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Fan Selection for Tunnel-Ventilated Houses

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Introduction

When building a new house or retrofitting an older one, tunnel fan selection is one of the most, if not the most, important decisions a producer has to make. A house's fans are essentially the engine of the ventilation system and as a result have a significant effect on a producer's ability to maintain the proper environmental conditions throughout the year.

Furthermore, with rising electricity prices, selecting the right energy-efficient fan can save a producer thousands of dollars a year. As a result, when selecting fans it is crucial that a producer compares fans not just on initial cost, but on fan performance, fan design characteristics, and operating costs as well.

Operating static pressure

When selecting a tunnel fan it is crucial to know the maximum static pressure the fan will be operating under. The higher the static pressure, the lower the amount of air moved by the fans, and the greater the number of fans required to provide the necessary amount of fresh air/wind speed to keep the birds cool during hot weather.

For turkey houses, the maximum static pressure typically ranges between 0.10 inches water column (0.10") (25 Pa) and 0.20" (50 Pa). Though factors such as pad area/maintenance, deflector-curtain installation, and tunnel-door installation/operation will have an effect on the maximum operating static pressure, the primary factor which determines the maximum expected static pressure is air speed. The higher the target air speed, the higher the static pressure will tend to be due to the exponential relationship between tunnel air speed and work (static pressure) required to pull air into and down a house. **Table 1** illustrates the typical static pressure range the tunnel fans will experience under various air velocities. The actual maximum pressure experienced can vary significantly with the aforementioned variables as well as house length, fan maintenance, and house tightness.

Table 1 Air velocity and corresponding static pressure for a traditional tunnel-ventilated turkey house

Target Air Speed	Static Pressure
500 ft/min (2.5 m/sec)	0.09" - 0.12" (23 - 31 Pa)
600 ft/min (3.0 m/sec)	0.12" - 0.15" (31 - 38 Pa)
700 ft/min (3.5 m/sec)	0.15" - 0.18" (38 - 46 Pa)
800 ft/min (4.0 m/sec)	0.18" - 0.21" (46 - 53 Pa)



Energy efficiency rating

A fan's energy efficiency rating is similar to a car's mileage rating. Instead of speaking in terms of miles per gallon, when comparing fans, we look at how many cubic feet per minute the fan can move with a single watt of power (cfm/watt or cmh/watt). As with a car's mileage rating, the higher the cfm/watt or cmh/watt the more energy efficient the fan. A 2.0 cfm/watt (3.4 cmh/watt) difference between two fans typically results in approximately a 10% difference in electricity usage.

In general, energy-efficiency ratings vary from approximately 15 cfm/watt (26 cmh/watt) to over 30 cfm/watt (51 cmh/watt). For every two cfm/watt increase in energy efficiency rating, fan operating cost will decrease by approximately 10%. Fan energy efficiency ratings should be assessed at the typical operating static pressure of 0.10" (25 Pa). It is generally recommended that tunnel ventilation fans should have an energy efficiency rating of at least 20.8 cfm/watt (35 cmh/watt).

Air flow ratio

A fan's air flow ratio is another important factor to consider when purchasing a fan. A fan's air-flow ratio is an indicator of how well the fan will hold up as static pressure increases due to factors such as dirty shutters, dirty pads, or the presence of baffle curtains.

To determine a fan's air flow ratio, divide how much air it moves at a static pressure of 0.20" (50 Pa) by how much air it moves at a static pressure of 0.05" (13 Pa). The higher the rating, the less the fan is affected by high static pressure **(Figure 1)**. Air flow ratios typically vary from 0.50 to 0.85. To put this into perspective, the air-moving capacity of a fan with an air flow ratio of 0.50 will decrease 50% or more in a worst-case scenario (a static pressure of 0.20" (50 Pa)), whereas a fan with an air flow ratio of 0.85 would only see a reduction in air-moving capacity of 15%.

To assure adequate fan performance at higher operating static pressures it is recommended that a tunnel ventilation fan have an air flow ratio of at least 0.76.



Figure 1 Air Moving Capacity vs Static Pressure

Butterfly shutters

Exterior butterfly shutters (Figure 2) tend to increase the air moving capacity of a fan because the fan does not have to work against gravity to hold open the shutters as is the case with traditional panel shutters. Since the fan is not working against gravity to hold open the shutters, fan performance does not decrease significantly as dirt accumulates on the vertical shutters thereby lessening the need to clean the shutters during a flock to insure maximum air moving capacity.

The downside of butterfly shutters is that the fan housing and components are in constant contact with the inside environment which can result in the formation of condensation on the fan surfaces and components during cold weather. The combination of moisture, dust, and ammonia can lead to issues with rust, which can reduce fan life. Butterfly shutters are typically better suited to warm climates where condensation issues tend to be minimal and high use can increase the benefit of a shutter that doesn't require frequent cleaning.



Figure 2 Tunnel fans with discharge cones and butterfly shutters

If you're looking to purchase a fan with butterfly shutters and you live in a climate where condensation is a common problem, fans constructed of fiberglass and/or polyethylene should be strongly considered. Though the fan will have a higher initial cost than one with a galvanized sheet metal housing, the potential increased life of the fan due to the reduction in corrosion related problems will often offset the additional cost.

