# EFFECT OF A POLYMER ON MITIGATING AMMONIA EMISSION FROM LIQUID DAIRY MANURE

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*Abstract:* Reducing ammonia ($NH_3$) emissions from manure has been a great interest for academic, regulators, dairy farmers, and the general public. Fresh liquid dairy manure was collected from a dairy central pit. A polymer ($MTM^{TM}$) was tested at five different doses to determine if the polymer had any effects on reducing $NH_3$ emission from the manure. Ogawa $NH_3$ passive samplers were used to trap $NH_3$ emitted from the manure for two, four, six, eight, 12, and 24 hours during two separate tests, respectively. Samples collected via the passive samplers were analyzed for ammonium-N ($NH_4$-N) concentrations by a QuickChem 8500 system. Manure pH values were monitored before and after applying the polymer to the manure. The average concentration reductions of $NH_4$-N in the extractant were 8.1%, 20.7%, 36.5%, 54.5%, and 88.2% for the polymer Treatments 1 to 5 over the entire test period, respectively. Statistically significant differences of the $NH_4$-N concentration and manure pH were detected between the treatments and controls. However, a lower dose treatment (0.5 ml polymer/5 l manure) did not show significant differences of the $NH_4$-N concentration and pH from control for the two-, four-, six-, and eight-hour samples, but showed significant differences for both the 12- and 24-hour samples. The test results have shown that a higher dose of polymer led to a lower manure pH and a lower $NH_3$ emission. Further studies are needed to test if the pH adjustment was the only mechanism for reducing $NH_3$ emission or other effects existed as well.

*Key words*: ammonia, emission, emission reduction, dairy manure, polymer

## INTRODUCTION

The emission of ammonia ($NH_3$) from dairy manure is not only a loss of valuable nitrogen, but also an air quality concern because $NH_3$ plays a role in the formation of ammonium sulfate which constitutes the bulk of airborne particulate matter of less than 2.5 μm, which has been a serious concern for causing respiratory diseases at higher concentrations [1-5]. In addition, subsequent deposition of $NH_3$ can lead to damaged vegetation [6], reduced biodiversity of natural ecosystems [7], and the nitrification and eutrophication of water bodies [8]. Given its adverse economic and environmental impacts, reducing $NH_3$ emissions from manure has been a great interest for academic, regulators, dairy farmers, environmentalists, and the general public. Several approaches have been suggested and evaluated for mitigating $NH_3$ emissions from excreted animal manure which include reducing nitrogen excretion through manipulating feeding rations, reducing volatile $NH_3$ in the manure, and segregating urine from feces to reduce contact between urease and urine [3]. Methods for reducing the more volatile $NH_3$ in manure include the reduction of manure pH, which shifts the equilibrium in favor of ammonium ($NH_4^+$) over $NH_3$; use of other chemical additives that bind $NH_4$-N; and use of biological nitrification-denitrification to convert $NH_4^+$ into non-volatile N-species such as nitrite, nitrate, or gaseous nitrogen. Other methods for mitigating $NH_3$ emissions target emitting surfaces, and include capturing air using physical covers and treating the captured air using bio-filters or/and scrubbers, and manure subsurface injection during land application. Manure collection facility designs and appropriate facility management are also essential for abating $NH_3$ emissions [3].

A number of techniques have been used for the determination of $NH_3$ in the atmosphere. These methods include direct chemiluminescence [9], filter packs [10], denuders [11], acid scrubbers [11] and photoacoustic analyzer [12]. In passive samplers, the atmospheric compound of interest diffuses to a reactive surface, which chemically traps the gas. Passive samplers have been successfully used to determine $NH_3$ in ambient air [4,13,14].

More Than Manure (MTM[TM]), a maleic-itaconic copolymer product, was developed by Specialty Fertilizer Products (Leawood, KS) for improving manure fertilizer use and reducing ammonia emission from manure. The objective of this study was to evaluate the effect of the polymer (MTM[TM]) on mitigating $NH_3$ emissions, by using $NH_3$ passive samplers, from liquid dairy manure within 24 hours after applying the polymer.

## MATERIALS AND METHODS

### Experiment Equipment

Twenty-five five-gallon buckets were used in this study for containing liquid dairy manure. Each bucket had a lid on which two 51-cm holes were made for facilitation of placing and removing passive samplers and a pH probe during the tests (Figure 1). The pH probe and pH meter (Figure 2) were purchased from Cole-Parmer and used to monitor dairy manure pH during the tests.

