TUNNEL VENTILATION FOR FREESTALL BARNS

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Introduction

The concept of tunnel ventilating animal housing structures originated with the poultry industry. It has now been widely adopted by most poultry and swine producers to ensure effective summer-time ventilation and improved heat stress relief. Poultry and swine producers have found that increased animal comfort during the summer can be economically achieved with properly designed, installed, and managed tunnel ventilation systems. The application of tunnel ventilation as a summer-time ventilation scheme in the dairy industry is relatively new.

The first dairy facilities targeted for tunnel ventilation were either naturally ventilated or poorly designed and operated mechanically ventilated tie stall and stanchion barns. Experience has shown that tunnel ventilation greatly improves the summer environment in these otherwise poorly ventilated structures.

Most recently, a number of dairy producers have retrofitted tunnel ventilation systems into existing large freestall barns. And a few new freestall barns have been specifically designed and constructed to incorporate tunnel ventilation as well.

This paper focuses on the application of tunnel ventilation to large freestall barns, specifically those typically housing more than 200 dairy cows. Much of the information presented is also applicable for tunnel ventilating tie stall and stanchion barns. For specific information on retrofitting tunnel ventilation into existing tie stall or stanchion barns, refer to Tyson *et al.* (1998).

Background

During summer conditions, dairy cow housing facilities need adequate **ventilation** and **air movement** to help keep cows' comfortable and healthy. These needs are discussed in detail below.

Ventilation

Proper ventilation of dairy housing barns is of paramount importance. Dairy cows need a constant source of fresh, clean air to maximize their production potential. Stale air adversely affects milk production and milk quality (Cassidy *et al*.,1987). High moisture, manure gases, pathogens, and dust concentrations present in unventilated or poorly ventilated barns provide an adverse environment for cows.

Proper barn ventilation consists of exchanging barn air with fresh outside air uniformly throughout the structure. The required rate of air exchange depends on a number of variables including the conditions of the outside air (temperature and moisture level) and animal population and density.

Air exchange can be accomplished with either a natural ventilation system or a mechanical ventilation system. With either option, a properly designed and managed system should result in barn air that is nearly equal in quality as the outside air on a year-round basis. The barn air concentrations of manure gases, dust, and pathogens should be low and the relative humidity should be about the same level as the outside air.

The natural ventilation process relies on a combination of key shelter characteristics and their management coupled with natural air movement for air exchange to happen. Shelters must be properly oriented--ideally with the sidewall perpendicular to prevailing summer winds. They need adequate sidewall, endwall, and ridge openings for air to enter and exit. Sufficient space must exist between a shelter and any wind blocking objects so naturally moving air has the opportunity to properly enter.

Barns that have inadequate openings or are sited incorrectly are subject to inadequate air exchange. Incorrect siting includes locating barns too close together (The minimum distance between nearest sidewalls of adjacent barns should be at least 80 feet.), orienting them incorrectly, or placing them immediately down wind from wind barriers that are seasonal such as corn or deciduous trees or permanent such as hills or bunker silos.

Air Movement

Barn air temperature is highly correlated with rate of ventilation. In the summer, without the aid of evaporative cooling, a barn's dry bulb air temperature can at best be maintained at nearly the same level as the outside dry bulb temperature. The dry bulb temperature in a barn will generally be higher than the outside dry bulb temperature in the summer unless adequate air exchange takes place.

A significant temperature lag can exist between the highest inside temperature and the highest outside temperature. This lag can be 2 to 6°F depending upon the amount of concrete and other thermal sinks incorporated into a building. The sun's radiant heat load, plus the heat given off by the cows, can significantly increase the dry bulb temperature in the barn and again, the resulting rise in temperature is simply related to air exchange. When barn air exchanges are generally greater than one (1) air exchange per minute during summer ventilation, the temperature increase within a barn will be minimal, e.g. less than 2°F.

