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## Ammonia is the Enemy

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August 01 2006 Article # 7208

You know that burning sensation that fills your nostrils as you're mucking out stalls? The fiery feeling spreads from your nose into your sinuses, down your throat, and billows through your lungs. It makes your eyes sting and water. Imagine living in the stall as your horse does, eating and sleeping with that suffocating, deadly ammonia gas. You can bet your horse feels the burn in his eyes and lungs, and his health and performance can suffer because of it.

Often, the smell of ammonia is a common denominator in horse housing. Most owners accept the stench as a normal and necessary part of stable management and maintenance, says Karen Hayes, DVM, and author of *The Perfect Stall* and its companion web site, [www.perfectstall.com](http://www.perfectstall.com).

The burning in the respiratory system is caused by the buildup of noxious gas from naturally degrading horse urine, but there's nothing necessary about it. Here, we look at the problems caused by ammonia and possible ways to make barns safer for you and your horses.

### Breakdown of Ammonia

Let's start from the beginning and look at how ammonia ends up in your horse's stall. First, excess protein from the diet is expelled from the horse's body through urine in the form of urea. Each time a horse eliminates its bladder, 1-1½ gallons of urine floods into the stall.

"No amount of bedding, no matter how absorbent it is, will catch that much urine," Hayes points out. "And, the problem is the urine that gets away."

The escaping urine trickles through the cracks of the stall mats, down the stall drain, or into overly deep bedding. Once trapped in these dark, oxygen-devoid areas, naturally occurring anaerobic bacteria get to work feeding on the nutrients of the urea-rich liquid, and the resulting by-product is ammonia.

Ammonia is a pungent-smelling, highly flammable gas, which is colorless at room temperature. It has commercial uses as a refrigerant and in the manufacturing of fertilizer, plastics, and explosives. Ammonia gas is also highly soluble in water and is used in solution as a cleaning agent.

The presence of ammonia produced from horse urine gives barns their notorious smell. While ammonia is a struggle for horses and their owners when trapped in barns, the substance otherwise plays a purposeful and natural role in the environment. The interaction of bacteria and ammonia is an integral part of the nitrogen cycle, the natural path nitrogen takes to cycle from air through soil before being taken up by plants and returned to its original, gaseous form.

### Ammonia's Impact

A 2001 study by the Equine Pulmonary Laboratory at Michigan State University's School of Veterinary Medicine found that young horses stabled during training suffered respiratory distress when compared to pastured horses of the same age. While dust and mold in feed and bedding played a part in pulmonary problems, Hayes believes exposure to ammonia also negatively impacts their respiratory systems.

She notes that ammonia is a caustic gas. "Besides just being unpleasant in a barn, ammonia gas burns the delicate tissues of the respiratory tract and the eyes and increases mucus production," Hayes says.

In humans, ammonia exposure causes narrowing of the throat and bronchi, fluid in the lungs, eye irritation, nausea, vomiting, and dizziness. According to the North Carolina Department of Health and Human Services, extended exposure to ammonia fumes can cause chronic inflammation of bronchi, airway hyperactivity, and chronic irritation of the eye membranes.

Due to the negative health impact of ammonia exposure on humans, the U.S. Department of Labor's Occupational Safety and Health Administration includes ammonia on its list of toxic and reactive highly hazardous chemicals. According to OSHA regulations, employers cannot expose construction workers to ammonia concentrations of more than 50 ppm.

"That ruling was not chosen arbitrarily," Hayes points out. "It was based on the established long-term, chronic effect on the respiratory system and the eyes."

Hayes became curious about ammonia levels in horse barns after seeing the OSHA standard. Following the guidelines set by OSHA, she started testing stables using a Drager, a small, bellow-like tool that takes air-quality samples. The results surprised her. "I've gone to fancy, multi million-dollar show barns, lifted up mats, and measured ammonia levels at 450 ppm," she says.

Whether a barn houses high-end performance horses or trusted lesson ponies, ammonia takes its toll on the animals' athletic abilities and their overall quality of life. The cough related to chronic obstructive pulmonary disease (COPD), or heaves, is often considered an unavoidable result of aging, but research suggests these conditions are exacerbated by ammonia exposure, says Fredrick Harper, PhD, equine extension specialist for the University of Tennessee's Department of Agriculture.

"If you have horses with the propensity for respiratory problems and put them in stalls with high levels of ammonia, you aggravate that situation," he says.

High ammonia readings at floor level are especially troubling for foals, which spend a majority of their days sleeping at their dams' feet, says Harper. A 2000 University of Kentucky study examined bedding foaling stalls with straw and cleaning the stall daily. Over a two-week period, ammonia at floor level rose from 2.5 to 228 parts per million (ppm).

