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DECREASING OF AMMONIA GAS LEVEL IN BROILER BREEDING WITH PHOSPHORIC ACID METHOD

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Abstract

The aim of this study is to test the new, non-marketable system for reducing the most common ammonia gas from the harmful gases in the broiler house and gain them to the farmers. This new system is designed to decrease the ammonia level in the poultry house environment without ventilation. The study was carried out in a broiler breeding house with a capacity of 3000, length of 21 m, a wall height of 3.3 m and a width of 10 m. The phosphoric acid system consists of 2 barrels with a volume of 70 liters placed on top of each other, 5 M phosphoric acid solution and polyethylene balls with three different surface areas. A 190 m^3 h^{-1} capacity fan is installed on the top of the system. It is aimed to reduce the ammonia level by passing the poultry air through this planned system. The phosphoric acid placed in the system is wetting the polyethylene balls and the ammonia in the poultry air passing through the surface of the polyethylene balls is trying to be trapped by the acid in these surfaces. This system, which has never been tried before, is thought to be successful in reducing ammonia levels in broiler chickens.

Key words: *ammonia, broiler, phosphoric acid, polyethylene ball.*

INTRODUCTION

Ammonia (NH_3) is an important pollutant gas that is emitted from poultry farms as a result of the microbial spoilage of the uric acid in poultry fertilizer. It prevents economic poultry husbandry with adverse impacts on animal and human health during the breeding period in coops resulting from an increase in the gas and dust density especially in periods when ventilation is difficult (Okuroğlu, 1987; İpek et al., 2002). The problem of eliminating contaminated air and odors inside the poultry housings has not been solved yet and it is still widely discussed (Nowakowicz-Dębek et al., 2016). Air change of about 0.5-6.0 m^3 h^{-1} kg^{-1} is required for attaining the optimum environmental conditions in poultry housings (Wlazlo et al., 2016). This results in a significant amount of pollutant gas emission to the atmosphere. Ammonium ions (NH_4^+) that form in litter may develop as melted ammonia on the surface, ammonium ions (NH_4^+) and free ammonia (NH_3). The ammonia gas coming from the litter surface spreads during a convection process. While it can generally remain for relatively shorter periods of time in the atmosphere ranging from a few hours to a few days, ammonium ions in aerosol form may remain in the atmosphere for up to 15 days (Wlazlo et al., 2016). Ammonia emissions have increased dramatically in the 20^{th} century, doubling or tripling at certain locations in the world. Studies that aim to limit the amount of nitrogen compounds released from poultry fertilizer are being carried out in many research centers in Europe and America (Jones et al., 2013; Zhang et al., 2010).

Various chemical applications such as zeolites, superphosphate, phosphoric acid, iron sulfate, acetic acid etc. are used for reducing ammonia emissions from animal manure. These chemical applications reduce ammonia emissions but may also result in different forms of pollution. For example, phosphoric acid addition may increase the phosphor content of litter (Singh et al., 2009).

The objective of the study was to try out a new system that is not in the market for reducing the ammonia gas which is the most widespread deleterious gas generated in the broiler housing and to make it available for the producers. In this regard, the applied Phosphoric Acid Setup has been developed within the scope of this study. The objective for developing this system was to reduce the level of ammonia without affecting the ambient temperature.

MATERIALS AND METHODS

The study was carried out at the deep litter broiler housing with a length of 21 m, height of 3.3 m and width of 10 m with a capacity of 3000 located at the Süleyman Demirel University, Faculty of Agriculture Research and Application Center. Rough sawdust was used as litter material during the husbandry period. Ventilation hatches with dimensions of 1.45 x 5.6 m were placed on the south and north walls. In addition, another ventilation hatch with a length of 0.5 x 21 m was placed on the roof. Ross hybrid chicks used frequently in broiler husbandry were used as live material in the study and the chicks were taken into the poultry housing when they were one day old. Careful attention was given to the requirements of broiler chicken.

