventive actions in order to increase the production of eggs, meat and other products on a commercial basis. Poultry farming business involves complexes for broiler chicken fattening, hen keeping and raising replacement hens, and incubators for keeping day-old chicken with their further supply to farms [1,2].

Poultry keeping technique depends on natural conditions, breeding system and farm's specialization. There are floor (on built-up litter, slatted or slotted floor), cage, extensive, aviary and combined poultry housing forms [3].

Since for experiment purposes manure from a poultry house with floor housing was used, we can outline the following specifics. In case of floor poultry housing, with run or without, chicks stay in a poultry house. This is the way the adult poultry stock is kept on small farms, at specialized poultry enterprises as well as when raising broilers, ducks, turkeys, geese and hens of the parent flock. Dry litter creates good veterinary hygienic conditions and poultry is kept on a warmer floor, which is important when there is a long-lasting cold winter. Litter in a poultry house is not replaced for a while, which makes the droppings cleaning process easier.

However, it must be remarked that improper fulfilment of process operations related to droppings removal and inappropriate storage and transportation may result in an environmental hazard.

Solid and liquid animal excrements are not equivalent by their composition and fertilizing properties. Liquid excrements contain more nitrogen (0.4-1.9%) and potassium (0.5-2.3%) than solid (0.3-0.6% and 0.1-0.3% respectively), while solid extremists have much more phosphorus (0.17-0.41%) as compared to liquid (0.07-0.1%). Nitrogen and phosphorous in solid excrements are contained in organic compounds and transformed into a receptive for plants form after their mineralization.

Total waste of the animal origin in Ukraine for 2011 generated by the farming livestock in general amounted to 26.5 tons and by the species was as follows: poultry – 9249.1 (35%); hogs – 8907.3 (34%); cattle – 8348.4 (31%) [2].

An environmental problem coming up in process of the activity of poultry farms is pollution of the atmosphere with such pollutants as ammonia, carbonic acid gas and hydrogen sulphide. Those gases are evolved as a result of vital functions of poultry and microbiological decay of organic substances in poultry houses.

Ammonia has a relatively short life in the atmosphere (from a few hours to 5 days), since it is easily absorbed by water or neutralized by acid gases (NOx and SO_2). Thus, it facilitates acidification of soil and eutrophication of surface water bodies [4].

The intensity of evolution of gaseous substances into the atmosphere depends on storage conditions (temperature, humidity, a manure reservoir type) and specific manure properties.

There are multiple cases of gas poisoning among the staff. Besides, they suffer stomach, eye and brain diseases and are more susceptible to oncologic illnesses [2].

Therefore, great attention is paid to the reduction of content of these gases in the air of poultry houses and their emission to the atmosphere [2].

The overall aim of our research is to develop a technology for processing raw poultry droppings into a formed product preserving all of its useful properties and possessing optimal parameters for storage and utilization in any period of a year. For research purposes, we used a real litter mixture from a poultry farm, consisting of poultry manure, chopped wheat straw and fine-ground CaO.

Raw poultry manure containing 65-75% of moisture makes it difficult to incorporate into soil.

An effective way to ensure ammonia absorption is to prepare compost compounds with the application of such natural disperse minerals as clinoptilolite, glauconite, bentonite and palygorskite. Using clinoptilolite and palygorskite as mineral additives in an organic fertilizer allows for efficient reduction of excessive moisture and adsorption from the gas phase of molecules causing foul smell.

II. Methods and results

Two types of sorbents were selected for the study purpose: palygorskite from Dashukivka Deposit in Cherkasy Region and clinoptilolite from Sokyrnytsia Deposit of Zakarpattia Region.

The absorbing materials are heat-resistant, have good mechanical stability and do not cause additional environment pollution, as they are natural bottom-sediment components.