When the air temperature in the barn rises to about 75°F and above at cow level for a sufficient period of time, cows become noticeably heat-stressed. Heat stress is known to cause:

- Depressed feed intake and milk production
- Slug feeding
- Reduced conception rates
- Compromised growth rates of unborn calves
- Sub-optimal cow health

During hot, humid conditions, providing adequate air exchange alone does not produce the air velocities needed at cow level to substantially remove the necessary amount of metabolic heat produced to keep cows' body temperature within their thermoneutral zone. Research has shown that heat stress can be alleviated or somewhat minimized by directing airflow past cows' bodies at a speed between 400 to 600 feet per minute if adequate air exchange already takes place (Shearer *et al*., 1991).

The lack of natural air movement is usually associated with hot summer days. As a result, many naturally ventilated dairy barns use axial-flow fans placed in areas where cooling of cows is prioritized, such as along feed barriers and resting areas. These fans merely move air within the barn; they do not provide air exchange. Fans are normally spaced about 10 times their blade diameter to achieve air speeds in the recommend range (Bray *et al*., 1994).

Existing barns that do not have effective summer ventilation or planned new barns that cannot be sited for good wind exposure are good candidates for employing tunnel ventilation.

Tunnel Ventilation

<u>Description</u>

Tunnel ventilation is a special and simple summer-time ventilation system. Its goal is to provide **air movement** and **air exchange** concurrently in a barn. Fans (called tunnel fans) are placed in one gable endwall of a building. They are operated to create a negative pressure in the barn causing air to be drawn into the opposite gable endwall opening (Figure 1). Once in the barn, the fresh inlet air travels longitudinally through the structure and is exhausted by the tunnel fans. For tunnel ventilation to function at its maximum potential, all sidewall, ceiling, and floor openings must be sealed to form the "tunnel."

Limitations

Tunnel ventilation is not generally an appropriate ventilation system for use in cool and cold periods. The air speeds associated with a well-designed tunnel system can result in cold drafty conditions when operated at those times. A reduction in the number of tunnel fans operating or decreasing the capacity of each fan by slowing the electrical motor will result in reduced air exchange rates that may not provide fresh air throughout the length of the barn. If the same tunnel ventilation equipment is used for cool weather ventilation, then appropriate measures must be implemented to ensure adequate mixing and to prevent serious gradients in air quality along the barn's length. This has been effectively done in poultry applications.

The maximum barn length that can be effectively tunnel ventilated is another limitation of the system. As the inlet air moves longitudinally through a barn, it becomes increasingly contaminated with air pollutants. At some point, the inlet air is no longer "fresh" and provides limited benefit to cows downwind from this point. Limited field data collected by the authors showed that temperature and relative humidity gradients between inlet and exhaust in a 600-foot long, tunnel ventilated six-row freestall barn were insignificant. However, additional research is needed to determine what the practical length limit is for tunnel ventilation in given climatic regions. The authors' initial research supports the commonly held concern: Can tunnel ventilation be effectively implemented in large freestall barns to create adequate velocity over cows in all areas of a barn?

Design Procedure

The procedure to design a tunnel ventilation system consists of two steps. First, the required total fan capacity is determined. Then this value is used as an input variable to determine the size of the air inlets.

Sizing Fans

Successful tunnel ventilation system design must achieve two goals: air velocity and air exchange. Each of these goals should be considered individually during the design stage to determine which one will ultimately govern. Experience has shown that the need to satisfy air velocity criteria will almost always control design.

The fan capacity must be sized accordingly to achieve the desired air velocity of 400 to 600 ft./min. in the barn. This is accomplished by multiplying the cross sectional area in the barn, in square feet, by the desired air speed to get a product with units of cubic feet per minute (cfm).

To check for adequate fan capacity to ensure proper summer air exchange rates, use 1,000 cfm of fresh air per cow. In order to determine the minimum required air exchange rate for summer ventilation simply multiply the number of cows in a barn by 1,000.