Ammonia remover system with phosphoric acid solution was tested in the study. A phosphoric level of 5 M phosphoric acid solution was added. Three different applications were tested for this purpose with an objective of decreasing ammonia level. The prepared phosphoric acid setup along with ammonia, temperature and moisture sensors placed at intervals of 1.5 m were placed inside the poultry housing as shown in Figure 1 after which measurements were carried out at the chick and human level. The first sensor was placed right next to the system (0 m) and the other sensors were placed at intervals of 1.5 meters along the long axis of the poultry housing. Sensor height from the ground was arranged depending on animal development. Two sensors were placed at a height of 1.7 m for determining the ammonia levels at the human level one of which was right next to the phosphoric acid setup with the other at a distance of 3 m (Top 0 m and Top 3 m).

Application 1. A plastic barrel with a volume of 70 l was used in the system. Eighteen holes were drilled on the barrel with diameters of 3.3 cm starting from 14 cm above the bottom of the barrel. Plastic pipes with lengths of 8 cm were placed in these holes for preventing acid seepage. A single hole with a diameter of 11.5 cm was drilled on the top of the system and a fan with a capacity of 190 $m^3 h^{-1}$ was placed here. A ½ polypropylene water pipe was made into a circle and placed right below the upper lid with 60 holes of 2 mm diameter drilled on it.

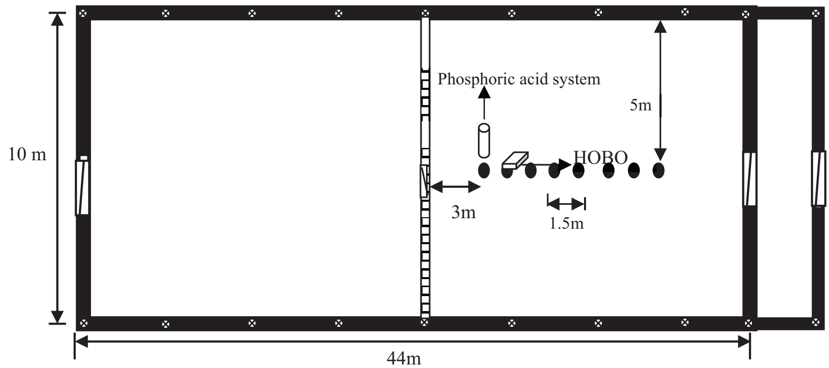

Figure 1. View of the phosphoric acid system and ammonia sensors

A total number of 80 plastic balls with diameters of 8.5 cm were placed inside the barrel for ensuring that the air passing through the barrel gets into contact with a larger surface area, thereby reaching a total interior surface area of 1.82 m^2. A single hole was drilled under the barrel which was connected to a pipe that was in turn connected to a pump. The outlet of the pump was connected to the circular pipe placed on top of the system. In short, the system wets the balls inside with phosphoric acid and the ammonia inside the air that passes in contact with the surface of the balls is tried to be absorbed by way of the acid on these surfaces.

Application 2. Whereas in the second application two plastic barrels were placed on top of each other and the system was operated with an increased surface area. Thus, the surface area was increased from 1.82 m^2 to 2.27 m^2 and measurements were obtained with doubled interior volume (Figure 2).

Application 3: A total number of 300 plastic balls with smaller diameters (4 cm) were also included in the system for increasing the total surface area. The surface area that the air flowing inside gets in contact with was increased from 2.27 m^2 to 3.78 m^2 following the final system change after which measurements were taken. Patent study was carried out for this developed system and the details of the system will be presented in another article.