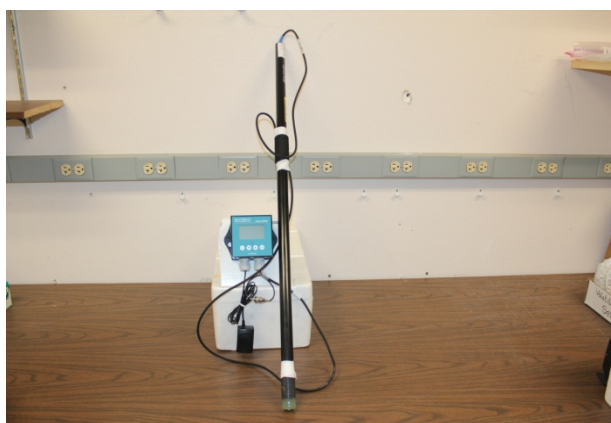*Figure 1. Five-gallon bucket with lid (two 51-cm holes were made on the lid)*



*Figure 2. pH probe and pH meter*

Ogawa passive $NH_3$ samplers (Ogawa USA, Inc., Pompano Beach, Florida, Figure 3) were used to determine the time-averaged concentrations of $NH_3$ in the head space of the five-gallon buckets containing both the polymer treated and untreated (control) liquid dairy manure. The dissembled components of the passive samplers were thoroughly cleaned before placing them into the headspace of the buckets by rinsing with deionized water, soaking in a 1 M HCl (Hydrogen Chloride) bath, rinsing again with deionized water, and then air-drying in a clean hood. The passive sampler filters were prepared by saturating a clean filter with 100 μl of 2% citric acid and air-drying before assembling the samplers. A total of 180 passive $NH_3$ samplers (figure 3) were prepared separately on April 12, 2012 (90 samplers) and April 26, 2012 (90 samplers) in the USDA Northwest Irrigation and Soil Research Micro laboratory located in Kimberly, Idaho (USDA ARS Kimberly). Assembled samplers were then placed into airtight containers and transported to the Waste Management Laboratory at University of Idaho Twin Falls Research and Extension Center (U-Idaho Twin Falls R&E Center) located in Twin Falls, Idaho for deployment.
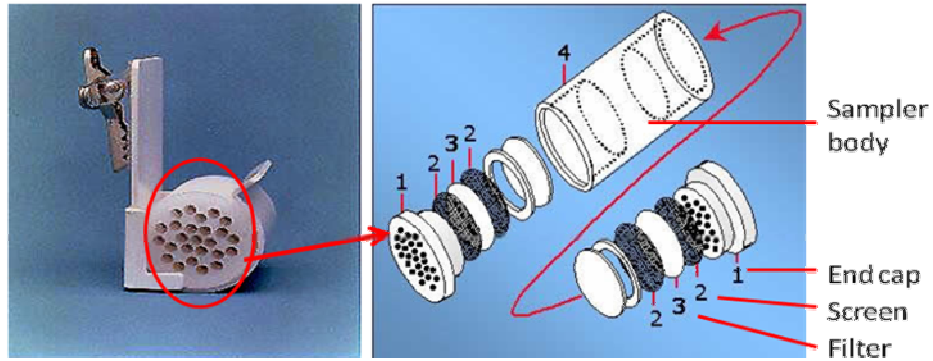
*Figure 3. Ogawa Passive sampler (modified from www.ogawausa.com)*

A flow-injection analysis system (Quickchem 8500, Lachat Instruments, Milwaukee, WI, Figure 4) was used to analyze $NH_4$-N extracted from passive sampler filters which trapped $NH_3$ in the head space of each bucket. The Quickchem 8500 system needs different carrier solutions which were prepared at the USDA ARS Kimberly based on the system's requirements.



*Figure 4. Quickchem 8500 analyzing system,*
*all carrier solutions (up) and auto sampler of the system (down)*

## Manure Source and the Polymer

Fresh liquid dairy manure was collected from a commercial dairy in Jerome, Idaho on April 13th and April 27th, 2012, respectively. The dairy was an open lot dairy with flush alleys. All the flushing wastes flowed into a central pit and then went through solid separation processes. After the solid separation, the wastes flowed into a series of lagoons. Liquid dairy manure was collected from the central pit where odor and gas emissions peak. The collected manure was then transported back to the U-Idaho Twin Falls R&E Center. At the U-Idaho Twin Falls R&E Center, the collected manure was well mixed before it was distributed into the five-gallon buckets without any extra pretreatments. The liquid dairy manure pH were 7.94 and 7.46 for the 13th and 27th samples, respectively. The polymer was provided by the J.R. Simplot Agribusiness Company (Boise, ID). The polymer had the following physical and chemical properties:

- Appearance: light yellow to brown liquid with characteristic light odor;
- Chemical Identification: mixture of maleic-itaconic copolymer partial calcium salt and maleic-itaconic copolymer partial ammonium salt, 50% W/W total solids solution in water;
- pH: 3.4;
- Specific gravity: 1.2;
- Freezing range: -5˚C.

