



Ammonia Monitoring in Animal Environments Using Simple Instruments

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Ammonia gas concentration is almost impossible to determine without using an instrument. Our human nose will not recognize ammonia until about 20 to 30 parts per million (ppm) has been reached. Farmers who have frequent exposure to livestock facilities with recognizable ammonia gas levels are known to lose their sensitivity to smell ammonia gas concentration. Even the casual visitor to an animal facility will acclimate to an ammonia odor within about 20 minutes. Fortunately easy-to-use and relatively inexpensive instruments are available for measuring ammonia level in animal environments (dairy, swine, beef, veal, poultry, dog kennel, horse, etc.). Highly accurate and sophisticated instruments are also available at greatly increased cost.

The lowest cost ammonia instrumentation that offers reasonable accuracy (about 20% of reading) is an instrument group called **Colorimetric Tube** (also known as Detector Tube). The pen-sized glass tube changes color along its length after exposure to ammonia gas as the contents of the tube react with the air contaminants (Figure 1). The length of the color change in the detector tube indicates the concentration of gas in the sample, similar to reading a glass thermometer. The ammonia concentration is determined at a location where the tube color has stopped changing with the concentration read from the scale printed on the glass tube. There are two main types of colorimetric tubes: *Pull tubes* and *Diffusion tubes*.



Figure 1. Colorimetric tubes.

Pull Tubes

A portable, quick, and relatively inexpensive way to detect gas levels is with a Pull tube inserted into a hand-held sampler pump (pump cost \$300-\$500). This manually-operated, piston-type pump (Figures 2 & 3) draws an accurate sample of ambient air through the colorimetric tube once both ends of the glass tube are broken off. This offers a one-time spot-check of ammonia level at a location of interest. The pump draws air through the tube for about 60 seconds. It is very important to hold the pump so the air pulled in through the tube comes from the location of interest. For example, this means holding it near the animal breathing zone during the sampling period if animal welfare measurements are the goal. Options exist for partially automating the process with an array of tubes that are sampled at prearranged intervals.

Diffusion Tubes

Diffusion tubes (also known as Passive tubes or Dosimeter tubes) offer an even less expensive colorimetric option to monitor ammonia gas in the animal environment since the sampler pump is not needed. Another advantage is that diffusion tubes provide an average ammonia level over a period of hours rather than the spot check of the pull tube. One end of the diffusion tube is broken off, time of deployment written on the tube, and then the tube is positioned in the environment of interest. As the name implies, ambient air slowly diffuses into the tube's



Figure 2. Pull tube in sampler pump.

contents offering a change in color due to the chemical reaction with ammonia in the air. A diffusion tube gathers information over 2 to 10 hours as ppm-hr. A scale is provided on the side of the tube for the direct reading. This concentration-time reading is divided by the number of hours of exposure to the barn air to get the average ppm over that monitoring period. The tube can be positioned near

(but out of reach of) the animals for welfare concerns or building ventilation exhaust as part of an emission calculation. A disadvantage of the diffusion tube process is the need for two visits to the animal environment hours apart to place the tube and retrieve the concentration reading.

Specifications

The thin glass colorimetric tube content is specific to the type of gas that is being measured. Dozens of gas- and vapor-specific colorimetric tubes are available, including ones for gases found in animal environments such as ammonia, hydrogen sulfide, and carbon dioxide. Several types of sampling pumps are available but the pump and pull tubes must be by the same manufacturer to match the volume of ambient air drawn through the tube with the reaction rate of the tube contents. As with other instruments, the pumps need to be periodically checked for problems such as leakage of older worn seals (tube instructions offer a quick test for leakage). Pull tubes and diffusion tubes come in a choice of measurable ranges so that accurate analysis is possible. For example, one manufacturer offers ammonia detection tubes in 2-500 ppm and 20-1000 ppm ranges. A useful range for within the animal-occupied area is up to 50 ppm ammonia for most animal species (up to 100 ppm for poultry). Within a manure storage environment, ammonia monitoring is needed up to 500 ppm. The high ends of these ranges are unlikely to be present in the animal and storage environments, but are possible. Each tube is used once to obtain a reading and then discarded. Colorimetric tubes cost about \$6 to \$8 per tube and are typically sold in boxes of 10 tubes. The tubes are stored in a cool (32-77°F) and dark place and need to be used prior to the expiration date indicated on the box (typical shelf life of one year).

Summary

Colorimetric tubes offer reliable and proven technology for roughly estimating ammonia gas concentration in animal environments. Their relatively low cost compared to other ammonia detection instrumentation and wide availability are benefits of their use. Pull tubes offer a quick snapshot of ammonia levels in various locations around the barn or kennel while diffusion tubes provide a time-weighted-average ammonia evaluation at a location over several hours.

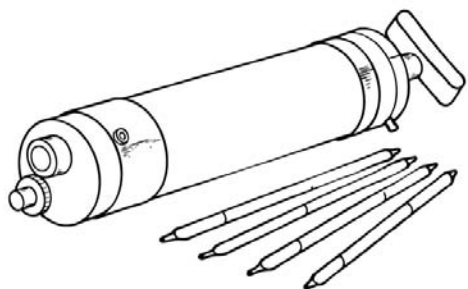


Figure 3. Another example of a sampler pump with pull-tubes for quick assessment of ammonia concentration. Diffusion tubes appear very similar to the pull-tubes but do not need the pump to take a time-weighted average ammonia reading over several hours.

Example calculation

Maintaining ammonia below about 10 ppm is a goal in veal calf housing so that good air quality is maintained for calf health. A diffusion tube is deployed at 9:15 am at a location near the feed buckets to monitor air quality near the animal breathing zone. At 3:30 pm the tube is retrieved. The color change of the contents indicates 50 ppm-hr. The time the tube was exposed to the veal barn air was 6 hours and 15 minutes, which is 6.25 hours. Calculation is $50 \text{ ppm-hr} / 6.25 \text{ hr} = 8 \text{ ppm}$ average ammonia level over this timeframe. The accuracy of colorimetric readings is noted as about 20-25% by the manufacturer so the actual ammonia level in this barn over that time period can be considered about 6 to 10 ppm.

Suppliers

Dräger, Sensidyne, Kitagawa, and Gastec manufacturer colorimetric tubes and pumps available from several sources, including the following two suppliers:

SKC Inc.

863 Valley View Road
Eighty Four, PA 15330-9613
Phone: 724-941-9701 Phone: 800-752-8472 (USA Only)
Fax: 724-941-1369
Web site: /www.skcinc.com
tech support: skctech@skcinc.com
customer service/ordering: skcorder@skcinc.com

Premier Safety and Service, Inc

Two Industrial Park Dr
Oakdale PA 15071
800-828-1080, regional sales manager
www.premiersafety.com

Diffusion colorimetric ammonia tube specifications:

Dräger:
www.draeger-safety.com
Tube Ammonia 20/a-D, 8101301 part number

Sensidyne
www.sensidyne.com
Tube number 501-TWA; 5-200 ppm ammonia

Gastec
www.gastectubes.com
Model 3DL; 0.1-10 ppm ammonia
model 3D: 2.5-1000 ppm ammonia

Where trade names appear, no discrimination is intended, and no endorsement by the Penn State College of Agricultural Sciences is implied.