One of the experiment stages was determination of optimal ammonia adsorption parameters. The concentration of ammonia not absorbed by the sorbents was determined using a standard (titrated) sulphuric acid solution and by reverse titration of the excessive acid with a sodium hydroxide solution, adding methyl red. The test was carried out under the following ambient temperature conditions: T= 10; 15; 20; 25°C. According to the test results, the ammonia absorption process ran the best at

20°C. Therefore, all the subsequent tests were conducted under isothermal conditions (20°C).

Palygorskite belongs to low-swelling bentonites, has a stratified pattern and possesses better adsorbability as to coarse molecules.

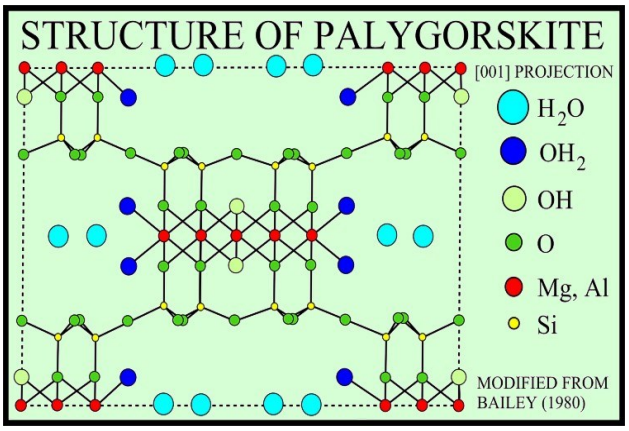

Fig. 1. Structure of palygorskite

The palygorskite composition formula is as follows:

$$(Mg_{1.54}\,Fe_{0.83}\,Al_{1.4})\,[(Si_{7.43}\,Al_{0.58})_4O_{20}]\,(OH)_2\,(OH_2)_{3.15} * 4.3H_20 \quad K_{0.22}\,Ca_{0.02}\,Mg_{0.17.}$$

Clinoptilolite has a better developed zeolite inlier pattern. Due to its unique adsorption, ion-exchange and catalytic properties, it is widely used as a sorption material.

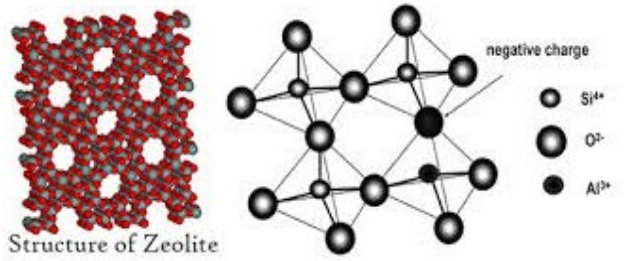

Fig. 2. Structure of zeolite

The clinoptilolite composition formula is as follows:

$$0.2Na_2O \cdot 0.26K_2O \cdot 0.43Ca \cdot 0.2Mg \cdot 9.57SiO_2 \cdot Al_2O_3 \cdot 0.09Fe_2O_3$$

Batches were prepared in the following sorbent weight ratios: 0g clinoptilolite : 10g palygorskite; 10:0; 1.5:8.5; 3:7; 5:5; 7:3; 8.5:1.5. The highest adsorption capacity was shown by a clinoptilolite to palygorskite ratio 1:1.

The next step was to determine a ratio of poultry manure to mixture of the sorbents. Batches were prepared in the following weight ratios: 10g mixture : 50g manure (1:5); 15:50 (1:3); 20:50 (1:2.5). When using the ratio 50g manure to 10g sorbents (5g palygorskite and 5g clinoptilolite), during the initial 15 minutes we observed slight concentration of emissive ammonia. As to the other samples, ammonia was completely absorbed from the poultry manure.

Conclusion

Adding a palygorskite and clinoptilolite mixture to litter for poultry houses significantly reduces the ammonia and moisture concentration in manure. This proves the efficiency of application of these minerals in litter content. Further, the received products may be utilized as an organic-mineral fertilizer.

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