Fan Selection for Poultry Housing

MISSISSIPPI STATE UNIVERSITY EXTENSION

Your fans are the engine of your mechanically ventilated chicken house. The fans are the force behind the exchange of air that is necessary to maintain a healthy environment for the birds and the people who look after them during every season of the year. Because of rising electricity costs, selecting the right energy-efficient fan can result in thousands of dollars a year in energy savings. Fans impact energy usage in two different ways. First, they use energy to operate (especially during the summer), but, second, how the fans are managed impacts the efficiency of the heating system within the building during cooler times of the year.

Fan management is critical to keeping birds alive in hot weather. However, it is also important in winter to prevent over-ventilating, which exhausts heat needlessly and increases the gas bill. Therefore, when building a new house or retrofitting an older one, **selecting the proper fan is one of the most important decisions a grower makes**. It is important to compare fans not only on initial cost but also on performance and operating costs in the coming years. Often, the cheapest fan is not the best option.

Principles of Fan Selection

Static pressure is the difference in pressure that a ventilation fan creates between the inside and outside of the chicken house. Static pressure can be measured with a Magnehelic static pressure gauge (**Figure 1**). When running, fans create a vacuum within a building by exhausting air and creating a low-pressure area within the building. The indoor environment, having a lower pressure than outdoors, will pull air in through sidewall or cool cell inlets in an attempt to equalize the pressure. This is called a negative pressure system. Many poultry houses operate at a static pressure between 0.04 and 0.12 inch of water. However, some newer and tighter houses may operate at a static pressure of 0.15 in full tunnel with all the fans running.

Fan **efficiency** is the amount of air delivery that a fan will provide per unit of electric power used, usually given in cubic feet per minute per watt (cfm/W). Generally, small fans are less efficient than larger fans. Efficiency ratings range from about 5 cfm/W to 25 cfm/W.

Air delivery is the amount of air that a fan will move under different conditions. The term is expressed as volume of air movement per unit of time. The standard unit is cubic feet per minute (cfm). The greatest amount of air is moved at 0.00 inch static pressure. As static pressure increases, a fan must work harder and the amount of air moved decreases.

Figure 1. Hand-held Magnehelic static pressure gauge.

Air flow ratio is an indicator of how well a fan will hold up as static pressure increases because of dirty shutters, clogged cool cell pads, baffle curtains, or a restriction in air flow (tunnel curtains or doors not fully open). The air flow ratio is determined by dividing the amount of air a fan moves at 0.20 inch pressure by the amount of air it moves at 0.05 inch pressure. Air flow ratios usually vary from 0.50 to 0.85. A higher ratio indicates a better fan, meaning the fan is less affected by high static pressures. An air flow ratio of 0.50 means a fan will lose up to 50 percent of its air-moving capacity in a worst case scenario, while a fan with an air flow ratio of 0.85 will lose only 15 percent of its air-moving capacity.

Selecting Tunnel Ventilation Fans

Any fan that you are considering should have been rated by an independent lab to show air delivery and efficiency as a function of static pressure. A certified laboratory runs fans through a series of standardized performance tests. The standardized tests help in ventilation system design and comparison shopping. Most fan manufacturers send their fans to the Bioenvironmental and Structural Systems (BESS) laboratory at the University of Illinois for performance testing. Fans are tested with accessories such as shutters, guards, and discharge cones in place to determine their air-moving capacity and energy efficiency ratings at static pressures ranging from 0.00 inch to 0.20 inch.

Test results for current tests as well as archived test data are available from the BESS laboratory at ***www.bess.uiuc.edu***. You can look up data on a number of agricultural fans at this site by clicking on **Agricultural Ventilation Fans**, then **Performance Tests**, then **Current (or Archive) Tests**, then **Fan Frequency** (this will be 60 Hz in the U.S.), then **Power Supply** (usually 1 phase, 230 volts in the U.S.), your **Manufacturer** name (Acme, etc.), and **Fan Diameter** (48", 52", etc.), then **Submit**. At the bottom of the report for any particular fan model, you will see something like this:

TEST RESULTS ACME BDR48J2-C				
Test: 00110	Static Pressure in water	Speed rpm	Airflow cfm	Efficiency cfm/Watt
Fan description: 48" belt drive, 1 hp Magnetek C782 motor, galvanized steel slant housing aluminum shutter, guard, and discharge cone	0.00	528	24,300	22.6
	0.05	526	23,400	20.8
	0.10	525	22,300	19.0
	0.15	523	21,100	17.1
	0.20	522	19,700	15.4
	0.25	520	17,200	13.0
	0.30	519	16,100	11.8