## Experiment Procedure

Due to a limited number of Ogawa passive samplers available, two separate tests were conducted starting on April 13th and April 27th, 2012, respectively. Well mixed liquid manure was randomly distributed into 25 five-gallon buckets with five liters of manure in each bucket for each of the two tests. A computer program (http://www.random.org/sequences/) was used to generate a series of randomized number. Four of the 25 buckets were randomly chosen based on the series of randomized number to be controls and treatments with five different doses (namely Treatment 1 = T1 = 0.5 ml polymer/5 l manure, Treatment 2 = T2 = 2 ml polymer/5 l manure, Treatment 3 = T3 = 4 ml polymer/5 l manure, Treatment 4 = T4 = 8 ml polymer/5 l manure, and Treatment 5 = T5 = 32 ml polymer/5 l manure) of the polymer, respectively. The polymer doses were based on manufacturer's suggestion. The remaining bucket was used for a time series test. The time series test was for determining if the passive samplers reached their saturation capacities during the test period; therefore, no polymer was applied to the time series test bucket. After pouring manure into the buckets and applying the treatments, all of the 25 buckets were covered with lids. Passive samplers were placed into the head space of each bucket via one of the 51-cm holes. After passive samplers were placed in the headspace of each bucket, all of the buckets were sealed by tape and were kept at the U-Idaho Twin Falls R&E Center during the test periods. The temperature in the U-Idaho Twin Falls R&E Center lab was maintained from 18 to 20˚C during the tests.

During the first test period starting on April 13, 2012, five passive samplers were placed into the time series test bucket. At two, four, six, eight, and 13 hours, a passive sampler was pulled out from the time series test bucket, respectively. Seventy-two

passive samplers were placed into the headspaces of the 24 control and treatment buckets with three samplers of each bucket. At two, four, and six hours, a passive sampler was pulled out from the headspace of each bucket, respectively. Right after pulling out the passive samplers, sampler filters were transferred using clean forceps into 15-ml centrifuge tubes and were stored in a refrigerator for later analysis. Manure pH was measured when a passive sampler was pulled out from a bucket. After all of the samples were collected, the centrifuge tubes were brought to the USDA ARS Kimberly for analysis.

During the second test period starting on April 27, 2012, six passive samplers were placed into the time series test bucket. At two, four, six, eight, 12, and 24 hours, a passive sampler was pulled out from the time series test bucket, respectively. Seventy-two passive samplers were placed into the headspaces of the 24 control and treatment buckets with three samplers of each bucket. At eight, 12, and 24 hours, a passive sampler was pulled out from the headspace of each bucket, respectively. Passive sampler collection and pH monitoring were following the same procedure as the first test.

At the USDA ARS Kimberly, the filters in each centrifuge tube were extracted with 5 ml 1 M KCl (Potassium Chloride) for 30 minutes on a reciprocating shaker. The extractant was filtered with 0.45 μm filter discs into 8 ml glass culture tubes. The filtered extractant was then analyzed for $NH_4$-N via the Quickchem 8500 system according to the system's operating procedure. The QuickChem 8500 system reported $NH_4$-N concentrations as mg/l. The first test of 77 samples and second test of 78 samples were analyzed on April 15 and 29, 2012, respectively.

## Statistical Analysis

The $NH_4$-N concentrations within the extractant were used to evaluate if there was any effects of the polymer on mitigating $NH_3$ emission from liquid dairy manure and used to compare if there were any differences between the controls and treatments in this paper; therefore, a higher $NH_4$-N concentration within the extractant means a higher $NH_3$ emission from the manure. Ammonium-N and pH data were checked first to eliminate potential outliers using SAS PROC UNIVARIATE. Statistical analyses were conducted using SAS PROC GLM for both pH and $NH_4$-N data. Statements of statistical significance were based on $P < 0.05$.