Discharge cones

Discharge cones reduce the "back pressure" on fans, thereby increasing the air moving capacity of a fan by between 5% and 10% without increasing power usage (Figure 3). The discharge cone also allows the installation of a wider wire mesh safety screen on the outside edge of the cone which tends to collect less dust/feathers than fans where a narrower mesh screen is required due to the closer proximity of rotating fan blades (Figure 4).

Figure 3. Tunnel fans equipped with discharge cones and wide spaced screen.



Figure 4. Tunnel fans without discharge cones and relatively fine mesh screen.



Motor location

Ideally a fan's motor is positioned within the fan housing and does not protrude into the house. When a fan motor protrudes into a house a large screened box often is required to protect workers from rotating fan parts (Figure 5). Furthermore; the motor and screened box make it difficult to winterize the fan during cold weather through the use plastic sheeting or insulated panels.

Belt tensioners

Loose fan belts reduce the speed at which an exhaust fan rotates, which in turn reduces the amount of air moved by a fan. A reduction in fan speed of just 10% will reduce the air-moving capacity of a fan between 10 and 15%. A tensioning device helps maintain the proper belt tension, which reduces slippage to maximize belt life and fan performance (Figure 6).

<image>

Figure 5. Tunnel fan motor extending

Figure 6. Tunnel fan equipped with belt tensioner.



Drive type

Though virtually all tunnel-ventilated houses are currently equipped with belt-driven fans, a number of manufacturers have recently developed direct-drive tunnel fans (Figure 7). Direct-drive fans eliminate belts and the associated maintenance and are often variable speed. Studies have found that using variable speed tunnel fans can reduce fan power usage from between 25% and 50% over conventional fixed speed belt-driven fans. Though these fans can cost two or more times conventional belt-driven fans, in areas with very high power cost they could prove to be a viable option.



Figure 7. Direct drive tunnel fans.

Independent Fan Performance Information

The University of Illinois BESS Laboratory website (<u>www.bess.illinois.edu</u>) is the leading source for agricultural fan performance data. Along with a fan's air-moving capacity at various static pressures, BESS Laboratory provides producers information on a fan's energy efficiency rating (cfm/watt), airflow, shutter location/type, motor model number, fan speed, and a variety of other potentially valuable details **(Figure 8)**.

Evaluating Fan Cost

One piece of information that is not listed on the BESS Laboratory website is cost. Too often the price of a fan is given too much weight when fan comparisons are made. The fact is, once a fan is installed, a producer will have to live with the ramifications of their decision for 15 years or more.

The question a producer has to ask is not how a fan performs when first installed but whether it will it do the job 10 years from now.

Figure 8. Sample report from BESS laboratory website

University of Illinois Department of Agricultural and Biological Engineering Bioenvironmental and Structural Systems Lab Final Report									
Project Number: Test Date:									
Fan:			Motor:			Shutter:			
Make-	Acme		Make-	AO Smith		Material-	aluminum		
Model-	BDR54J1		Model-	K56A99B8	33	# Doors-	14 per column		
Blade dia	54"		Hp-	1.0		# Columns-	- 2		
Orifice dia.	- 54.6"		RPM-	1725/1425	5	Door length	1 28.3"		
			Volts-	115/230		Location-	intake		
Blade:			Amps-	9.6/4.8					
Number-	4		Hz-	60		Guards:			
Shape-	propeller		Phase-	1		Description	- wire		
Material-	galvanize	d steel	S. F	1.3		Spacing-	2.1" concentric		
Pitch-	-					Location-	exhaust		
Clearance-	0.3"		Housing:				•		
D			Material-	gaivanized	i steel	Discharge	Cone:		
Drive Snea	aves:		Intake area	- 50.5" X 50.	5	Deptn-	37.5"		
Drive dia	- AK39, 3.8" o.d.		Discharge-	54.6" dia.		Minor dia	54.6"		
Axie dia	AK144, 14.3" o.d. Depth- 29.5" top Major dia 71"					71*			
Notes:	0								
Test Conditions:									
T(wb):	63.5 Barometric pressure, recorded				29.18				
T(db):	79 Barometric Pressure, corrected				29.05				
.									
Static	A :								
(in H2O)	(ofm)		Valta	Amno	Matta	ofmAlatt			
(11.H20)	(0111)	140	VOILS	Anips	4004	CIII/Wall			
0.00	28600	442	229.9	5.02	1004	28.4			
0.05	27400	441	229.6	5.31	1120	25.4			
0.10	20900	440	229.9	5.80	1201	22.7			
0.15	24100	430	229.0	6.17	1201	17.5			
0.20	19700	436	229.0	6./1	1314	17.5			
0.20	16700	435	229.5	6.83	1410	11.8			
5.50	.5700	-100	220.0	0.00	.410	.1.0			

Items to Consider when Evaluating Fan Cost

- Power usage A power usage difference of 20% may not seem like much today, but what about in the future?
- Rust A little surface rust in a few years can lead to a fan that will need to be replaced in 10 to 15 years.
- Longevity It may move a lot of air when the shutters and the evaporative cooling pads are clean and static pressure is relatively low, but what about in a few years when the pads are dirty and the belts are loose?
- Sufficient power Will the fan have the power to move the air to keep the birds cool?

It is important to take the time to closely consider all aspects of fan performance, design, and maintenance when selecting fans for tunnel-ventilated houses. Saving a few hundred dollars up front by choosing to install a lower quality fan can easily end up costing thousands of dollars over the life of a fan.

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