Ammonia (NH_3) Measurement in Livestock and Lab Animal Facilities

Ammonia is a colorless, flammable gas with a pungent odor. It is commonly present in animal environments that are inadequately ventilated.

Ammonia is primarily produced by the decomposition of urea, present in urine, in the presence of the enzyme urease, which is present in feces.

A second source of ammonia is from animals that are fed high-protein diets that contain excess nitrogen to ensure that all of their nutritional needs are met. Excess nitrogen that is not metabolized is excreted in the form of urea, ammonia, and organic nitrogen in feces. This can lead to ammonia levels building up in animal facilities that have poor ventilation which can have negative impacts on both the human workers and the livestock. In the case of workers, several government agencies have established safety regulations and guidelines to protect workers. Some examples are listed in the table below:

NIOSH[1]	25 ppm TWA, 35 ppm STEL
OSHA PEL[2]	50 ppm TWA, 8 hour
OSHA IDLH[2]	300 ppm
ACGIH[3]	25 ppm TWA, 35 ppm STEL
WHO OEL[4]	25 ppm

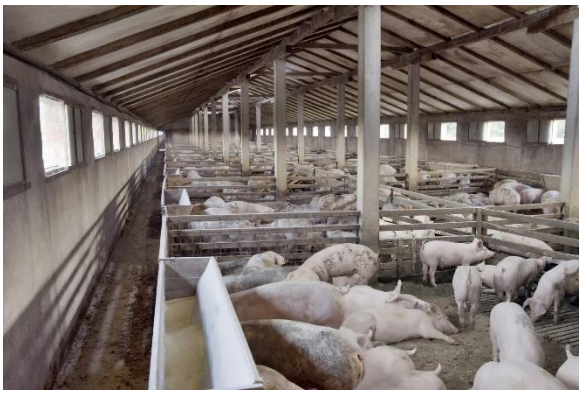
Keep in mind that worker exposure levels are calculated for *healthy, adult workers* and not for the general population. China, for one, has far lower exposure limits for ammonia in general population, "IAQ" environments (0.3 ppm, 1 hour mean value)[5].

In humans, exposure to high levels of ammonia can cause irritation to the eyes, nose, and respiratory tract. Bronchial narrowing can also occur, causing chest tightness, wheezing, and dyspnea. It should also be noted that the human nose, while extremely sensitive to ammonia due to its pungent odor is unable to quantify it. In animals, exposure to high concentrations of ammonia (approximately 25 Ppm) can adversely affect their health and lead to lower body weight[6].
While it is common practice to apply chemicals such as urease inhibitors to hinder the

[1] The National Institute for Occupational Safety and Health (NIOSH)
NIOSH Pocket Guide to Chemical Hazards last reviewed April 2011
[2] US Occupational Health & Safety Administration Regulation (Standards-29 CFR), 1997. Table Z-1 Limits for Air Contaminants-1910.1000.
[3] ACGIH: Documentation of the Threshold Limit Values (TLVs) and Biological Exposure Indices (BEIs) - Ammonia. 2015.
[4] WHO IPCS International Program on Chemical Safety, Health and Safety Guide No.37, 1990

[5] Chinese Indoor Air Quality Standard, GB/T 18883-2002
[6] Reece, F.N., B.D. Lott, and J.W. Deaton. 1980. Ammonia in the atmosphere during brooding affects performance of broiler chickens. *Poultry Science* 59(3): 486-488.

conversion of nitrogen to ammonia[7], the concentration of ammonia can effectively be lowered through an increase in the ventilation rate. Better ventilation will not only directly reduce the ammonia concentration, but will indirectly increase the drying rate of the litter that the animals excrete on.



Animal agriculture is estimated by the US EPA to be responsible for roughly 50-85% of total man made ammonia present in the US[8]. Ammonia that is present can also react with other compounds, to form ammonium nitrate and ammonium sulfate. These compounds contribute to concentrations of PM 2.5, particulate matter sized below 2.5 µm, which is inhalable and can penetrate deep in to the lungs.

Lab animal facilities are exposed to levels of ammonia from the animals present in the cages. While ammonia levels within individually ventilated mice cages are generally within any human regulations, they are greater than the room level[9]. As temperature and humidity increase, so do the ammonia levels present in the cages. The increase in humidity leads to bacterial generation of ammonia. Noting the ammonia concentrations within cages helps to determine when to replace the bedding and cage changes as there is no set schedule.[10]

To ensure that levels of ammonia are not too high, an NH3 electro-chemical sensor, such as those installed in GrayWolf probes, can be utilized to monitor the concentration. This type of sensor provides good resolution, a low limit of detection, and has very little cross-sensitivity with other compounds. Due to the size, portability and responsiveness of GrayWolf meters, spot checking or long-term logging of ammonia is quick and easy. Test multiple cages,

[7] Use of Urease Inhibitors to Control Nitrogen Loss From Livestock Waste, U.S. Department of Agriculture, 1997.
[8] Battye, R., W. Battye, C. Overcash, and S. Fudge. 1994. *Development and Selection of Ammonia Emission Factors.* EPA/600/R-94/190. Final report prepared for U.S. Environmental Protection Agency, Office of Research and Development. USEPA Contract No. 68-D3-0034, Work Assignment 0-3.

[9] Rosenbaum, M., VandeWoude, S., Volckens, J., Johnson, T. *Disparities in Ammonia, Temperature, Humidity, and Airborne Particulate Matter between the Micro-and Macro-environments of Mice in Individually Ventilated Caging.* H AM Assoc. Lab Animal Sci. 2010. Mar; 42(2): 177-183.
[10] Ooma, T., Artwohl, J., Conroy, L., Schoonover, T., Fortman, J. *Concentration and Emission of Airborne Contaminants in a Laboratory Animal Facility Housing Rabbits.* J Am Assoc. Lab Animal Sci. 2008 Mar; 47(2): 39-48.

or locations within a lab animal facility, swine farm, poultry farm or in similar facilities, while operating at varied %RH, temperature, ventilation, population density or other conditions.

Depending on the environment that is being monitored, GrayWolf offers two different ammonia sensors. For livestock farms, where ammonia concentrations may be much higher, GrayWolf has a sensor with a range up to 1000 ppm. For lower concentration applications, such as monitoring in a lab animal facility, GrayWolf offers a 100 ppm sensor.

AdvancedSense® Pro with Ammonia Probe

A temperature sensor comes standard and there is the ability to add additional parameters such as relative humidity which, along with °C/°F, directly influences ammonia concentrations.

More in-depth analysis for livestock and lab animal facilities can be performed by monitoring additional parameters such as particulate, carbon dioxide, VOCs, air velocity, and differential pressure; all of which GrayWolf offers for purchase or rental in a single meter or monitoring system.

GrayWolf's ammonia instruments are able to work as stand-alone monitors or may be interfaced with additional equipment for simultaneous display, logging, and remote on-line access and alarm of multiple parameters. All of the logged data is downloaded to GrayWolf's WolfSense PC data transfer and reporting software. Optional software is available to automate the reporting process.

U.S.A. (WORLDWIDE HEADQUARTERS)

GrayWolf Sensing Solutions, LLC

6 Research Drive, Shelton, CT 06484 USA

IRELAND

GrayWolf Sensing Solutions, LTD

Annacotty Industrial Park, Unit 1C

Annacotty, County Limerick, IRELAND

For More Information Call:

Tel: 1-203-402-0477 or 800-218-7997

E-Mail: SalesTeam@GrayWolfSensing.com

Web: **www.GrayWolfSensing.com**