Figure 2. Designed phosphoric acid system

RESULTS AND DISCUSSIONS

Application 1. The applications for the phosphoric acid method used in the study were tried to be depicted graphically. As can be seen in Figure 3, the system was operated when the ammonia level measured by the 0 m sensor right next to the setup reached 25 ppm. The researchers specify the ammonia level limit value for the poultry housing as 25 ppm (Choiniere and Munroe, 1997). Values decreased in the 0 m and upper 0 m sensors right after the system was operated, whereas the values acquired from the 1.5 m sensor increased. This is most likely due to an ammonia gas concentration difference inside the poultry housing and the onset of gas diffusion from ammonia rich regions towards the system. As a result, decreases and increases occurred in the other sensors which were not at sufficient levels for explaining the effectiveness of the system. However, it can be observed as a result of examining Figure 4 which depicts the average values that the first sensor yields lower values in comparison with the sensor right next to it thus indicating that the system has decreased the level of ammonia. Low ammonia levels detected around the locations of 9 m and 10.5 m sensors can be explained by the entry of fresh air into the system when the gate near these sensors is opened and closed while controlling the system.

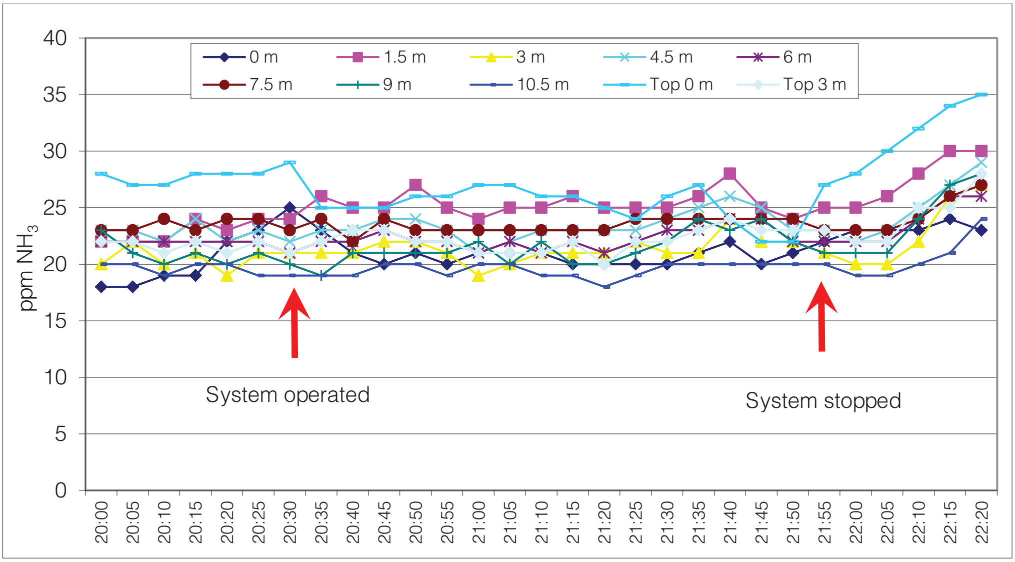

Figure 3. Ammonia values measured by application 1

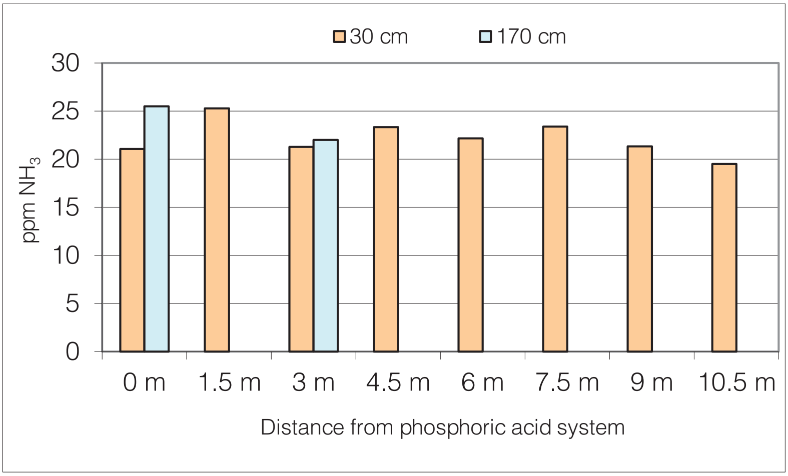

Figure 4. Average ammonia values obtained by application 1

It can be indicated upon examining the values acquired from 0 m and upper 0 m sensors which yielded the highest decrease during the operating time of the phosphoric acid system that a decrease of about 5 ppm took place which would not be too significant for decreesing the level of ammonia inside the poultry housing. However, this result may also be due to the failure to prevent the gas flow and diffusion inside the poultry housing. It is also apparent that there is a need to place a greater number of systems for determining the impact of the system on the whole area. It can be suggested to use temperature values of around 24-26°C for about 3 week old broiler chicks upon examining the temperature values for the poultry housing (Büyüktaş et.al., 2016). It was determined that these values have been met upon an examination of the measured temperature values. In addition, it is also suggested that the proportional moisture value for the interior of the poultry housing should not be lower than 40 % and higher than 70% (Çelik, 2011). This value should be between 60% and 70% for a good development and feathering (Büyüktaş et al., 2016). An examination of the proportional moisture values put forth that the suggested values have been met for the animals during the measurement period.

Application 2. Surface area was increased from 1.82 m^2 to 2.27 m^2 thus trying to determine the level of ammonia in order to ensure that the system operates more effectively. The ammonia values and average values determined for the system have been given in Figures 5 and 6.