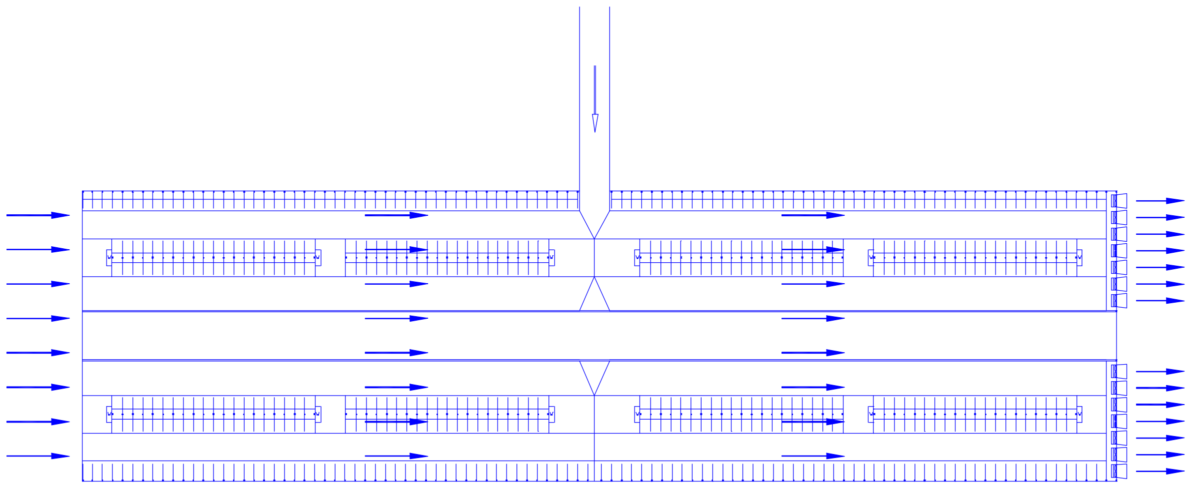

Figure 1. Plan View of A Typical Tunnel Ventilated Freestall Barn.

Use the larger of the two values calculated above to determine the overall theoretical fan capacity required.

<u>Design Example</u>

To illustrate the design procedure, assume that a producer plans to retrofit an existing six-row freestall barn that houses 500 cows with tunnel ventilation. The existing barn is 106 feet wide, which is narrow by today's design standards, and has 10-foot high sidewalls. The barn is fully insulated with rigid board insulation along the lower side of the truss bottom chords. The insulation in effect creates a ceiling in the barn. Using the ceiling as an upper boundary, the cross sectional area of the barn is calculated to be approximately 1,730 sq. ft. Multiply the desired air velocity of 500 ft./min. by the cross sectional area to get a product equal to 865,000 cfm. Now, check to see if this provides sufficient air exchange in the barn. Multiple 1,000 cfm/cow by 500 cows to get 500,000 cfm. For this example, a design based on providing the desired air velocity governs. Cumulative fan capacity should be 865,000 cfm.

Now, lets increase the number of cows in the barn to 950. Since the barn cross sectional area doesn't change by adding cows (only the length), the fan capacity to achieve desired air velocity does not change. However, this number of cows requires 950,000 cfm of air (1,000 cfm/cow x 950 cows) to satisfy the requirements of air exchange. In this case, air exchange, not air velocity, governs design. For this case, cumulative fan capacity should be 950,000 cfm.

Sizing Inlets
The size of an air inlet must have sufficient opening so the required air volume can enter a barn without having to overcome excessive resistance to flow from friction and turbulence. Higher resistance creates increased static pressure conditions within a barn and decreases effective fan capacities. Inlets are best sized to provide a minimum of 1 sq. ft. of area for every 400 cfm of fan capacity (Tyson *et al.*, 1998). Try never to exceed 700 cfm per 1 sq. ft. of inlet area.

Using the calculated fan capacity for the example above, the minimum required inlet area can easily be calculated. For the condition where air velocity governs design, the minimum required inlet area should be 2,162 sq. ft. (865,000 cfm/400 cfm per 1 sq. ft.). If air exchange controls design, then the minimum required inlet area is 2,375 sq. ft. (950,000 cfm/400 cfm per 1 sq. ft.). Both of these inlet areas exceed the cross sectional area of the barn (approximately 1,730 sq. ft.).

