

Ammonia is the Enemy

by: Michelle Anderson

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 Dräger, 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.

Ammonia Beware

That pungent barn smell is a sign your horse is breathing a hazardous chemical.

It is the hallmark scent of barns the world over, a foul stench that strikes you upon entrance... and occasionally nearly knocks you down. Even in carefully cleaned stalls, traces of odor remain, and many barn owners consider it an unchangeable facet of the equine industry. But the source of odors stems from the breakdown of equine waste, which produces ammonia – a noxious gas that could contribute to reduced performance and overall decreased health of your beloved stall resident.

What is Ammonia?

Ammonia is a caustic and highly flammable gas, yet it is used commercially as a cleaning agent, refrigerant, fertilizer component and in the production of plastics and explosives. In addition,

ammonia is an important cog in the nitrogen cycle; nitrogen rotates from the air to the soil and is taken up by plants, which return it to its gaseous form. It is here that equines play their role. Horses expel excess dietary protein (what is not metabolized during digestion) through their urine in the form of urea, which enters the soil to be absorbed by plants. In evolutionary tradition, the wild horse is no longer affected as it roams freely away from urine-soaked areas, but the modern domesticated horse is often stall-bound and can suffer effects. Here, when urine floods the stall, it can seep into cracked stall mats, drains or deep bedding, and in these dark, quiet places, anaerobic bacteria feed on the nutrients in urea and produce ammonia, which rises to be inhaled by you and your horse.

<http://www.ecmagazine.net/Spring07/Photosp07/Ammonia1.jpg>

Foals are at higher risk for ammonia exposure because they spend so much time on or near the stall floor.

Hazards of Ammonia

According to the U.S. Department of Labor's Occupational Safety and Health Administration, ammonia is a toxic, reactive and highly hazardous chemical.

Their recommendations warn that concentrations of greater than 50 ppm can cause serious harm to human beings. Even in the cleanest barns, ammonia levels in equine stalls exist well above this concentration. Furthermore, the North Carolina Department of Health and Human Services warns that humans exposed to ammonia can suffer chronic inflammation of airways, airway hyperactivity, and chronic irritation of eye membranes

If human exposure to ammonia is dangerous, how much more for the horse who breathes it in higher doses for sustained periods? Although acute toxicity for horses is unlikely, problems crop up from long-term, low-level exposure, according to the International Veterinary Information Service. Researchers M.S. Davis and W.M. Foster released a paper indicating that as little as 10 ppm for 5 to 7 weeks can cause dysfunction of the horse's mucus membranes, which decreases immune response and makes the horse susceptible to other pathogens.

<http://www.ecmagazine.net/Spring07/Photosp07/Ammonia2.jpg>

Research has shown that ammonia exposure increases airway inflammation, which compromises racing performance.

If a horse's health is affected, eventually performance will be as well. In 2001, Michigan State University's Equine Pulmonary Laboratory released a study, which found that stabled young horses during training suffer respiratory distress compared to young horses that are pastured during training. The researchers studied two groups of horses, examining their airways monthly for signs of inflammation. The first group was stalled for three months, while the other remained

on pasture, and then the groups were switched. The researchers found a significant increase in respiratory inflammation in the stalled horses that decreased when the horses were put on pasture. “We conclude that stabling is associated with inflammation of both the upper and lower airway of young horses,” they wrote. While dust and mold in feed could have an impact, ammonia definitely plays an important role, and respiratory distress can harm athletic ability and decrease performance levels.

Susan J. Holcombe, PhD, also at the Equine Pulmonary Laboratory, released a paper on the causes of airway inflammation in horses, noting that ammonia is linked to mucus accumulation in the equine airway. Furthermore, Holcombe stated that mucus accumulation is positively correlated with poor racing performance.

Ammonia’s effects are exacerbated in foals, according to Frederick Harper, PhD and extension horse specialist for the University of Tennessee.

According to Harper, approximately 15 percent of all foals suffer a severe respiratory disease before they are one year old, although most occur between 2 to 6 months. Since foals spend a great deal of time on or near the stall floor, ammonia exposure is heightened. In addition, young foals have immature respiratory systems, so they are increasingly susceptible to disease, according to Harper. This makes ammonia reduction all the more crucial.

<http://www.ecmagazine.net/Spring07/Photosp07/Ammonia3.jpg>

Limit stall time as much as possible, which will allow your horse to breathe plenty of fresh air – and not noxious chemicals.

Combating Ammonia

While ammonia’s effects are clearly harmful, its presence is not a necessary part of your barn’s environment. There are several steps you can take to reduce ammonia exposure for your horse even if it cannot be completely eradicated from your barn.

1. Consult an equine nutritionist.

Stop ammonia at the source! While protein is important, an equine nutritionist can help you form a diet specific to your horse’s needs and eliminate unnecessary protein, which contributes to excess urine production.

Additionally, including yucca schidigera in your horse’s diet will also help prevent the absorption of ammonia in the horse’s hindgut.

2. Limit stall time.

Let your horse roam the outdoors as much as possible – even in the cold winter months. A warm, sealed barn may seem cozy, but it really encourages bacteria growth and ammonia production.

Not only will fresh air eliminate ammonia exposure, but plenty of grazing and free movement will only enhance your horse's quality of life.

3. Ventilate.

For many horse owners, total pasture time is not an option, but when you must stall your horse, provide adequate ventilation. Proper air flow through your barn will provide your horse with fresh air, distribute air evenly, regulate temperature and moisture levels and help to remove odors and gases.

4. Clean stalls regularly.

Remove urine and wet bedding daily from your horse's stall and strip the stall about once a week. If possible, remove your horse from the stall while you clean because ammonia will be stirred up by the cleaning process.

5. Choose absorbent bedding and an ammonia neutralizing agent.

Research has shown absorbent bedding helps to decrease ammonia levels. In addition, consider mixing a quality neutralizing product with the bedding to help absorb ammonia. Choose a product that doesn't merely mask the odors but eliminates them by actually absorbing ammonia molecules. (see sidebars for more information)

6. Eliminate areas where urine pools.
Karen Hayes, author of *The Perfect Stall*, recommends using interlocking or seamless stall mats and sealing them to prevent urine escaping through the cracks. Bedding, mixed with a quality neutralizing product, can then be applied on top of the mats for an ideal stall.

If your barn reeks of ammonia, don't despair! With a few changes in your management strategies, it is possible to reduce and even eliminate the harmful effects of ammonia on your horse's health and performance