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Poultry Housing Tips

Motor Size is a Poor Indicator of Fan Power Usage!

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Far too often when comparing tunnel fans one of the first things people look at is the size of the motor. The thought being, the smaller the motor size, the less the fan will cost to operate. Though in general this is true, the fact is that not all motors of a given size will consume the same amount of power. For instance, Figure 1 illustrates the range of power consumed by 158 different 48" fans tested by BESS Laboratory. Though all the fans were equipped with a 1 HP motor the amount of power consumed by the fans ranged from 700 watts to a little under 1,300 watts!

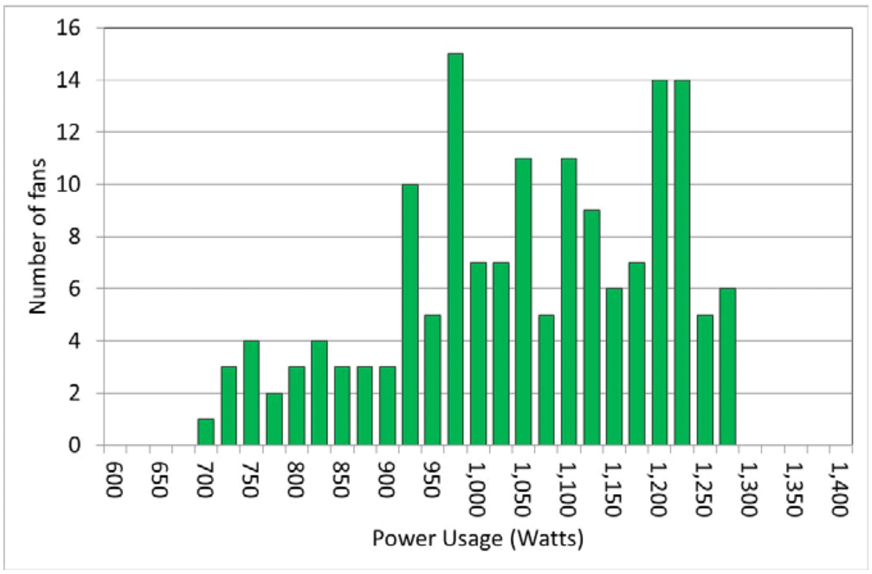

Figure 1. Power used by various 48" fans with 1 HP motors.

To understand why there are differences in power usage between fans equipped with a 1 HP motor it is first important to understand what is meant when a motor is labeled as "1 HP." By definition 1 HP is equal to 746 watts of power. A 1 HP motor is designed to deliver at least 746 watts of power to the motor shaft. If the motor is not connected to a load, it obviously will not do any work, but will still use a small amount of power. If it is connected to a fan blade that requires 746 watts of power it will deliver that amount power. If it requires less or more, it will attempt to deliver that amount. Thus the amount of power that a 1 HP motor uses depends more on how it is loaded than on how much it is capable of.

If it takes 900 watts of power to rotate a particular 48" fan's prop at its speed of, let's say 400 rpm, a motor will "try" to deliver 900 watts of power, regardless of the size of the motor. If the motor on the fan is only capable of delivering 746 watts of power (1 HP) to drive the prop it will tend to overheat, because it is being overloaded. But if the motor is capable of delivering 1,492 watts of power (2 HP) it can easily supply the 900 watts of power without any concern for overheating. It is not as much how much power the motor is capable of delivering that will determine the amount of power it will use, but rather how much work/power is required of it to spin the fan prop at the specified speed. It is really no different from a car's engine. How much gas car's engine uses depends more on how much the engine is loaded (i.e. how fast the car is going) than its size/displacement.