In practice, the inlet is best achieved by providing as much open area as available on the endwall opposite the tunnel fans. A well-designed inlet for a large freestall barn is shown in Figure 2. The endwall gable truss and four trusses adjacent to the endwall truss have a different design than the other trusses in the barn. This allows additional air to enter through the gable curtain below the ceiling. Ideally, additional lower endwall cladding could be removed so as much air as possible will enter at cow level.

<u>Selecting and Locating Fans</u>
Only quality, high efficiency fans should be selected for tunnel ventilation systems. Quality fans help ensure reliable performance. Efficient fans save on energy usage although they typically cost more to purchase initially. Payback time varies based on the number of hours per year fans are operated and the cost of electrical power at the given location.

Fan efficiency, expressed as cfm/watt, is determined by comparing the volumetric output (cfm of air) to the electrical input (watts). For smaller fans (24 inches in diameter or smaller fan), efficient fans will have a rating of about 12 cfm/watt when operating against 0.10 inch of static pressure. Moderate sized fans (36 and 48 inches) will have a rating of approximately 17 cfm/watt at 0.10 inch of static pressure (Turner and Chastain, 1995). Large fans (60 inch diameter) have the highest rated efficiency—approximately 19 cfm/watt at 0.10 inch of static pressure. Since air-flow demands of freestall barn tunnel ventilation systems are high, 60-inch fans are recommended for all new construction and retrofit applications.

The literature suggests that tunnel fan capacity should be selected based on an operating static pressure of 0.10 inch (Tyson *et al*., 1998) for tunnel ventilated tie stall barns. Limited unpublished data collected by the authors and industry ventilation professionals in a long tunnel ventilated freestall barn indicates that the operating pressure exerted on tunnel fans is significantly higher. Based on the data, it is recommended that tunnel fans for large freestall barns be sized to operate

Figure 2. Inlet for a Tunnel Ventilated Six Row Freestall Barn.

against 0.15 inch of static pressure to ensure design air velocity and air exchange rates are achieved. For a tunnel ventilated barn with 22 60-inch fans, the cumulative reduction in fan capacity is almost 60,000 cfm when the fans are operating against 0.15 inch of static pressure as opposed to 0.10 inch. Two additional fans with a capacity of approximately 27,250 cfm each would need to be added to in order to achieve volumetric design numbers. Large negative pressures (pressure > 0.15 inch wg) in barns under tunnel ventilation conditions are a good indicator of inadequate inlet area.

Fan performance charts provided by reputable fan manufacturers can be used to determine the efficiency of their fans. Also, a summary of fan performance ratings based on tests can be obtained from *Agricultural Ventilation Fans, Performance and Efficiencies* (Ford *et al*., undated).

Fans should be located across one gable end wall of the barn (Figure 3). In order to maximize airflow across cows' bodies, locate as many fans as possible close to the barn's floor level. Additional fans required should be stacked above the first row, again keeping subsequent rows of fans as low as possible. Try to avoid placing fans above the center door on a drive-through style barn. Fans located in this position may cause air to move down the center and high above the feed alley. This does not provide maximum benefit to the cows.

Figure 3. 60-Inch Tunnel Fans on a Six-Row Freestall Barn.

Fan Safety

Large tunnel fans are usually belt-driven by multiple horsepower motors and have heavy-duty metal or aluminum blades. Contact with rotating blades is dangerous. Care must be taken to eliminate potential contact by humans and cows alike. Removable screens, usually available from fan manufacturers, should be installed on both the inflow and outflow sides of the fans. Providing additional space between the cow zone and fan inlets creates a designated area for fan maintenance and enhances safety. This space can be created by adding three to four feet to the barn length and installing gates or fencing to develop a work area between the barn endwall and the cow zone (Figure 1).

Fan Controls

Tunnel ventilation is a summer-time ventilation system. Since air conditions vary throughout the summer, controls should allow for adjustment of tunnel fans to accommodate these changes. Successful operation is fully dependent on proper fan control. It is recommended that a pre-defined bank of tunnel fans (A bank is several individual tunnel fans that are controlled together.) be turned on at a barn air temperature near 70°F. Additional banks of fans are subsequently turned on at temperature intervals until all fans are operational at 80°F. This process is defined as fan staging and can be accomplished manually or automatically.

