Horse Barn Ventilation

Introduction

Even with their winter hair coat, horses are particularly sensitive to drafts and are affected by a number of respiratory ailments resulting from moisture accumulation and foul air. In addition, the respired moisture often condenses on colder building surfaces and accelerates barn deterioration. A good ventilation system can provide a dry and draft-free environment for the horses and minimize building-deterioration problems.

During the winter, the ventilation system must provide fresh air and remove the respired moisture to maintain a reasonably dry environment (70% relative humidity or less). As the outside temperature warms in the spring and summer, more ventilation is required to remove excess body heat from the horses. Ventilation uses two physical properties of air to be effective.

First, cold outside air has very little moisture-holding capacity, whereas warm air can hold considerable water vapor. For every 10°C temperature increase, the moisture-holding capacity of air approximately doubles. This fact allows the ventilation designer to heat the incoming fresh air so that it can "sponge up" the respired moisture from the horses. If little or no heating is done, then a large volume of air needs to be exchanged to remove this moisture. Alternatively, a large temperature increase only requires a small quantity of fresh air to control the humidity.
Second, warm air is less dense than cold air and is therefore lighter or more buoyant. This principle can work well in natural ventilation systems where the warmer barn air is allowed to rise up and out a peak vent or chimney, carrying the respired moisture with it. The greater the temperature difference between inside and outside, the larger is the uplift or buoyancy force to exhaust this foul air. Unfortunately, the cold incoming replacement air can fall to the floor and create significant drafts during the fall-winter-spring time period. Buoyancy is not effective in warm weather since there is very little temperature difference between inside and outside. For these conditions, natural ventilation relies on summer breezes.

This factsheet will discuss three types of housing with appropriate ventilation systems for horses.

**Cold Barn, Naturally Ventilated**

Totally enclosed, cold housing requires considerable management to adjust the ventilation openings to prevent drafts and condensation problems. Often, these barns will not be insulated or will only have minimal insulation to prevent condensation. The ventilation system's challenge is to achieve sufficient air flow to control moisture without creating drafts.

<table>
<thead>
<tr>
<th>Table 1. Natural Ventilation Openings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Width</td>
</tr>
<tr>
<td>Side-wall Opening (mm)</td>
</tr>
<tr>
<td>Eave Opening (mm)</td>
</tr>
<tr>
<td>Ridge Opening (mm)</td>
</tr>
</tbody>
</table>

Generally, these cold barns will have an open ridge that is never closed to allow slightly warmer, moist air to rise and escape. A small eave opening will introduce fresh air at the top of the side wall, well away from the animals, to reduce draft potential. Larger ventilation doors are provided along both side walls for additional air movement. They can be tilt-in wall panels, adjustable curtains, or sliding panels, which will be controlled either manually or automatically, based on weather conditions. Figure 1 shows a typical barn cross-section and provides recommended sizes for these ventilation openings.

**Figure 1.** Barn cross-section showing the minimum recommended openings for natural ventilation.
Many riding arenas use this type of construction and ventilation. Whenever there is a concentration of horses and riders coupled with increased activity levels, even more respired moisture is produced within the building for the ventilation system to remove.

To prevent condensation problems, it is imperative that the under side of the roof steel be covered with a minimum RSI 0.7 (R-4) insulation as a drip barrier. Many barns will also have the side walls lined with minimal insulation to further reduce condensation and provide a slightly warmer environment. A building contractor can assist with selecting and installing this insulation.

**Warm Barn, Naturally Ventilated**

Many horse barns are fully insulated to provide a more comfortable environment both for the horses and the staff. If no supplementary heat is added, then a fully insulated barn can operate 5 to 10°C warmer than outside, but may freeze in winter weather. To prevent freezing, a heating system should be installed rather than reduce or eliminate the ventilation.

