Time Integrated Value Environmental Control Technology: Step Up to the Times

This modern ventilation and cow-cooling system controller helps improve cow environment

By Curt A. Gooch and Michael B. Timmons

Introduction

Proper ventilation and supplemental cooling are key components to successful cow comfort and well being during summertime conditions. Poor ventilation and/or the lack of cow cooling will result in heat stress. Heat stress is known to reduce feed intake, which leads to declined milk yields. Without supplemental cooling, milk production in high-producing herds can drop 20 to 30 percent after the onset of hot, muggy periods. Heat stress also adversely affects reproductive performance and causes cows to be more susceptible to mastitis and other diseases.

To achieve ventilation two different systems are possible—natural ventilation and mechanical ventilation. Natural ventilation is preferred over mechanical ventilation because it is more cost effective to install and operate. Natural ventilation relies on air movement generated by Mother Nature coupled with building siting and key design components to provide adequate air exchange. However, when any of these variables are compromised, cows will suffer from a poor environment. Effective natural ventilation is a challenge on some Northeast dairy farms because of the poor potential to exchange air. Tunnel ventilation is an option for producers to consider.

Tunnel Ventilation

Tunnel ventilation relies on banks of large fans operating at one end of a tie stall or freestall barn to draw air in through large openings located at the opposite end. (For more information see *Tunnel Ventilation for Freestall Barns* on the PRO-DAIRY facility's web page at: www.ansci.cornell.edu/prodairy/index.html or contact the primary author.)

Supplemental Cooling

When air temperature and moisture levels are elevated, ventilation alone will not keep cows cool. Air movement (400 to 600 fpm) over cows' bodies has been shown to help relieve heat stress. Evaporative cooling of either the barn air or the cows directly is an additional step available to improve cow comfort when summer temperatures elevate even further. This subject is covered by Rick Stowell in his paper: "Heat Stress Relief and Supplemental Cooling" available as part of the publication *Dairy Housing and Equipment Systems* (NRAES-129). Contact NRAES at 607-255-7654 or review *Supplemental Cooling to Provide Heat Stress Relief for Northeast Dairy Cows—You Can't Afford Not to Do It!* Volume 2, Number 4 of the Total Dairy Nutrition Newsletter located at www.ansci.cornell.edu/dm/dm.html.

Conventional Control Systems

Both tunnel ventilation and supplemental cooling systems need to be properly controlled. Multiple thermostats or simple stage controllers are conventionally employed.

Conventional staging environmental controllers use the current value of the inside temperature and a user defined target value for the inside temperature to determine which stage of ventilating and/or cooling equipment to activate. As the difference between the barn air temperature and the target temperature increases, additional ventilating and/or cooling equipment is activated. The problem with conventional controls is they do not recognize accumulated heat stress and merely react to changing air temperature. Just because barn air cools off at night does not mean that the cows' core body temperature is also cooled down.

Time Integrated Variable Controller

A Time Integrated Variable (TIV) controller is a micro-controller based staging temperature controller designed to interface with ventilation and cooling equipment.

Like a conventional staging controller, the TIV controller also makes decisions based on the barn air temperature and the target temperature set by the barn manager. The unique characteristic of the TIV controller is that it uses a quantity referred to as the inside temperature TIV to slightly modify its control decisions when cow heat stress is perceived.

TIV value is the average inside temperature for the last 12 hours, or a 12-hour rolling temperature average.

A TIV controller calculates and maintains a running record of the average inside temperature for the last 24 hours of operation. The TIV controller compares an instantaneous 12-hour TIV value to a target TIV value. TIV controllers currently manufactured for dairy applications have a target TIV value of 70°F. If the instantaneous 12 hour TIV value is greater than 70°F, TIV controller switches to the TIV control mode. When the TIV control is active, the staging controller operates as if the target temperature was 6°F lower than the value actually selected by the barn manager. This increases the time period that each bank of fans and evaporative cooling equipment will run before they turn off, allowing additional cow cooling to occur and removal of accumulated heat load.

TIV is an indication of the cumulative heat stress that the animals have been subjected to, and TIV based control allows the controller to modify its control decisions based on heat stress. When time integrated temperatures indicate cows may have experienced cumulative heat stress, the ventilation and cooling systems will operate for a longer period to cool the cows as compared to the conventional stage controller. In effect, the TIV controller tries to over-cool the animals once heat stress has occurred to compensate for periodic heat stress.