Manual Control

Manual control requires frequent attention by designated individuals who have been trained in the principles and operation of a tunnel ventilation system. System performance can be significantly compromised by the lack of human attention or error. Changing weather conditions can require frequent or abrupt changes in tunnel stages and may happen when no trained operator is available. For this reason, a tunnel system is well suited for automatic control.

Automatic Control
Automatic controls are more reliable from a day-to-day perspective, but require scheduled preventive maintenance to ensure proper, continuous operation. Good performance results from properly locating the sensor that provides input to the controller. Sensors should be located so they "sense" the air that represents the condition within the barn **at cow level**. Sensors should be placed so that they are not affected by solar radiation or extreme localized conditions resulting from system short circuiting.

Automatic control can be accomplished using off-the-shelf stage controllers available from several ventilation companies. As discussed above, stage controllers turn pre-defined banks of fans on and off based on an input signal received from an in-barn temperature sensor. The temperature at which the first bank of tunnel fans turn on and the bandwidth (temperature interval) between stages are a few of the variables that can be manually adjusted with most stage controllers. Also, remember that the barn's curtain system can also be used as one of the fan banks.

Time Integrated Variable Control
An experimental controller to improve the control of tunnel ventilated dairy barns is currently being evaluated. This controller, called Time Integrated Variable (TIV) control (Timmons *et al*., 1995), keeps a running record of the number of degree hours in a barn over a 12-hour period. If the degree hour value is greater than a pre-defined value, the target off temperature for each bank of fans is lowered by a discrete temperature interval (currently set at 3°F). This increases the time period that each bank of fans will run before they turn off, allowing additional barn cooling to occur. After an extended hot period, a drop in the barn air temperature doesn't mean that cows' core body temperature has dropped. This experimental controller recognizes this fact and attempts to supper cool the barn in order to remove additional heat from the cows.

Staging and Louvers
It is important to note that staging of tunnel fans, either automatically or manually, requires the use of mechanical or static pressure activated louvers on the inlet side of each fan. Each louver should open when its fan turns on and closes when it turns off. Operating in this fashion, the louver will prevent the system from short-circuiting by preventing air traveling in the reverse direction through a non-operating fan.

Sidewall Management
Since tunnel ventilation is only a summer-time ventilation system, another means of providing air exchange needs must be in place the remainder of the year. Natural ventilation is a most logical choice. It needs to be properly designed into a tunnel ventilated freestall barn.

Natural ventilation requires curtain sidewalls to act as air inlets and air outlets.

When employing tunnel ventilation in freestall barns, theoretically curtain sidewalls should be completely closed to form the “tunnel.” Observation of cow response indicates that insufficient air movement may take place in the rows of stalls adjacent to a completely closed sidewall. Subsequent field measurements have shown that barns with solid sidewalls or curtain sidewalls that are fully closed have little or no air movement along the outer row of stalls and outer alley. Opening the curtain walls slightly (approximately 2 inches) by raising the lower curtain from the bottom up allows a small amount of air to enter along the length of barn at cow level. Doing this is contrary to proper tunnel ventilation theory but has been found to be imperative in order to create some airflow along stalls on the outside walls, particularly where velocity distribution is non-uniform.

Unique Barn Needs

Some tunnel ventilated barns have specific, unique needs to maximize air quality and air velocity at cow level depending on their initial design. These needs can include air baffles and manure gas protection.

Air Baffles

Barns with high ceilings tend to have large amounts of air movement close to the ceiling. Air initially flowing down the barn at cow level collides with cows and subsequently rises to go past them. Once the air rises, field measurements have shown that a large portion of it will stay high in the barn until reaching the tunnel fans. This occurs unless an air deflector or baffle is installed to redirect the air back towards cow level. One barn has shown to benefit from placing horizontal air baffles laterally across the barn at approximately 100-foot intervals. Six-feet high baffles were constructed from traditional curtain wall material and supported by a cable and turnbuckle system to create each baffle. Visual observation of the air-flow through the barn subsequent to baffle installation indicates that the air baffles would provide an even more benefit if spaced closer together.

