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As the temperature drops, rises and drops again ventilating livestock barns becomes a real challenge. A good rule of thumb in the cooler months is to never have condensation on the inside walls of the barn. Try to keep the inside temperature as close to the outside temperature as possible, so just above freezing when old man winter comes calling. Also, it is a good time of year when you are dealing with the cold to start thinking if your barn has sufficient ventilation for the summer months. Below are some good points to consider from the Dairyland Initiative.

Heat Abatement and Ventilation of Adult Cow Facilities

There is no one perfect ventilation design that can be used universally given the wide variety of dairy barns that lend themselves to a variety of ventilation solutions.

1. **Provide target air speed in the cow's resting area microenvironment.**
   We need to provide fast moving air in the resting area in the summer and a gentle breeze in the winter.

2. **Exhaust the heat, moisture, dust, and noxious gases from the barn at an adequate rate year-round.**
   Ventilation is the provision of fresh air to the building space, which displaces contaminated, warm, humid air. If we do not effectively exhaust this air, then the cattle will be at risk for heat stress (summer/hot climate) and poor respiratory health (winter/cold climate).

3. **Ensure that the system works well across all seasons.**
   Too often, the design of the ventilation system is effective for one season (most commonly the summer), but fails in the winter when the air exchange rate is reduced. It is important to design a system from the start that can function equally well at low and high ventilation rates.

Ventilation Design Checklist:

- *Provides target air speeds in the resting area*
- *Achieves adequate ventilation rates year-round*
- *Works well across all seasons*

The Cow and Her Thermal Environment

Dairy cows generate a lot of heat. A cow milking 120 lbs (54 kg) of milk per day generates about 6,300 BTU (British Thermal Units) per hour – twice as much heat as a cow producing only 40 lbs (18 kg) of milk per day (3,300 BTU/h), and 19 times the 330 BTU/h a human produces at rest.

While cows are quite cold tolerant, they are heat stressed at a temperature that most humans find comfortable; their thermoneutral zone is in the range of 40 to 70 ^{o}F (4 to 21 ^{o}C). Therefore, when designing a comfortable thermal environment for dairy cattle, it needs to function independent of human intervention. Cows cannot wait for us to turn the fans on!

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We often keep cattle too warm in the winter, compromising air quality so that workers are not chilled, and in the summer, we do not activate cooling systems at a low enough temperature for often the same reason.

The challenge for barn design in the winter is to achieve sufficient turnover of air within the barn to obtain good air quality. This will limit the risk for respiratory disease, and typically means that we need to ventilate the barn at around 4 to 8 air changes per hour. Meanwhile, during the summer, the requirement for clean fresh air to ventilate the barn continues at a greater rate of around 40 to 60 air changes per hour.

We know that cows are susceptible to the combination of both heat and humidity. To account for both, we use the Temperature Humidity Index (THI), which adjusts temperature to account for the impact of high humidity to describe climatic conditions.

THI is calculated as:

THI = (dry bulb) Outdoor Temp ^{o}F – (0.55- (0.55 x (Relative Humidity %/100)) x (Outdoor Temp ^{o}F – 58)

THI takes into account the impact of relative humidity (RH) on the cow. Cow behavior and performance are impacted at about a THI of 68. At 20% RH, this would be at 75 ^{o}F (24 ^{o}C), but at 90% RH, cows would be stressed at 69 ^{o}F (21 ^{o}C). Thus, the more humid it is, the lower the ambient temperature at which the cow will experience heat stress.

Cows accumulate heat rapidly while lying down (about one degree F (0.5 ^{o}C) per hour of rest) and dissipate heat when they stand (about a half a degree F (0.25 ^{o}C) per hour). As temperature increases, the number of lying bouts per day stays the same, but lying bout duration decreases. Daily lying times may rapidly fall to as low as 6 hours per day during times of heat stress as cows stand more and thermal pant to cool. Cows may exhale more than 4 gallons (15 liters) of water from her lungs per day! This significant behavioral change, coupled with the physiological changes occurring due to heat stress, are responsible for the clinical signs we associate with hot weather.

Requirements for Natural Ventilation Check List

- *Free of wind shadows*
- *A sidewall opening of at least 50% in the summer and a minimum eave opening of 1 inch per 10 feet (2.5 cm per 3 m) of building width in the winter*
- *Open ridge 2 inches per 10 feet (5 cm per 3 m) of building width*
- *Recommended 1 in 4 roof pitch with smooth ceilings*

Mechanical Ventilation

The following situations would make mechanical ventilation more desirable than natural ventilation:

1. The barn has significant wind shadows
2. The barn must be oriented north-south rather than east-west
3. The barn has more than 4 rows of stalls
4. Multiple barns are planned parallel to each other
5. Cows bunch due to heat stress

Heat Stress Check List

- *Your cows could be heat stressed if:*
- *Daily milk weights drop by more than 5 lb (2 kg) per cow during a warm weather period*
- *Conception rate drops by 5 or more points during the summer months*
- *Lameness due to sole ulcers spikes in the early fall about two months after heat onset*
- *Cows bunch away from side and end walls in the summer*

Sufficient air changes per hour (ACH)

- 4 to 8 ACH in the winter
- 40 to 60 ACH in the summer (Usually ~40 ACH for tunnels, ~50 ACH for cross-ventilated barns)
- Linear or staged ramping function between the minimum and the maximum ventilation rates

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