## RESULTS AND DISCUSSION

The time series test results are shown in Figure 5. The linear relationship between the $NH_4$-N concentrations and the deployed times indicated that the passive samplers did not reach their saturation status during the test period for both of the tests, which was good. Had the passive samplers reached their saturation, the results would have been compromised.
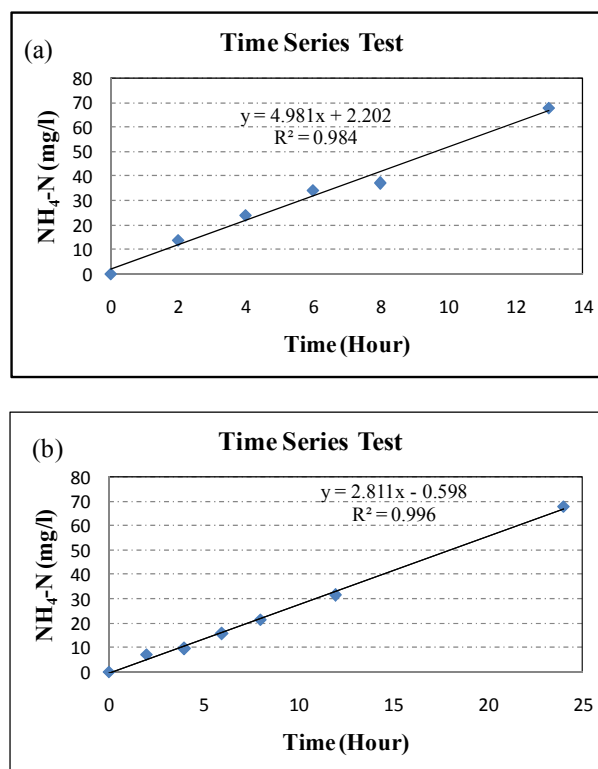
*Figure 5. Time series test for (a) first test and (b) second test.*

All the $NH_4$-N and pH data from both the control and treatments are shown in the Tables 1 and 2 for the first and second test, respectively. The concentration reductions of $NH_4$-N in the extractant, which were defined as (100 × [control concentration-treatment concentration]/control concentration), were 8.1%, 20.7%, 36.5%, 54.5%, and 88.2% for Treatments 1 to 5 over the entire test period, respectively.

*Table 1. First test results*
*(C = Control = without polymer treatment, Treatment 1 = T1 = 0.5 ml polymer/5 l manure,*
*Treatment 2 = T2 = 2 ml polymer/5 l manure, Treatment 3 = T3 = 4 ml polymer/5 l manure,*
*Treatment 4 = T4 = 8 ml polymer/5 l manure, and Treatment 5 = T5 = 32 ml polymer/5 l manure)*

| Treatment | Ave. ± SD* for $NH_4$-N (mg/l) | | | Ave. ± SD* for pH | | |
|---|---|---|---|---|---|---|
| | 2 Hours | 4 Hours | 6 Hours | 2 Hours | 4 Hours | 6 Hours |
| C | 13.28 ± 1.52 | 27.20 ± 4.84 | 38.88 ± 5.28 | 7.94 ± 0.03 | 7.94 ± 0.03 | 7.94 ± 0.06 |
| T1 | 12.78 ± 1.69 | 24.05 ± 1.19 | 36.88 ± 3.57 | 7.88 ± 0.04 | 7.88 ± 0.03 | 7.88 ± 0.04 |
| T2 | 12.08 ± 0.87 | 20.88 ± 0.70 | 29.53 ± 1.04 | 7.52 ± 0.08 | 7.53 ± 0.07 | 7.55 ± 0.05 |
| T3 | 9.54 ± 1.86 | 17.65 ± 2.26 | 25.15 ± 3.84 | 7.19 ± 0.12 | 7.31 ± 0.11 | 7.33 ± 0.09 |
| T4 | 6.67 ± 1.51 | 12.18 ± 1.39 | 17.68 ± 1.42 | 6.98 ± 0.04 | 7.01 ± 0.06 | 7.04 ± 0.05 |
| T5 | 2.05 ± 0.58 | 3.64 ± 0.17 | 5.19 ± 0.34 | 6.24 ± 0.05 | 6.31 ± 0.01 | 6.34 ± 0.03 |

*Based on four samples.

*Table 2. Second test results*
*(C = Control = without polymer treatment, Treatment 1 = T1 = 0.5 ml polymer/5 l manure,*
*Treatment 2 = T2 = 2 ml polymer/5 l manure, Treatment 3 = T3 = 4 ml polymer/5 l manure,*
*Treatment 4 = T4 = 8 ml polymer/5 l manure, and Treatment 5 = T5 = 32 ml polymer/5 l manure).*

