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Introduction

The release of ammonia into the atmosphere is coming under careful examination as a major player adversely affecting human health. Ammonia reacts with acid gases to form small particulates, 2.5 μ m and less, which can be inhaled directly into the lungs resulting in a variety of ill effects. Increasing evidence indicates that direct deposition of ammonia affects the pH balance of lakes and streams, which alters the balance of life in these habitats. Ammonia has been monitored for years from industrial sources but little has been done regarding agricultural sources. In 1998, ammonia emissions from all sources in the U.S. were estimated at 4.9 million short tons of which agriculture accounted for 71% and fertilizer application accounted for an additional 15%(USEPA, 2001). Much of the data on ammonia emissions is based on estimations because of the difficulties associated with making real time measurements that can take into account the many variables associated with the release of ammonia into the atmosphere. Ammonia is very difficult to measure because it has the propensity to stick to most surfaces making rapid, repeatable measurements difficult. The range of ammonia concentrations, from ambient (< 5ppb) to exhaust fans from a hog confinement building (>20 PPM) also makes accurate measurements difficult. Current instrumentation includes passive samplers such as denuders and impingers, chemiluminescence detectors, open-path FTIR and UV, and tunable diode laser spectrometers. Each of these instruments has advantages and disadvantages including sampling time, detection limits and cost.

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Ion Mobility Spectroscopy (IMS) is a technique which has been in existence since the Sixties, but until recently has been used very little outside the research laboratory (Hill, 1990 and Bacon, 1990). Advances in the technique have led to the development of IMS instrumentation for the detection of explosives, chemical warfare agents, drugs, and gases such as chlorine, hydrogen fluoride and ammonia.

How an Ion Mobility Spectrometer Works

Sample is drawn into the instrument and forced over a semi-permeable membrane on the outside of the cell. This membrane allows analytes of interest to enter the cell. Purified dry instrument quality air sweeps the membrane on the inside of the cell and delivers the sample to the reaction region. Here the sample is ionized by a weak plasma formed by a nickel 63 radioactive source. A dopant is added to this flow to enhance the ionization process and increase specificity. The ionized molecules drift through the cell under the influence of an electric field. An electronic shutter grid allows periodic introduction of the ions into a drift tube where they are separated based on charge, mass, and shape. Ions strike the detector resulting in the production of a current, which is amplified and measured as a function of time to generate a spectrum. A microprocessor evaluated the spectrum and determines the concentration based on peak height. Because of the specificity of the membrane, enhanced ionization, and time-of-flight, there is the highest degree of certainty that the analyzer is measuring only the compound of interest. The advantages of the IMS include sensitivity, specificity, low cost, reliability, and on-board calibration.

INSTRUMENTATION

An Ion-Pro IMS system from Molecular Analytics, Sparks, MD was used to perform the

analysis. The instrument requires a continuous source of clean, dry air with a dew point of -40°C and a flow rate of 5liters/min for analyzer. An additional 20liters/min of air is required for the multiport system. The air source was a Model 1000-25M continuous, oil-less compressor from Jun-Air, Buffalo Grove, IL. The air dryer was a membrane dryer, Model 64-01, from Parker Hannifin (Balston), Twerksbury, MA.

MEASURMENT LOCATIONS

Measurements are currently being made or have been made at three sites reflecting different aspects of ammonia emissions arising from swine production. The first site is a 4600 head swine finishing unit designed for natural ventilation with a deep pit beneath the buildings for manure collection. Samples were taken in the fall of 2001, spring of 2002, and summer of 2002 at 50 feet and 100 feet from the north side of the three buildings to take advantage of prevailing winds. At the 100-foot distance, samples were taken at 20 feet and 40 feet vertically to look at the upward dispersion of ammonia.

The second site was a 80 acre field to which anhydrous ammonia was applied in the fall (150 pounds/acre). Measurements were made before and after application.

The third location was a cornfield to which manure was incorporated in the fall. The manure was placed into open furrows which were then sealed immediately with a disc after application. Samples were taken before, during and after application.

RESULTS

Data will be presented demonstrating the use of Ion Mobility Spectroscopy for measuring losses of ammonia from various aspects related to swine production. The contribution of environmental factors such as air temperature and wind direction/wind speed will be discussed.

Ammonia levels from the buildings ranged from <10 ppbv to more than 1000 ppbv during the measurement time frame. Concentrations rapidly decrease with distance. Wind direction also plays a major role in the concentration of ammonia measured.

Ammonia concentrations following anhydrous application peaked at 250 ppbv within 4 hours post application and decreased rapidly. A second low level increase was noted during the afternoon of the second day.

Ammonia concentrations following manure application increased rapidly to nearly 400 ppbv and fluctuated considerably during the next two days. Since manure was continually being applied, interpretation of the data is difficult.

Data will also be presented demonstrating the performance of the spectrometer over time using a known continuous source of ammonia. In both laboratory and field settings.

REFERENCES

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