The side-wall vent openings will be similar to those used for cold, natural ventilation systems with the addition of insulated panels or double-glazed window-type vents. Rather than a continuous peak vent, these barns can be equipped with one or more chimneys for exhaust. If the stable has an attic or overhead feed storage loft, the chimney must be insulated to at least RSI 1.8 (R-10) and extend completely through the attic or loft and exit the peak as an enclosed shaft. This prevents condensation problems as well as subsequent feed-quality and building-deterioration concerns.

Generally the chimneys shown in Figure 2 are 600 mm square (2 by 2 ft) in one-storey barns and 1200 mm square (4 by 4 ft) for practical reasons in two-storey barns. Provide a total exhaust air-shaft capacity of 0.5 to 1.0 per cent of the stable floor area. A control damper with 90 per cent closing capability located near the top of the chimney will keep the chimney charged with warm air so that cold down drafts do not occur. The damper is usually controlled manually by cable.

*Figure 2.* Natural ventilation is the system of choice for most horse barns unless supplementary heat is added.
For summer stabling considerably more side-wall opening (5 to 10 per cent of the stable floor area) is required to allow the fresh air in one side or end and out the other by summer breezes. Doors and windows can provide the additional air openings needed but still require adequate management to prevent drafts overnight or during storms.

### Warm Barn, Fan Ventilated

This type of barn should be fully insulated to at least RSI 3.5 (R-20) and have a heating system to provide a draft-free environment. Since every fan places a small vacuum on the room, all openings into the structure (including cracks around windows and doors) can become jets of air and are likely to be drafts. For this reason, it is imperative that a properly designed air inlet be provided and that the incoming air be heated as quickly as possible to remove its draft potential and enhance its moisture-holding capacity before reaching the horses and/or the exhaust fans.

(i) **Exhaust Fans:** The range of ventilation required per horse is from at least 20 CFM (cubic feet per minute) in winter to at least 200 CFM during warm weather. Unless there are more than 15 horses in the stable, you will select the smallest commercially available fan (approx. 300 CFM) as the base ventilation rate and provide sufficient supplemental heat to maintain this level of continuous air exchange. This higher rate is necessary since air quality is still a function of the rate of air exchange rather than horse population.

Ideally, ventilation designers would like to provide two air changes per hour to guarantee good-quality air. However, many barns are limited to one air change per hour to minimize heating costs. At typical horse-barn stocking densities, a winter ventilation rate of 40 CFM per horse (double the minimum) will be no more than one air change per hour.

Since it is important to provide a reasonable progression of ventilation stages or steps between the winter minimum and the summer maximum, the use of at least two exhaust-
fans with two-speed or variable-speed feature is necessary. A good choice for barns housing less than 15 horses is a pair of variable speed fans with capacities of 300 to 1000 CFM and 1000 to 3000 CFM respectively. These fans should be automatically controlled by a temperature sensor to maintain the desired barn conditions. A ventilation equipment supplier can assist you further with sizing and proper installation of the exhaust fans.

(ii) **Air Inlets:** Air inlets can be slot-type openings through the top of the side wall from outside or through the ceiling from a fresh-air attic space or duct. Several companies offer this style of inlet as pre-manufactured units. It is possible to use windows as the air inlet if they are well managed. Their problem is the frequency of adjustment required as the temperature or wind changes and the high possibility of drafty conditions. Provide 0.2 square metres (2 ft²) of intake opening for every 1000 CFM (cubic feet per minute) of air exchange required.

Some existing two-storey barns are already quite leaky and can easily provide the fresh air capacity required for fall-winter-spring ventilation without installing specific air inlets. The challenge with these barns is preventing drafts from this air infiltration. Often an internal air duct system can mix sufficient barn air with this infiltration air to create a blended air mix that eliminates the draft problem.

Some newer horse barns use an air duct type of ventilation system to assist uniform distribution of the fresh air throughout the entire barn. With this system and a tight barn, the fresh air is allowed in one end of the barn through motorized shutters or other openings, mixed with some barn air and distributed along the length of the barn through an air duct with holes spaced along one or both sides of the duct.