| Treatment | Ave. ± SD* for $NH_4$-N (mg/l) | | | Ave. ± SD* for pH | | |
|:---:|:---:|:---:|:---:|:---:|:---:|:---:|
| | *8 Hours* | *12 Hours* | *24 Hours* | *8 Hours* | *12 Hours* | *24 Hours* |
| *C* | *21.93 ± 1.22* | *33.83 ± 1.07* | *75.45 ± 1.77* | *7.46± 0.03* | *7.46 ± 0.02* | *7.37 ± 0.02* |
| *T1* | *19.90 ± 1.50* | *29.90 ± 2.77* | *69.93 ± 4.06* | *7.40 ± 0.02* | *7.40 ± 0.02* | *7.29 ± 0.01* |
| *T2* | *15.63 ± 2.73* | *26.73 ± 3.12* | *61.93 ± 4.43* | *7.22 ± 0.02* | *7.25 ± 0.02* | *7.18 ± 0.03* |
| *T3* | *12.68 ± 1.09* | *20.33 ± 1.36* | *46.40 ± 4.83* | *7.02 ± 0.02* | *7.06 ± 0.03* | *7.02 ± 0.02* |
| *T4* | *9.85 ± 0.76* | *14.38 ± 1.29* | *34.03 ± 2.20* | *6.82 ± 0.02* | *6.88 ± 0.01* | *6.86 ± 0.02* |
| *T5* | *1.99 ± 0.49* | *2.91 ± 0.28* | *8.47 ± 1.67* | *6.11 ± 0.08* | *6.19 ± 0.03* | *6.23 ± 0.02* |

*Based on four samples.

Test data at all the sampling time points (2, 4, 6, 8, 12, and 24 hours) from both the first and second test showed a reduction trend of $NH_3$ emission with higher doses of the polymer (Figures 6 and 7).
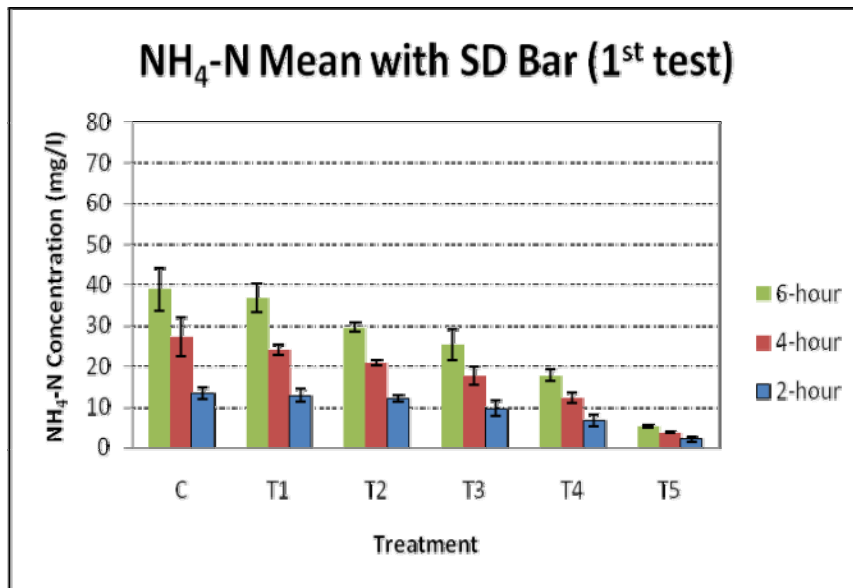


*Figure 6. Ammonium-N concentration vs. treatment for the first test*
*(C = Control = without polymer treatment, Treatment 1 = T1 = 0.5 ml polymer/5 l manure,*
*Treatment 2 = T2 = 2 ml polymer/5 l manure, Treatment 3 = T3 = 4 ml polymer/5 l manure,*
*Treatment 4 = T4 = 8 ml polymer/5 l manure, and Treatment 5 = T5 = 32 ml polymer/5 l manure).*
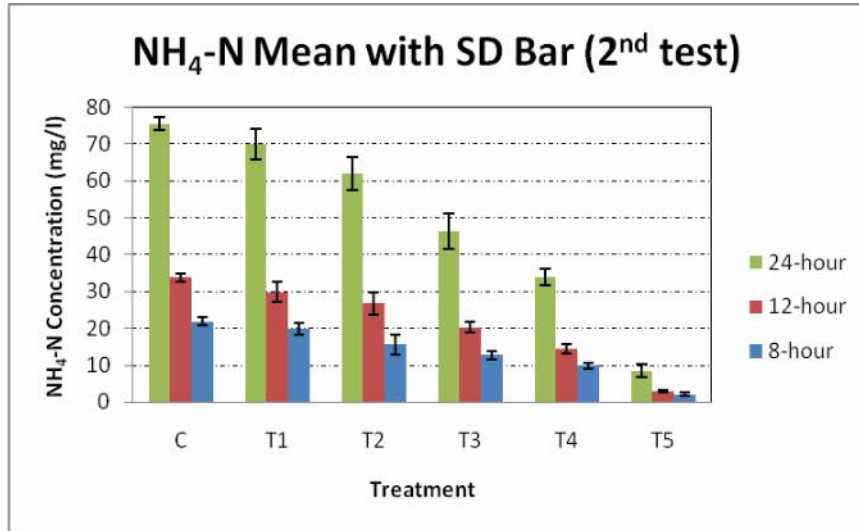
*Figure 7. Ammonium-N concentration vs. treatment for the second test*
*(C = Control = without polymer treatment, Treatment 1 = T1 = 0.5 ml polymer/5 l manure,*
*Treatment 2 = T2 = 2 ml polymer/5 l manure, Treatment 3 = T3 = 4 ml polymer/5 l manure,*
*Treatment 4 = T4 = 8 ml polymer/5 l manure, and Treatment 5 = T5 = 32 ml polymer/5 l manure).*