"It's been suggested that a level of just 10 ppm causes problems in other animals, such as calves," Harper says. "It appears that levels in horse stalls are probably so much that we might be challenging or damaging foals."

### Ammonia Solutions

Since ammonia gas is a bad thing for humans and horses, it is prudent to limit exposure to the fumes. Despite traditions in horse-keeping, Harper and Hayes believe owners can find and adopt better ways to house horses and prevent barns from having that notorious urine smell.

**Keep horses outside** Clean paddocks or pastures with protective run-in sheds create healthy environments for horses. Hayes cites the multiple benefits of keeping horses outside--fresh air, constant grazing, and regular movement. In open air, urine will not be trapped, and horses will not breathe high concentrations of ammonia.

"We tend to look at horse housing from a human point of view rather than a horse point of view," Hayes says. "Especially when it's cold, people want to keep horses cozy inside a closed-up barn."

Those warm, closed barns compound the ammonia problem as the heat spurs on bacterial growth while also agitating ammonia molecules and causing the gas to rise. Instead, Hayes says, horses are happier and healthier outside.

**Clean stalls regularly** Remove visible urine and wet bedding as the first and most basic step to reducing ammonia levels in stalls. Make stall cleaning a daily or twice-daily practice to create sanitary living conditions for your horse. When cleaning stalls, remove all soiled bedding. Harper recommends daily maintenance--removing all solid matter and "wetness"-- and stripping stalls at least once a week.

He advises treating stripped stalls with hydrated lime or other commercial stall products to help dry urine and freshen the stall.

**Choose bedding wisely** Some research suggests that bedding with higher levels of absorbency result in lower levels of ammonia in a stall. Straw is the least absorbent, followed by wood shavings, then paper.

"I wouldn't recommend anyone use straw other than for foaling," Hayes says. "After the foal is born, strip out the straw and replace it with kilned shavings (to eliminate pathogens that can live in the pores of wood)."

**Extra protein means more ammonia** "One of the biggest problems, I think, is that we feed our horses too much protein," Harper says. Excess protein fed to a horse is expelled in the urine and contributes to the production of ammonia in the stall. Work with your veterinarian or an equine nutritionist to help create a balanced diet for your horse. You'll save money and improve your horse's health, Harper says.

**Clean empty stalls** Studies show that agitating bedding causes ammonia gas to rise. Of course, ammonia gas low to the ground negatively impacts your horse when he's lying down or has his head down to eat, but you can protect your horse by removing him from the stall during cleaning. To protect yourself from rising ammonia, wear a face mask or respirator along with protective eyewear.

**Eliminate urine escape routes** Stall mat seams and gaps create the perfect place for urine to disappear, then its out of sight, out of mind--at least until the ammonia starts to rise up from the depths of the stall. Wood floors soak in moisture, including urine, and a dirt or clay floor can become saturated. Same goes for stall drains, which Hayes points out "don't flush." Once urine is trapped under the mats, the flooring material, or in the drain, urine pools and your own Petri dish starts growing right under your horse's nose.

The best solution for controlling ammonia, says Hayes, is to eliminate all areas where urine collects. She suggests investing in seamless or locking stall mats and sealing them so urine can't penetrate or pool under them. These mats also form a solid seal around the edges of the stall and keep urine on the surface. The mats also pay off in the long run because they provide cushioning for the horse's legs and actually require less bedding material than traditional mats or dirt or wood floors.

**Ventilation** Tight barns don't allow ammonia fumes to escape. Good ventilation, including areas for air to enter and escape the barn, provides horses with fresh air. Some type of forced air circulation might be necessary to deal with building levels of ammonia gas, says Hayes. Ammonia gas is heavy and lingers down low. To move the gas up and out of the stall, the barn might need a mechanical system.

Hayes cautions against using box fans, which her own research shows stir the air, but don't move it out of the stall. Instead, she recommends installing ceiling fans certified for outdoor use. A slow-moving ceiling fan forces fresh air down, which replaces the stale ammonia-filled air.

Barn designer Lorri Hayword of LaFayette, Ga., says some agricultural lighting manufacturers are making fan-light combinations specifically for stables.

#### Take-Home Message

You won't completely eliminate ammonia in your barn, but even small steps can improve your horse's health. Hayes stresses adopting new ways to look at your horse's living quarters. The next time you step into a barn and that pungent odor fills your nostrils and burns your eyes, remember a barn doesn't have to smell, and your horse doesn't have to live with ammonia.



**Readers are cautioned to seek the advice of a qualified veterinarian before proceeding with any diagnosis, treatment, or therapy.**

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