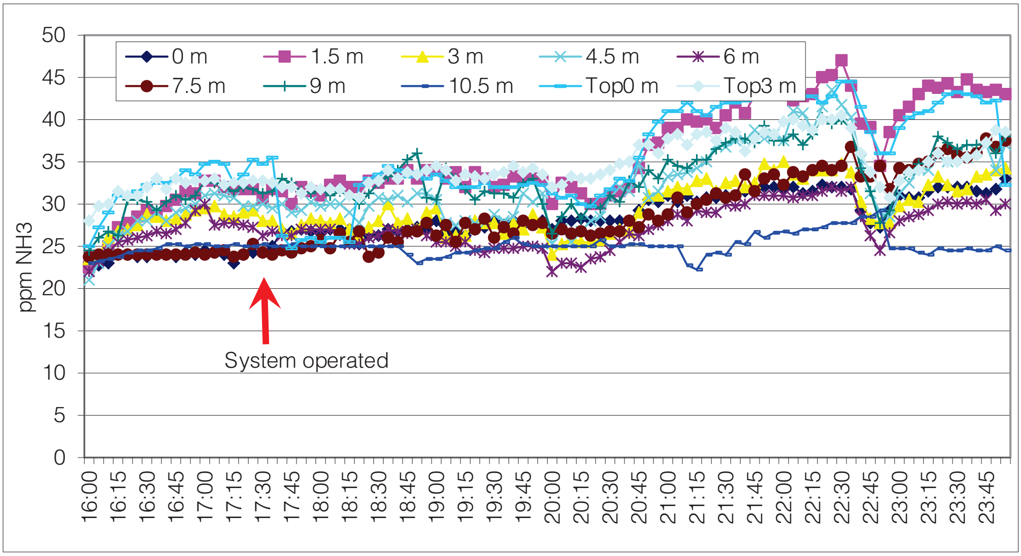

Figure 5. Ammonia values measured by application 2

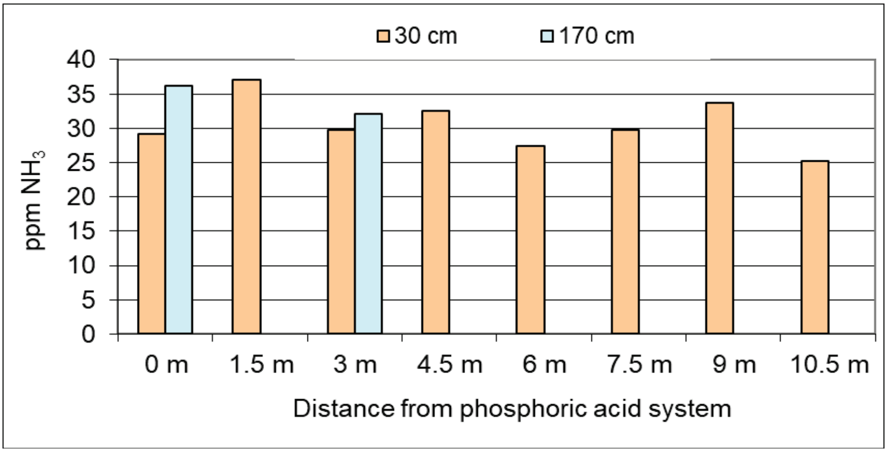

Figure 6. Average ammonia values obtained by application 2

It was observed that the ammonia values inside the poultry housing increased in direct proportion with the manure amount from the animals depending on their development. Because, Ritz et al. (2006) indicate the source of ammonia as excrements of animals left in the environment. Figure 6 indicates that system effectiveness increased with increased surface area and in particular, the sensor at the top 0 m (170 cm) has been found to have reduced ammonia levels at around 10 ppm. However, this decrease was not observed in the 0 m sensor. The decrease in the upper 0 m placed at around human height level took about 1 hour and it was observed that the ammonia values started to increase in the following period due to a rapid release of ammonia resulting from heated litter after the heaters were turned on. It was observed upon an examination of the average values given in Figure 6 that the decrease in the ammonia values near the system was more distinct in comparison with application 1. This finding is an indication that the development of the system shall be beneficial. Temperature and moisture values for the measurement period were tried to be kept at around the values suggested for the animals in this measurement application.

Application 3. It was observed as a result of an examination of the data acquired during application 2 that the effectiveness of the system inside the poultry housing decreased the ammonia levels but that the decrease was not at the expected level which indicates the necessity of remodifying the system in order to obtain more distinctive results. 300 balls with smaller diameters (4 cm) were added to the system for increasing the total surface area in the system and measurements were continued. The surface area that the air passing through the system gets in contact with was increased from 2.27 m^2 to 3.78 m^2 with the final change in the system. Data acquired from measurements on the final revised version of the system have been given in Figure 7. Averages for the related values have been given in Figure 8.