For both the first and second test, results showed that a higher pH leaded to a higher $NH_3$ emission at all the sampling time points (Figures 8 and 9). A correlation analysis between average $NH_4$-N in the extractant and manure pH showed that there was a strong correlation between $NH_3$ emission and manure pH. The coefficients of correlation are shown in Table 3.
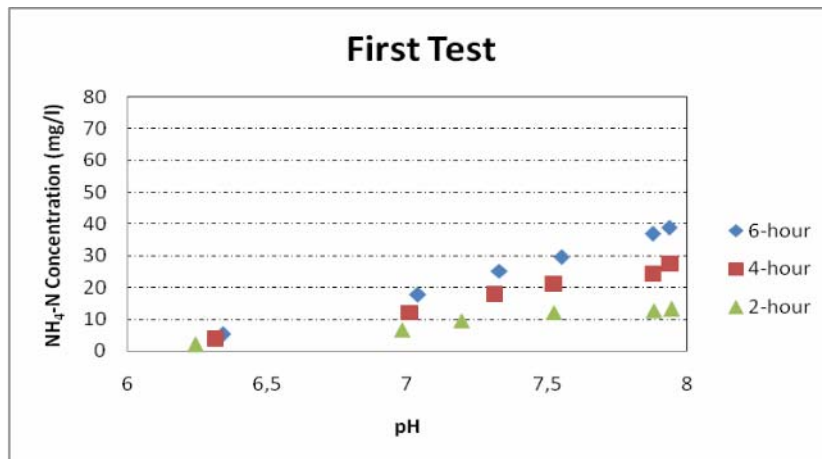


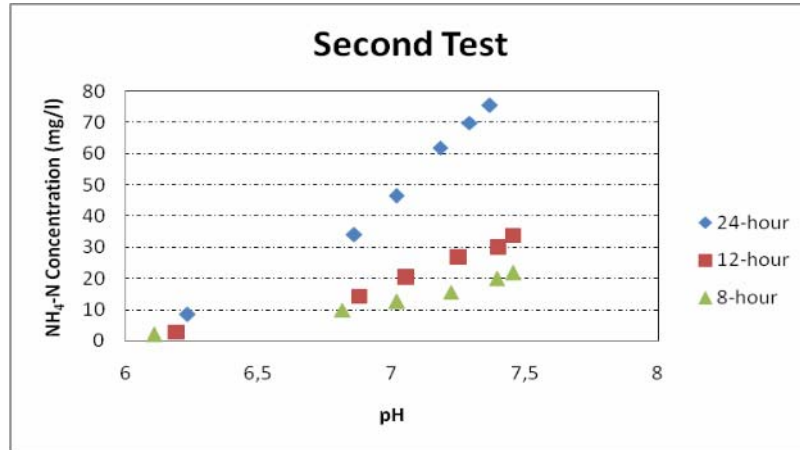*Figure 8. Ammonium-N vs. pH for 2-, 4-, and 6-hour results*

*Figure 9. Ammonium-N vs. pH for 8-, 12-, and 24-hour results*

*Table 3. Coefficient of correlation between average ammonium-N and manure pH*

| Sampling Time | 2-hour | 4-hour | 6-hour | 8-hour | 12-hour | 24-hour |
|---|---|---|---|---|---|---|
| Coefficient of Correlation | 0.98 | 0.99 | 1 | 0.98 | 0.98 | 0.98 |