Accessories are important and necessary for the fan to function properly. However, **accessories often reduce air flow and efficiency**. Shutters can be especially detrimental to air flow, depending on placement location. You should expect a 10 to 15 percent reduction in air flow using inlet-side shutters and a 15 to 25 percent reduction using discharge-side shutters. Choose shutters that will open to a full horizontal position. Air flow will be decreased if the shutters do not fully open. For the safety of people and animals near the fans, guards are necessary and must be in place. Round ring guards are less detrimental to air flow than wire mesh guards with square or rectangular openings. Properly designed guards should disrupt air flow and efficiency by less than 5 percent. A well-designed housing and discharge cone can improve fan performance by decreasing air turbulence. A discharge cone and proper housing design can improve air flow at least 15 percent.

Set High Standards and Maintain Your Fans

Do not choose a fan based strictly on its diameter. In addition, never assume that two fans of equal size will always perform the same. Different motors, the curvature of the blades, and other features will have a huge effect on a fan's performance. Most agricultural fans are equipped with propeller-type blades. Propeller fans are excellent at moving large amounts of air at low static pressures seen in poultry houses. However, conditions inside most chicken houses are harsh, requiring heavy-gauge blades made of corrosion-resistant materials. Blades may be constructed of many different materials including steel, aluminum, cast aluminum, molded fiberglass, and various plastics. Testing of several 50-inch fans has demonstrated that the air delivery (at 0.10 inch of water) ranged from 18,000 to 28,600 cfm, and the efficiency ranged from 14.3 to 24.5 cfm/W (Harmon et al., 2010). Therefore, **set your standards high** when selecting for energy efficiency. If you consider a fan with an energy efficiency ratio of not less than 20 cfm/W at 0.10 inch static pressure and an air flow ratio of at least 0.73, you will be choosing one of the best fans tested by BESS laboratory. This type fan may be more expensive initially, but it will be less expensive to operate over the life of the fan.

Realize that a "cheap" fan is probably not the most efficient choice you can make. While it is easy to be persuaded by a low initial price, keep in mind that this could cost you more in operating expense and upkeep than if you chose a higher-quality fan in the beginning. Fans are like everything else: you get what you pay for. Efficient motors cost more. They have more copper windings and are, therefore, more expensive to produce. It may take 2 to 3 years to see the payback from reduced electrical consumption, but a high-quality fan continues to save you money long after that. High-efficiency motors are available to be used on well-designed agricultural fans, but make sure you are not sacrificing air flow for efficiency. Efficiency will be of little value if you can't move enough air to keep the chickens alive. Some power companies provide rebate incentives for ventilation fans that meet their high cfm/W standards. Power providers can help you calculate the electricity savings when comparing new fans or the payback time in electricity savings when replacing older fans. By taking advantage of these opportunities, growers can determine which efficiency upgrades are the most economical.

Fan maintenance must be a part of your overall management program. Dirty shutters are a common problem in many poultry houses, and dirty shutters and fan blades can reduce air delivery by as much as 40 percent (Wheeler, 2002). Clean the shutters, blades, and guards after every flock of chickens. Check pulleys, fan belts, and belt tensioners because belt slippage can reduce air flow and increase belt wear. It's a good idea to replace belts on tunnel fans every spring before hot weather arrives. Be cautious when relying on a visual fan inspection. It may be difficult to spot a problem that is costing you a 5 to 10 percent loss in fan power. However, if you have multiple fans that are losing 5 to 10 percent of their air-moving capability, you will soon have an overall reduction of 25 to 30 percent in wind speed down the house. Instead of the 600 to 800 feet per minute you thought you were pulling, you may only have 420 to 560 feet per minute. This could be devastating on a hot afternoon in July or August with big birds on the farm.

It is wise to individually static pressure test each fan between flocks. Most growers conduct static pressure tests to determine the tightness of their house. The same principle is used to monitor fan performance over time (Brothers et al., 2014). Close all sources of incoming air and ensure that curtains are up, vents are closed, inlets and doors are closed tight, and fan shutters are working properly. Then, turn on one individual fan and record the static pressure of that one fan. Now, turn that fan off and do the same to the next fan until all the fans have been tested and the static pressure recorded for each fan. Any fan that is 0.02 points less than the average of all the other fans should receive immediate attention. Keep in mind that the fans that also do most of the minimum ventilation may be the fans that show a problem first because they are doing double duty and will likely show power loss before the others.