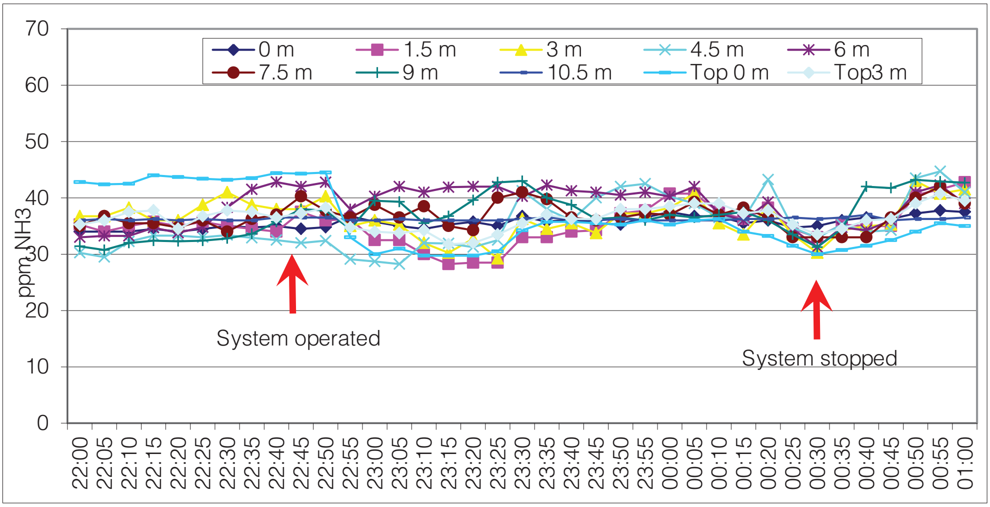

Figure 7. Ammonia values measured by application 3

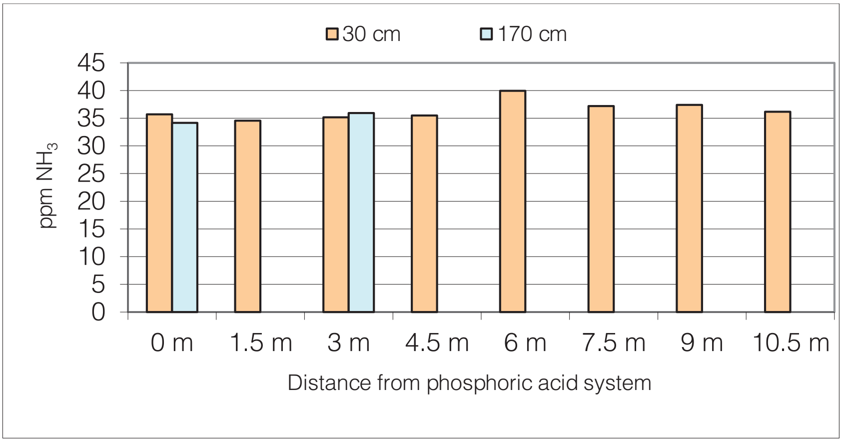

Figure 8. Average ammonia values obtained by application 3

As can be seen from Figure 7, values obtained from the Upper 0 m sensor placed at human height level started decreasing suddenly after the phosphoric acid setup was turned on and the system yielded a decrease from a peak measurement value of 45 ppm to around 30 ppm.

This distinctive decrease could not be attained in other sensors.

The Upper 0 m sensor is located nearest to the outlet of the phosphoric acid system.

Therefore, the ammonia level in this region starts decreasing suddenly once the system is started.

Whereas the other sensors are affected later from the decrease and all sensors indicate a decrease in the ammonia level inside the poultry housing as a function of time after the system is started.

The system was shut down for demonstrating its efficiency since the ammonia level inside the poultry housing did not decrease rapidly after the system was started.

In this scope, the system was shut down at 00:30 after which a tendency to increase was observed in the values.

Thus, it was concluded that the increase of ammonia level inside the poultry housing was prevented during the time that the system was running.

The poultry housing was not ventilated to allow for ammonia levels of 25 ppm during this measurement period.

Therefore, the measurement was started when the average ammonia level reached around 35 ppm.

Ammonia values increase significantly in any closed animal barn if the ambient air is not changed or sufficient ventilation is not provided. Levels of ammonia and other deleterious gases are especially high during winter time due to limited ventilation conditions. Values of around 60 ppm were measured in the poultry housing where the study was carried out.

Development of animals is affected adversely when the ammonia level exceeds the suggested values and live animal gains (Malone, 1985; Atasoy, 2000).

Hence, precautions should be taken for improving the ambient air in poultry housings and to eliminate its adverse effects.

It is important to show that the system is effective as a result of operating in high concentrations of ammonia in the poultry house. The ammonia level in the poultry housing never decreased below 25 ppm during the time period when the third application took place.

The system was operated during this measurement when the ammonia levels were quite high and the change as a function of time was tried to be determined (Figure 9).

Poultry housing ammonia levels decreased significantly right after the system was operated. Decrease was greater and more distinct at the Upper 0 m from among the measurement points. This is due to the fact that the measurement point is close to both the system as well as the system outlet. Similarly, distinctive decreases were recorded by the 0 m sensor which is the closest sensor to the system at the animal level.