Ammonia volatilization occurs because $NH_4$-N in manure is converted to dissolved $NH_3$ gas, by the reaction:

$$NH_4^+\text{-N} \rightleftarrows NH_{3g} + H^+$$

The reaction produces more $NH_{3g}$ as pH or temperature increases, and as the $NH_4$-N concentration in manure increases. When the temperature is held constant, pH determines the equilibrium between $NH_4^+$ and $NH_3$ in aqueous systems. A lower pH results in a lower proportion of aqueous $NH_3$, thus leading to a lower potential of $NH_3$ volatilization. The polymer reduced manure pH at all dose levels tested within the test time period in this study, thus reducing $NH_3$ emission. The polymer may have other mechanisms leading to mitigation of $NH_3$ emission such as ammonium binding and/or biological treatments that assimilate and immobilize volatile N or transform volatile N into non-volatile inorganic N. A potential evidence was that Treatment 2 showed significant differences of $NH_4$-N from control for longer time samples (4-, 6-, 8-, 12-, and 24-hour), but not for 2-hour samples. One possible reason was that the polymer may have the capability of immobilization of volatile N compounds or may manipulate microbial activity or control enzyme activities related to $NH_3$ emission, but these effects need a longer time. However, no other N-species in the manure were monitored in this study. More studies are needed to draw a conclusion.

Based on the SAS results for $NH_4$-N (Table 4), Treatments 3, 4, and 5 showed statistically significant differences of $NH_4$-N concentrations from control and the other treatments for all the 2-, 4-, 6-, 8-, 12-, and 24-hour samples. Treatment 2 showed significant differences of $NH_4$-N concentrations from control and the other treatments for the 4-, 6-, 8-, 12-, and 24-hour samples, but Treatment 2 did not show significant differences from control for 2-hour samples. Treatment 1 showed significant differences of $NH_4$-N concentrations from control and the other treatment levels for the 12- and 24-hour samples, but Treatment 1 did not show significant differences from control for the 2-, 4-, 6-, and 8-hour samples.

Again, this may be an indication that the polymer contributed to mitigation of ammonia emission in other ways than just reducing manure pH.

*Table 4. SAS results for ammonium-N*
*(C = Control = without polymer treatment, Treatment 1 = T1 = 0.5 ml polymer/5 l manure,*
*Treatment 2 = T2 = 2 ml polymer/5 l manure, Treatment 3 = T3 = 4 ml polymer/5 l manure,*
*Treatment 4 = T4 = 8 ml polymer/5 l manure, and Treatment 5 = T5 = 32 ml polymer/5 l manure).*
*Means with the same letter in the following parenthesis are not significantly different.*

| Treatment | Mean of $NH_4$-N (mg/l) | | | | | |
|---|---|---|---|---|---|---|
| | First Test | | | Second Test | | |
| | 2-hour | 4-hour | 6-hour | 8-hour | 12-hour | 24-hour |
| C | 13.3 (A) | 27.2 (A) | 38.9 (A) | 21.9 (A) | 33.8 (A) | 75.5 (A) |
| T1 | 12.8 (A) | 24.1 (A) | 36.9 (A) | 19.9 (A) | 29.9 (B) | 69.9 (B) |
| T2 | 12.1 (A) | 20.9 (D) | 29.5 (B) | 15.7 (B) | 26.7 (D) | 61.9 (D) |
| T3 | 9.5 (B) | 17.7 (D) | 25.2 (B) | 12.7 (D) | 20.3 (E) | 46.4 (E) |
| T4 | 6.7 (D) | 12.2 (E) | 17.7 (D) | 9.9 (E) | 14.4 (F) | 34.0 (F) |
| T5 | 2.0 (E) | 3.6 (F) | 5.2 (E) | 2.0 (F) | 2.9 (G) | 8.5 (G) |

Test data showed that the polymer reduced manure pH. The SAS results for manure pH are shown in Table 5. All the treatments reduced manure pH significantly for the 8-, 12-, and 24-hour samples during the second test. For the first test, all the treatments, except the Treatment 1, showed significant differences of pH between control and the treatments for the 2-, 4-, and 6-hour samples during the first test. Treatment 1 did not show significant differences of pH from control for the 2-, 4- and 6-hour samples. The test data also showed that a lower pH resulted in a lower $NH_3$ emission which agreed with others results.[15, 16]