Reducing the ceiling level will result in increased volumes of air traveling through a given cross sectional area in a given barn if the number of tunnel fans remains the same. However, a lower ceiling is not desirable with barns naturally ventilated the remainder of the year. This suggests that dairy barn design may have to change fundamentally to year-round mechanical ventilation, if economically feasible, in order to provide a barn geometry design that addresses the severe problems in summer conditions.

Manure Gas Protection

Freestall barns with liquid manure drops to gravity gutters located below the barn floor need special attention during planning and design to minimize manure gas flow from storage back into the barn.

Gravity flow discharge pipes that are always submerged below the free water surface in storage need no additional attention. The lack of air movement through the pipe will prevent meaningful gas flow into the barn. However, gravity flow pipes that are not always submerged have the potential of transferring large volumes of gases back into the barn when they are above the free water surface. Rigid rubber or other inert material can be used to develop a flapper that will help to seal off the pipe. As an additional preventive measure, locate the discharge of a gravity flow pipe as far away as possible from designated agitation sites. Significant concentrations of gases are typically released during manure agitation, especially at the site of the agitation device.

Fly Control

Observation has shown that barns outfitted with tunnel ventilation have a noticeably lower population of flies than naturally ventilated barns. Flies seem to prefer more static air conditions than are present in a properly designed tunnel barn. The few flies that are present tend to favor resting on the leeward side of the cow indicating their dislike for the moving air. Bird populations also seem less apparent, due either to the moving air or perhaps because of the reduced number of bird perches because the presence of a ceiling.

Economics

The net return on investment for a tunnel ventilation system is a function of how well cows maintain milk production for an adequate number of days in a tunnel ventilated barn each summer as compared to a naturally ventilated shelter. The additional cost of purchasing, installing, operating, and maintaining the tunnel system must be offset by the sustained milk production in order for the investment to deliver a return. Keep in mind here that lost milk production is not the only negative impact of heat stress. Reduced conception rates, compromised growth rates of unborn calves, and sub-optimal cow health should also be assessed when performing a complete economical analysis of the system.

Combining Supplemental Evaporative Cooling and Tunnel Ventilation

Research has shown that additional metabolic heat can be removed from cows by applying the principle of evaporative heat transfer in two different ways (Bray *et al.*, 1994). The first approach is to cool the air in a barn; the other is to directly cool each cow individually. Common to both approaches, heat is removed by the process of evaporating introduced moisture. Cooling barn air has some limitations in humid environments due to the lack of additional moisture holding capacity of nearly saturated air. Cooling cows directly is an effective means to remove heat in humid locations and can function in arid climates as well.

Cooling Barn Air

When cooling barn air, moisture can be introduced into the air in two ways: mister nozzles and evaporative pads. Mister nozzles jet water at high pressure directly into air. The high pressure coupled with proper nozzle design results in the near atomization of the released water. Atomized water evaporates more effectively than larger water droplets. Naturally ventilated barns with mixing fans commonly have misters located on the discharge side of fans. In tunnel ventilated barns, several individual mister nozzles can be mounted to a system of laterals that in turn is supplied by a manifold pipe (Figure 4). Laterals and mains need to be mounted high enough to allow adequate clearance for feeding, scrapping, and bedding equipment to operate without interference. By installing a flexible drop hose off the lateral, each mister nozzle can be located closer to cow level and will enhance the cooling affect.

As the distance between the mister nozzle and the cow stall bed decreases, it becomes increasingly important that the water particles leaving mister nozzles are as small as possible. That is unless a sprinkling system is the design approach as described below. Larger particles of water do not evaporate as quickly or efficiently as smaller ones and undesired stall wetting can occur. Wet stall beds can lead to dirty cows, uncomfortable stall conditions, and elevated somatic cell counts. Complete design of a mister system is beyond the scope of this paper. The reader is referred to Bray (1998) for additional design information and a list of hardware suppliers.

