THREE TO FOUR ROWS OF DISCHARGE HOLES are preferred. Larger holes should be positioned on the side of the tube to throw air further. Smaller holes should be located in the tube's center.

All tubes are not created equal

Designing and installing a positive pressure tube should be done by a skilled professional. Costly mistakes may result otherwise.

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MANY positive pressure tube ventilation systems have been installed in calf barns in the past five years. While it is a simple matter to mount a fan to the end of a perforated tube, it is not simple to achieve uniform distribution of fresh air without a draft to each calf in a barn.

As investigators of calf disease problems on farms, we occasionally find poorly designed tube ventilation systems that contribute to these problems. This article will review the primary features of successful tube systems in calf barns.

Appropriate volume of fresh, clean air

The first step is to determine how much air to deliver through the tube system and select an appropriately sized fan. Traditional recommendations for a minimal winter ventilation rate in calf barns range from 15 cubic feet per minute (cfm) per calf to four air changes of the building volume per hour. With more experience, we now recommend sizing the fans to achieve four air changes per hour.

In general, one tube system can nicely ventilate a width of about 25 to 30 feet. If the calf barn is wider, it is preferable to install two or more systems where the combined fan capacity equals four air changes per hour. The basic tube system needs to be supplemented with additional ventilation from natural or mechanical systems in moderate and hot weather.

It is important that only clean outdoor air is delivered through the tubes. The fans can be mounted in outer walls or boxed into an attic where they access only air from the outside. The fans must not be located inside the calf room where they can recirculate polluted interior air.

Fans must also be maintained over time. As fans age, they frequently lose capacity. Belt-driven fans need maintenance including belt replacement and tightening. Occasionally, screens over the fans become plugged with straw, dust or even freezing snow, resulting in less than optimal ventilation rates.

Uniform discharge from the tube

The second step is to fit the fan to a tube that allows for a uniform discharge of air along the entire length of the tube. Stated more directly, the tube usually needs to have a larger diameter than the fan.

Uneven air discharge along the length of the tube is not a trivial problem. Many tubes have been installed by well-meaning people who are not aware of the problem. In an extreme case that we investigated, air was emerging at 100 feet per minute (fpm) from the holes nearest the fan and 2,000 fpm from holes near the end of the tube. Calves that were housed near the fan were receiving almost no fresh air, while calves housed furthest from the fan were subjected to a nonstop chilling draft.

The most common cause of uneven distribution is that the tube is too narrow. More precisely, the tube is mismatched with the fan and does not have a sufficient cross-sectional area to carry the volume of air at moderate speeds. A common rule of thumb suggests that the tube should be large enough to carry the air from the fan at speeds less than 1,200 fpm. The speed is estimated by dividing the fan capacity (in cfm) by the cross-sectional area of the round tube (in square feet).

For example, an 18-inch fan may deliver 2,800 cfm. If connected to an 18-inch diameter tube, the air speed in the tube on the end near the fan is expected to be an excessive 1,584 fpm. If the same fan is mounted on a 21-inch diameter tube, the speed would drop to an appropriate 1,164 fpm.

A full explanation of the problem of uneven discharge requires a discussion of fluid mechanics that is well beyond the scope of this article, but a simple description may be useful. As air travels down the tube, some air leaves at each hole resulting in less air moving along at ever declining speed. As the interior velocity is reduced, the static pressure that forces air from the tube rises. With larger diameter tubes, the interior velocity and static pressure become more uniform from end to end.

Air delivery without a draft

The third step is to determine the size and location of the holes in the tube so that fresh air is delivered to each calf without creating a draft. A draft is defined as air moving at a speed of greater than 60 fpm, while air moving at a slower and imperceptible speed is considered to be "still" air. Static pressure within the tube forces air out through the holes. An air jet forms that gradually widens and slows in the form of a cone.

Engineers have developed equations to predict the "throw" distance which is the distance between the tube discharge hole and the point where the air jet has slowed to the speed of still air. Our current design guidelines try to achieve conditions of still air at a point about 4 feet above the resting surface of the calves.

The throw distance is largely determined by the static pressure within the tube and the diameter of the discharge hole. The greater the static pressure within the tube, the higher the discharge speed and the further the air jet travels before slowing to 60 fpm. In addition, the diameter of the discharge hole has a tremendous effect on throw distance.

An example would be a tube with one row of holes that are 1 inch in diameter and another row that are 3 inches in diameter. If the static pressure within the tube causes the air to leave the tube at a speed of 1,200 fpm, the air would travel approximately 7 feet from the 1-inch holes and 21 feet from the 3-inch holes before slowing to still air.

The holes are positioned at specific locations around the sides of the tube in order to direct the air where desired. The locations are described by clock position as viewed looking down the tube from the fan end. A row of holes at 3 o'clock would go straight out to the right side, while another at 6 o'clock would go straight down.

Traditional tubes had two rows of holes of very limited sizes, but some manufacturers now offer a wide variety of options. We have developed a preference for three or four rows of discharge holes where larger diameter holes throw fresh air further to the sides, and smaller holes are located to minimize the throw distance directly below the tube.

An example is illustrated in the photo. The height of the tube determines the desired throw distances, so the exact sizing of the holes cannot be determined until the height of the tube is specified. Finally, the interval between the holes is dependent on the fan capacity, the size of the holes and the length of the tube.

A good performing ventilation tube system rarely happens by accident but is rather the result of a relatively complex design process. It is worthwhile to have the tube systems designed by knowledgeable people. Locate trained consultants on The Dairyland Initiative website at http://on.hoards.com/Wis-tube-design.

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