Application of TIV

A TIV controller can be used in both freestall and tie stall tunnel ventilation and supplemental cooling systems. A typical stage controller will provide eight stages for use with a temperature differential of 2°F per stage. An example of how a tunnel barn ventilation and cooling system for a six-row freestall barn could be outfitted with a TIV controller is shown in Figure 1.

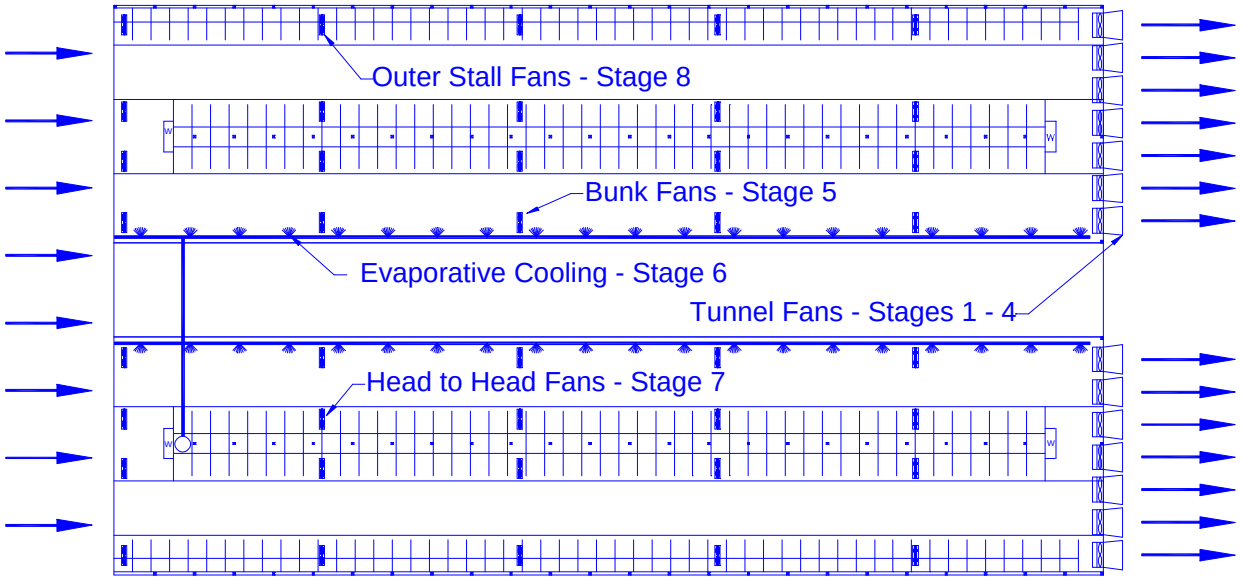

Figure 1. Six-row freestall barn outfitted with tunnel ventilation, cooling fans, and an evaporative cooling system all controlled by a TIV controller.

Twenty-two tunnel fans are located at one endwall as shown (most of the fans are eliminated for clarity). The tunnel fans are grouped into banks. Two fans stacked on top of each other are located at the end of the outer row of stalls. Three more fans positioned laterally adjacent to each other are located at the end of the head to head stalls. Together, these five fans make one fan bank. Two more rows of three fans each are located on top of the last three fans in the first bank. Three more fan banks are formed by grouping these six fans in groups of two. The same configuration is applied to the opposite side of the drive through feed alley.

If geographic location requires additional cooling, cooling fans are located over the feed bunk, and possibly over each row of stalls. Each row of fans is an additional stage of cooling. An evaporative cooling system can be installed to provide further cooling if needed. This would be an additional stage or could be made to activate with the last stage of fan cooling (or any other stage for that matter).

With the barn outfitted as described, eight stages of ventilation and cooling are employed. Since the mechanical and supplemental cooling is not needed all year, stage groupings can be modified slightly to allow for the initial stage to activate the natural ventilation system controller.

TIV technology is new, innovative, and here for producers to try. The cost of a TIV controller is only slightly more than a conventional stage controller but offers better management of the cow environment during summer-time conditions.

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