Multiple mister systems can be installed in a large barn to provide additional management flexibility and reduce the size of individual distribution mains.

Moisture can also be introduced at the tunnel inlet by using evaporative pads. These are large, porous moisture-laden pads that allow inlet air to pass through them. As moving air passes through the pad, water is evaporated and the temperature of the air is reduced. Evaporative pads are not commonly used because of their initial expense. As more information on cow performance versus environment becomes available, pad systems may in fact be economically justified.

Individual Cow Cooling (Sprinkling Systems)
The process of cooling each cow individually results in cooling the cow directly and not the air surrounding the cow. The metabolic heat generated by cows is used as the heat source to evaporate water that is applied to their backs. Thus, heat is transferred from the cows directly to the air.

Sprinklers mounted in prioritized areas are the primary means to incrementally apply water droplets to a cow's back and upper flanks. Large water drops are desired in order to quickly wet the hair coat to the skin. Once the hair coat is saturated, the sprinkler system is turned off and subsequently the applied water is allowed to evaporate. This wetting and drying cycle is continuously repeated as needed to provide cooling.

Air moving over a cow's body after water has been applied will greatly enhance the heat transfer process, by as much as a factor of 3 or 4. With a properly designed tunnel ventilation system, sufficient air movement should theoretically occur at the cow level to enhance the evaporation process. See Bray (1998) and Bray *et al*. (1994) for additional information on sprinkling cows and system design information.

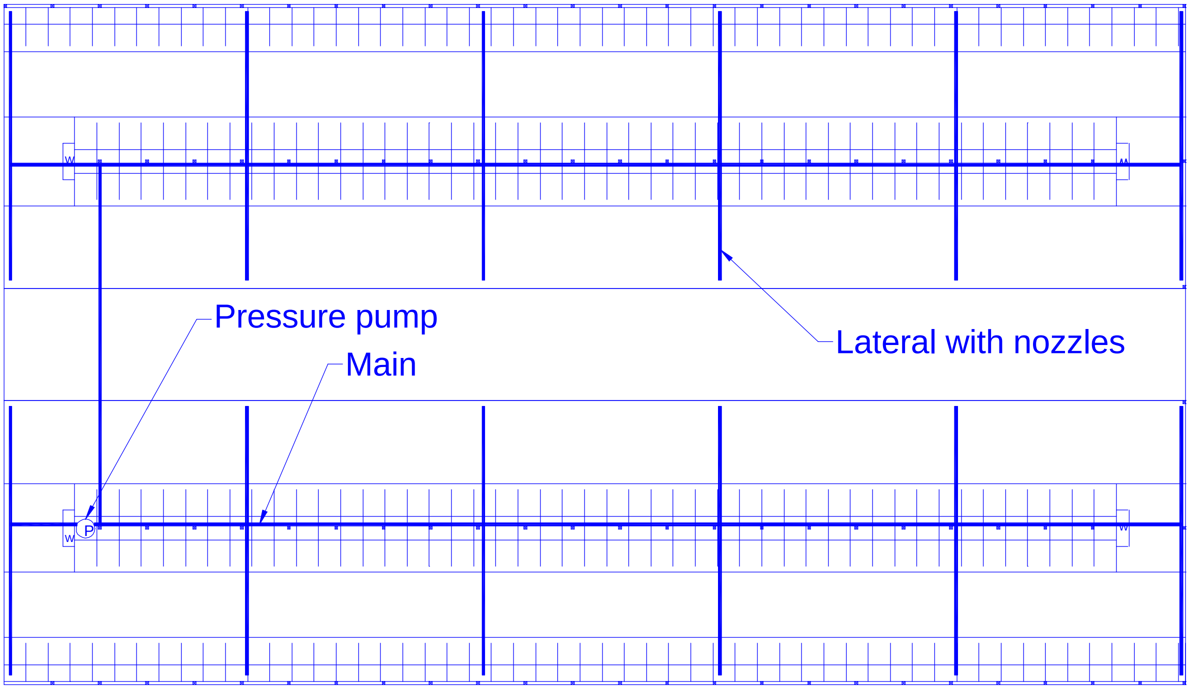

Figure 4. Manifold Mister Systems in A Tunnel Ventilated Barn.

