

BY DESIGN

Finding balance in ventilation system design and operation

by Erin Cortus, University of Minnesota



The premise behind ventilation system design is balancing heat, moisture and gas loads in a building

to keep the cattle environment at a comfortable temperature and humidity with good air quality. A good environment goes hand in hand with nutrition and genetics for animal care and productivity.

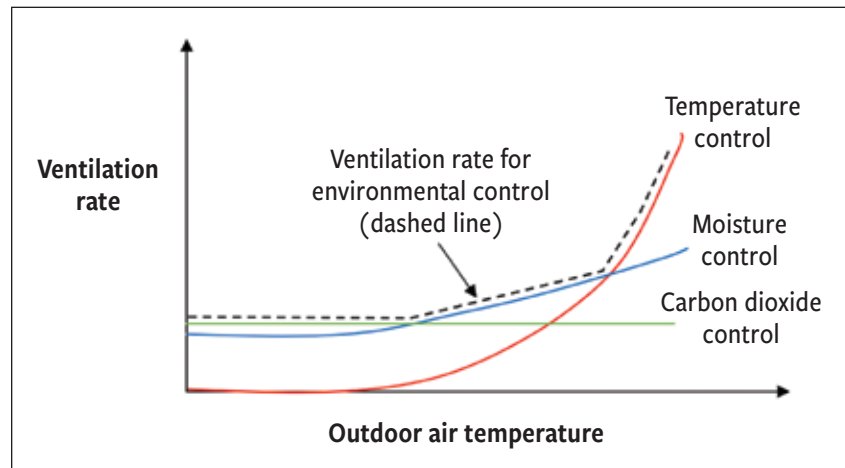
Within a barn, heat is generated primarily by the cattle. Heaters may be a significant source in buildings for calves, but are less likely to be part of a production barn. Lights and other equipment can also generate a little bit of heat. Moisture is generated through exhalation, manure and, to a smaller extent, sweating by the cattle.

Sprinklers or misters also add moisture to the barn environment when in use.

Carbon dioxide is the most predictable gas for purposes of design, because animal respiration is the major source — but we need to be mindful of ammonia and dust as well, which come from manure, feed and other sources. The air exhausted from the barn is the primary and only consistent method for heat, moisture and gas removal from the barn.

Ventilation system design and operation manipulates the amount of removal relative to generation to help maintain indoor environmental conditions within desirable ranges. However, one ventilation rate cannot adequately balance heat, moisture and gas simultaneously.

Fig. 1: Ventilation rate for environmental control



NOTE: The ventilation rate through a barn (dashed line) should prioritize carbon dioxide, moisture or temperature removal, whichever need is greatest.

Cattle generate heat, moisture and gases at different rates, and these rates change with number of head, animal mass, activity and productivity. Plus, warmer air can hold more moisture. The same amount of moisture in the air can be 90% relative humidity at 32° F, and 12% at 86°.

Finally, ventilation brings in outside air, which contains varying levels of background heat and moisture, depending on the day.

To find balance, seasonal considerations help prioritize ventilation operation for heat, moisture or gas. During warm weather, ventilation is at a maximum to limit the amount of temperature rise inside the barn above outside air — usually 2°-8° if there is no evaporative cooling. This high ventilation is sufficient to remove moisture and gas.

During cooler weather, ventilation can be lowered to conserve some heat in the barn, but needs to be high enough to remove moisture or gas. Fog or damp surfaces are indications there is not enough airflow during cold weather for moisture removal. Higher gas levels can also be an indication more airflow is needed. Luckily, cattle are

fairly tolerant of lower air temperatures. With calves or other smaller animals, heaters are often needed to add heat back in when ventilation for moisture control removes too much heat to maintain a comfortable temperature in the barn.

Fog or damp surfaces are indications there is not enough airflow during cold weather for moisture removal.

Engineers use book values for heat, moisture and gas generation rates, while considering building materials and climate conditions to guide design of both mechanically and naturally ventilated barns to deliver appropriate ventilation. However, day-to-day animal observations help a farmer fine-tune the ventilation system to the ever-changing environment within and outside a barn to keep cattle comfortable. |

Editor's note: "By Design" is a regular column of the *Angus Beef Bulletin* featuring facility and homestead design for cattlemen. Erin Cortus is an assistant professor and Extension specialist in the Bioproducts and Biosystems Engineering Department of the University of Minnesota.

"The greatest ability is dependability"
- Bob Jones Sr.

HYDRABED

Experience the rugged dependability of HydraBed.

Lifetime Bale Arm Warranty
Five-Year Structural Warranty
Two-year System Warranty

HydraBed
Sabetha, KS
www.hydrabeds.com
1-800-530-5624