These ducts are generally constructed with plywood or plastic board materials. Some of these ducts are insulated to further reduce condensation but this should not be necessary if the air mix is warm enough. Ideally these ducts should have a hinged bottom to allow periodic cleanout of dust and dirt. Some companies have tried dust filters on the ducts but daily cleaning made them impractical. This type of system is shown in Figure 3. Note that it could also uniformly distribute any required supplemental heat.

**Figure 3.** An internal air distribution duct is a good method of mixing and circulating fresh air with stable air as well as any supplementary heat that may be added.
Design Criteria

Step 1. For **quantity of air circulation**: Use 10 CFM per square metre of stable area (1 CFM/ft$^2$ of stable area).

Step 2. For **size of duct**: Provide 0.1 square metres per 1000 CFM (1 ft$^2$/1000 CFM).

Step 3. For **hole sizing**: Select on the basis of required travel distance to the wall. The air from each hole needs to be jetted to the wall on the other side of the stall rather than fall prematurely onto the horse. As the table shows, a large hole will jet more air farther than a small hole given the same air pressure.

<table>
<thead>
<tr>
<th>Travel Distance</th>
<th>Hole Size</th>
<th>Airflow/Hole</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 m</td>
<td>20 mm</td>
<td>3 CFM</td>
</tr>
<tr>
<td>3 m</td>
<td>30 mm</td>
<td>8 CFM</td>
</tr>
<tr>
<td>4 m</td>
<td>40 mm</td>
<td>14 CFM</td>
</tr>
</tbody>
</table>

Step 4. For **number of holes**: Divide quantity of air circulation required (Step 1) by the allowed air flow per hole (Step 3).

Step 5. For **hole spacing**: Distribute uniformly along length of duct.

(iv) **Supplementary Heat**: If the horse stable is to be kept above freezing, then supplemental heat is required. The barn should be adequately insulated and sealed (except for air inlets) and the desired operating temperature established to determine the amount of heating required. Obviously, the higher the desired temperature, the higher the cost of operating the facility. Sale and show barns are often heated to discourage winter hair coat growth or to encourage the shedding of hair. For normal stabling, an operating temperature of $10^\circ C (50^\circ F)$ is quite common and will minimize heating costs. Specific heating requirements should be calculated for each stable, but a guideline for a
reasonably well-insulated barn with normal ventilation rate would be 500 to 1000 watts per horse (1700 to 3400 BTU/hr/horse). Often, a forced-air electric unit heat is used for this purpose but the more economical propane-fired or natural gas unit heaters are gaining popularity. Other choices include a conventional forced-air furnace or a hot water boiler system located in a separate room. Consult a ventilation and heating supplier for design assistance.

(v) Controls: Most ventilation suppliers offer an electronic controller that interlocks the ventilating fans and the heating system so that heating can operate with minimum ventilation but ensures the heating system is off before the ventilation rate is increased. This type of control is essential to limit heating costs. It is advisable to locate the controller out of easy reach to prevent frequent and unauthorized changes to the desired settings.

Other Considerations

Dust: Dust can be a significant respiratory irritant in horse stables and riding arenas. It is important to use clean bedding materials. Periodic wetting of the arena floor surface is a common method of minimizing dust levels.

Monitoring Equipment: Some basic monitoring tools should be available to check the barn environment. A minimum-maximum thermometer will show the temperature fluctuation that the stable experiences. The humidity level can be monitored with a sling psychrometer or an electronic hygrometer. Smoke pencils can be used to check air movement and the potential for drafts in the stable area. Various gas levels, such as ammonia and carbon dioxide, can be measured with gas detection tubes. These devices are available through scientific supply companies.

Additional Information

Farm building contractors, ventilation suppliers and engineering consultants can provide technical assistance concerning ventilation system design and installation. Be sure to include ventilation when planning your horse stable.

For more information:
Toll Free: 1-877-424-1300
Local: (519) 826-4047
E-mail: ag.info.omafra@ontario.ca