The observed decrease stopped after some time and the poultry housing ammonia level was determined to be below 50 ppm.

When the values obtained from the sensors at the human level were examined in Figure 10 depicting the average values, it was observed that the ammonia level was lower at the point closer to the system.

Average ammonia levels inside the poultry housing remained at levels much below the peak value of 60 ppm.

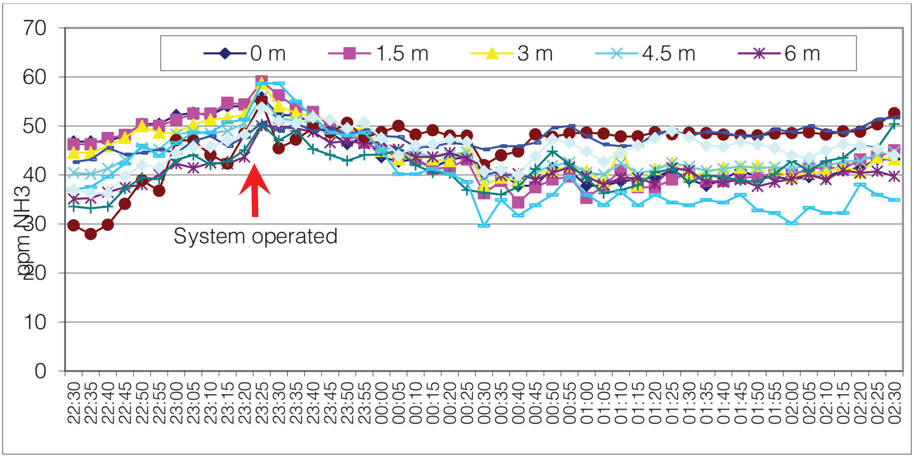

Figure 9. Ammonia values measured by application 3

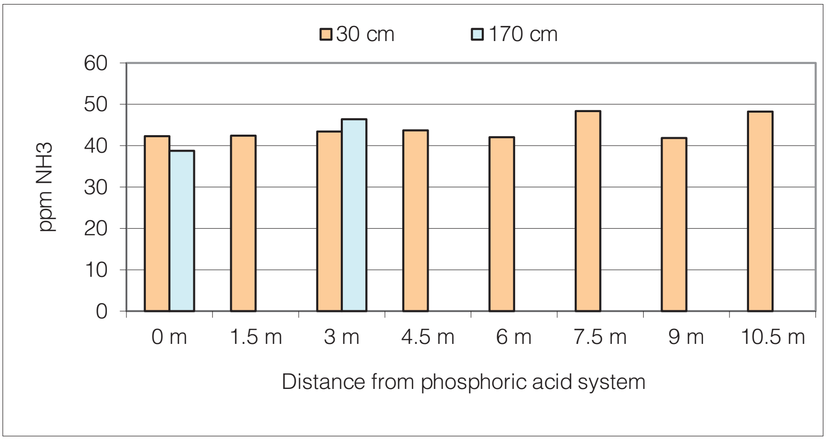

Figure 10. Average ammonia values obtained by application 3

CONCLUSIONS

The phosphoric acid system is designed on the basis of holding the ammonia inside the poultry house by trying different surface area applications. It was concluded based on the values obtained as a result of the study that the phosphoric acid setup used is successful in reducing the ammonia level inside the poultry housing and that a different system setup may be beneficial for ensuring that the system operates more effectively. It was especially concluded that the ammonia level can be reduced to values below the critical value of 25 ppm by placing more than one system inside the poultry housing. It was not possible to place more than one phosphoric acid system in the poultry housing in the study since it was planned to place only one phosphoric acid system. Therefore, system effectiveness was different at each point of the poultry housing. It was observed that the ammonia levels measured by sensors close to the system decreased rapidly. It was thus concluded that the system which is not out in the market yet and which has been tried for the first time is successful and that there is a need to further improve the system in order to increase its effectiveness.

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