Hybrid Ventilation

As has been stressed previously in this paper, tunnel ventilation is a summer-time system. A barn that uses tunnel ventilation should have an alternative ventilation system in place for the remainder of the year. Since natural ventilation is the primary choice for the other seasons, the combination of the two in the summer is possible. The combination can economically maximize air flow and air quality given the ambient conditions.

A standard temperature stage controller with several stages to control curtain sidewalls, baffled air stacks, and tunnel fans can easily allow hybrid ventilation to be accomplished. Additionally, a misting or sprinkling system to provide supplemental cow cooling could also be controlled with the same controller. The only additional controller input variable would be ambient wind speed and direction. The controller would evaluate wind speed, direction, and barn air temperature to decide the necessary adjustment for the current mode of ventilation. Or it would decide to switch from one mode of ventilation to another if required. For example, if the inside barn temperature is 77°F and the ambient wind velocity is 450 ft. per minute at a direction normal the longitudinal length of the barn, the curtain sidewalls would be fully open. If the temperature increases to 80°F and the wind speed and direction stays the same, no change takes place. Now assume that the wind speed drops to 100 feet per minute. This speed is insufficient in to provide adequate cow cooling at a temperature of 80°F, so the curtain sidewalls would close and the tunnel system would turn on. Obviously, weighted averages for all input variables would be needed along with time delays to avoid rapid adjustments or system changes.

One possible set up for a totally integrated ventilation system controlled with a stage controller is as follows.

Stage 1	Top Curtain Adjustment (Curtain system)
Stage 2	Tunnel Bank No. 1 On
Stage 3	Tunnel Bank No. 2 On
Stage 4	Mister System No. 1 On
Stage 5	Tunnel Bank No. 3 On
Stage 6	Tunnel Bank No. 4 On
Stage 7	Mister System No. 2 On

Unanswered Questions

Continued industry interest in employing tunnel ventilation for large freestall barns is evident. Tunnel ventilation system designers have a unique challenge since complete design information is not available. Dairy producers and ventilation system operators need additional guidelines that will allow them to make better-informed management and operational decisions. Pertinent questions that currently are unanswered include:

1. What is the practical length a barn can be tunnel ventilated?

2. How can uniform air velocity in the barn be best maintained?

3. What are the optimal settings for automated controls?

4. What is the cost/benefit ratio for tunnel ventilated barns?

Other Considerations

Tunnel ventilated freestall barns should consider an appropriately sized standby power source to provide back-up power to the tunnel fans and their control system during power outages. Standby power generators are normally needed on dairy farms to ensure uninterrupted electrical service to milk harvesting and cooling equipment. Including the electrical loads of the tunnel fans when sizing back-up generators will help to ensure continuous fan operation during periods of lost utility power.

Another consideration is to install an alarm system that alerts farm employees if electrical service is interrupted to the tunnel fans. Alarm systems are highly recommended for any barn that relies on mechanical ventilation year round. Cows in these barns are subject to adverse air and temperature conditions soon after tunnel fans stop running. An evacuation plan should be in place to remove cows from the barn if needed. Minimally, automatic curtain drops need to be in place in the event of mechanical power failure. This is standard and required equipment on all poultry houses.

Summary

Properly designed and operated tunnel ventilated freestall barns provide both air exchange and air movement. Both are required in hot weather conditions. Tunnel ventilation is a viable option for both existing barns that are not accomplishing proper summer-time ventilation or planned new barns that cannot be situated for acceptable wind exposure. Good natural air exchange and an adequate number of properly sized and located axial-flow fans remains the preferred ventilation option at this time until several untested concerns are addressed. If the ventilation of diary facilities follows that of the poultry and swine industries, and several of the concerns are addressed, tunnel ventilation may eventually become a popular way to provide summer ventilation and heat stress relief for large freestall barns.

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