A full tunnel test can also be performed on the house to look for problems. To do this, put the house in full tunnel mode, turn on all the fans, and record the static pressure. If the pressure goes down the next time you test or at a later date, you may have maintenance issues or electrical issues or both. In this case, you might do individual fan tests to see if individual fans may be causing the problem. If the static pressure goes up since the last test, there may be a restriction in air flow entering the house. Clogged cool cell pads or a tunnel inlet not completely open could cause such a restriction.

Factors to Consider

How many fans will it take? Integrators will specify a certain number of fans for new house construction or for retrofitting older houses. How do they come up with this number of fans? There must be enough fans to exchange the air in the house at least once per minute. With the trend being to grow bigger birds, an air exchange of more than once per minute is becoming more popular. Air speeds of 800 feet per minute or higher are common in many new and retrofitted houses today.

How can I tell what my air velocity needs to be? If you have a 500-foot-long house, your air velocity needs to be 500 feet per minute to exchange the air in your house in 1 minute. To calculate your actual air velocity, you divide the total fan capacity of your house by the cross-sectional area of the house (width of your house times the average ceiling height). Let's say your house is 50 feet wide by 500 feet long and you have 15 50-inch fans installed with a cfm capacity of 27,000 cfm for each fan. Fifteen times 27,000 is a total fan capacity of 405,000 cfm. If you have an average ceiling height of 10 feet, and your house is 50 feet wide, the cross-sectional area of your house is 500 feet (10 ft x 50 ft). If you divide 405,000 by 500, you will get 810 feet per minute. This is how much air speed you will have down the house under the given conditions. What if you are operating against a higher static pressure and your fans are only moving 25,000 cfm each? Fifteen times 25,000 is a total fan capacity of 375,000 cfm. If you divide 375,000 by 500, you will get 750 feet per minute air speed down the house.

The cross-sectional area of your house will make a huge difference in the air velocity you can achieve and the air exchange rate. If your house does not have a drop ceiling or at least baffles, the greater volume of air inside your house that must be exchanged will slow the air speed down considerably. This may be a concern during periods of hot weather with big birds on the farm. However, **you likely have a few extra cfm above the minimum required**, and that will be a good thing in this case. In most cases, fan capacity numbers do not exactly match the requirements of your house, and you end up slightly exceeding the minimum. Having a few extra cfm in reserve will be beneficial as fan wear begins to accumulate over time, dust and dirt build up on shutters and blades, and fan belts begin to slip (Donald, n.d.). Also, air velocity is usually slightly lower at bird level than it is above their heads, so having a little extra cushion of cfm will be useful when dealing with periods of extreme heat and the increased heat load associated with growing larger birds.

Static pressure increases are also a drain on air velocities. As the house is operated at a higher static pressure, the air velocity will drop because the fans are working harder to move air against a higher pressure. For example, evaporative cooling pads usually increase the static pressure slightly. The fans must work harder to pull air through the holes in the pads (compared to pulling air through a big hole in the wall if the pads were not there). In addition, the fans work even harder to pull air through a wet cool cell pad than a dry cool cell pad.

We have mainly discussed fans, but the fans are not the only piece of the ventilation puzzle. The amount of cool cell space on each side of your house, the condition of the cool cell pads themselves, the tunnel curtains or doors, and the number, size, and design of your minimum ventilation inlets all play critical roles in the overall ventilation capabilities of your house and all are equally important. Each of these pieces will need attention and maintenance from time to time.

Summary

Fans make poultry production in environmentally controlled houses possible. Good-quality fans are essential for mechanically ventilated poultry houses to perform efficiently. In most cases, the cheapest fan is not the best option over the long run. Inefficient fans waste energy. In addition, inefficient or mismanaged fans may result in poor air quality that can stress birds. Birds that are stressed are more susceptible to disease outbreaks and are less efficient in the areas of growth and feed efficiency.

When choosing fans, select a model that has been rated and tested by an independent laboratory. Most fan manufacturers use the BESS testing lab at the University of Illinois. This laboratory has both current and archived data online for practically every agricultural fan on the market. Verify how different fans perform against a static pressure of at least 0.10 inch of water. Also check the efficiency, air delivery, and air flow ratio of the fan you are considering.

Do not change or replace fans or any part of your ventilation system without talking to your service technician first. The Extension Service has tools that can help you measure the wind speed, static pressure, and rpms on your fans to determine if your house is operating efficiently. Let us know if you would like for us to assist you or your service technician in this endeavor.

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