*Table 5. SAS results for pH*
*(C = Control = without polymer treatment, Treatment 1 = T1 = 0.5 ml polymer/5 l manure,*
*Treatment 2 = T2 = 2 ml polymer/5 l manure, Treatment 3 = T3 = 4 ml polymer/5 l manure,*
*Treatment 4 = T4 = 8 ml polymer/5 l manure, and Treatment 5 = T5 = 32 ml polymer/5 l manure).*
*Means with the same letter in the following parenthesis are not significantly different.*

| Treatment | Mean of $NH_4$-N (mg/l) | | | | | |
|---|---|---|---|---|---|---|
| | First Test | | | Second Test | | |
| | 2-hour | 4-hour | 6-hour | 8-hour | 12-hour | 24-hour |
| C | 7.9 (A) | 7.9 (A) | 7.9 (A) | 7.5 (A) | 7.5 (A) | 7.4 (A) |
| T1 | 7.9 (A) | 7.9 (A) | 7.9 (A) | 7.4 (B) | 7.4 (B) | 7.3 (B) |
| T2 | 7.5 (B) | 7.5 (B) | 7.5 (B) | 7.2 (D) | 7.3 (D) | 7.2 (D) |
| T3 | 7.2 (D) | 7.3 (D) | 7.3 (D) | 7.0 (E) | 7.1 (E) | 7.0 (E) |
| T4 | 7.0 (E) | 7.0 (E) | 7.0 (E) | 6.8 (F) | 6.9 (F) | 6.9 (F) |
| T5 | 6.2 (F) | 6.3 (F) | 6.3 (F) | 6.1 (G) | 6.2 (G) | 6.2 (G) |

**CONCLUSIONS**

The results obtained from this study have shown that mitigation of $NH_3$ emission from liquid dairy manure can be achieved by using the MTM[TM] polymer. Developing manure additives that effectively abate $NH_3$ emission from manure could be a key step toward the goal of mitigating $NH_3$ emission. The tested polymer showed average

concentration reductions of $NH_4$-N in the extractant were 8.1%, 20.7%, 36.5%, 54.5%, and 88.2% for the polymer Treatments 1 to 5 over the entire test period, respectively. Significant effect on mitigating $NH_3$ emission from liquid dairy manure within 24 hours after applying the polymer was observed. However, a lower dose treatment (0.5 ml polymer/5 l manure) did not show significant differences of the $NH_4$-N concentration and pH from control at short time periods (two-, four-, six-, and eight-hour sampling times). The test results have shown that a higher dose of polymer led to a lower manure pH and a lower $NH_3$ emission. Further studies are needed to test if the pH adjustment was the only mechanism for reducing $NH_3$ emission or other effects existed as well.

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# EFEKAT POLIMERA NA SMANJENJE EMISIJE AMONIJAKA IZ TEČNOG GOVEĐEG STAJNJAKA

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***Sažetak***: Smanjenje emisije amonijaka ($NH_3$) iz tečnog stajnjaka je od velikog interesa za istraživače, nadzorne organe, vlasnike farmi muznih krava i javnost uopšte. Svež tečni stajnjak je skupljan iz centralnog kolektora na farmi. Polimer ($MTM^{TM}$) je testiran u pet različitih doza da bi se ispitao uticaj polimera na smanjenje emisije $NH_3$ iz đubriva. Ogawa $NH_3$ pasivni sakupljači uzoraka su korišćeni za sakupljanje $NH_3$ oslobođenog iz đubriva tokom perioda od 2, 4, 6, 8, 12 i 24 časa, u dva odvojena testa. U uzorcima sakupljenim pasivnim sakupljačima analizirana je koncentracija amonijaka-N ($NH_4$-N) korišćenjem aparata QuickChem 8500. pH vrednosti su praćene pre i posle dodavanja polimera u đubrivo. Prosečno smanjenje koncentracije $NH_4$-N u ekstraktantu je bilo 8.1%, 20.7%, 36.5%, 54.5% i 88.2% pri tretiranju različitim dozama polimera u testovima 1 do 5. Statistički značajne razlike u koncentraciji $NH_4$-N i pH vrednosti đubriva su uočene upoređivanjem tretiranja različitim dozama i u različitim vremenskim periodima. Međutim, tretiranje nižim dozama polimera (0.5 ml polimera na 5 l đubriva) nije dovelo do značajnog smanjenja u koncentraciji $NH_4$-N i pH vrednosti u kontrolnim uzorcima izmerenim posle 2, 4, 6 i 8 časova, ali je dovelo do značajne razlike između uzoraka izmerenih posle 12 i 24 časa. Rezultati ispitivanja su pokazali da više doze polimera dovode do niže pH vrednosti đubriva i smanjenja emisije $NH_3$. Dalja ispitivanja su neophodna da bi se ispitalo da li je podešavanje pH vrednosti jedini mehanizam za smanjenje emisije $NH_3$ ili postoje i drugi mehanizmi.

***Ključne reči***: *amonijak, emisija, smanjenje emisije, goveđi stajnjak, polimer*