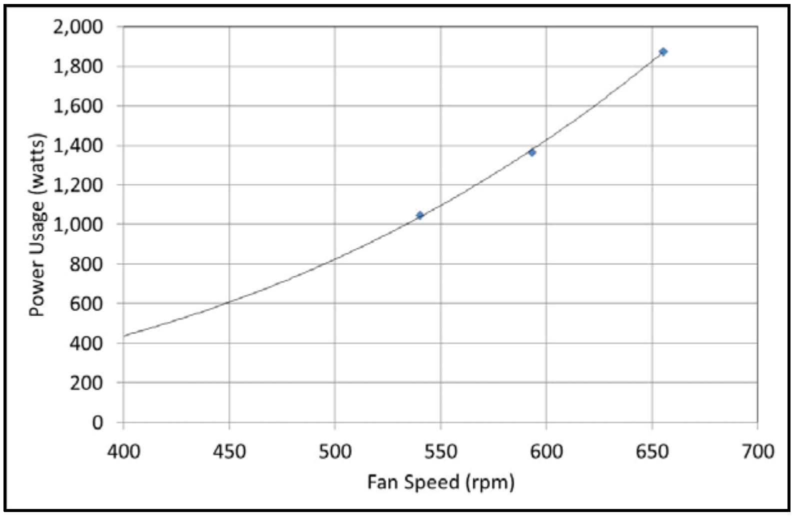

Figure 2. Fan power usage vs. fan speed.

Figure 2 shows the power usage of a particular 52" fan with a 2 HP motor as a function of prop speed. The power required to rotate the fan blades can vary close to 100% depending on how fast the fan blades are rotating. Increasing the prop from 540 to 593 rpm, just an increase of 9%, increases the power used by the fan motor from 1,046 to 1,365 watts, an increase of 31%. Increase it to 650 rpm (20% increase) and power usage nearly doubles! Again...its not the size of the motor that determines how much power a fan uses but rather how much work is required of it.

Another factor that determines fan motor power usage is motor efficiency. Electrical motors are not 100% efficient...that is you have to put more than 746 watts of electricity into a fan motor to get 746 watts of usable power out of the motor to drive the fan prop. There are power losses in a motor associated with electrical resistance in the motor windings, friction in the bearings, etc. These losses are manifested in the form of heat. Fan motor efficiencies typically run between 74 and 86% at full load, which means roughly 20% of the power a fan motor uses is used to produce heat and not to rotate the fan blades. Just taking into account motor efficiency, to get 746 watts of usable power out of a typical 1 HP fan motor, you have to put in between 867 and 1,008 watts of power into the fan motor.

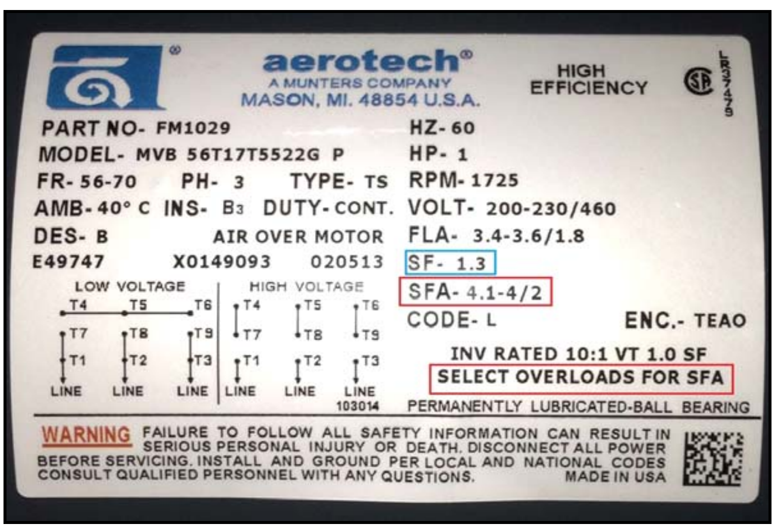

Figure 3. 1 HP fan motor nameplate.

A third factor is the a motor's service factor. A motor's service factor is essentially a measure of how much a motor can be overloaded without fear of damage. For instance, a motor with a service factor of 1.2 means that the motor can be overloaded by 20% without fear of motor damage. So a 1 hp motor with a 1.2 service factor is capable of suppling 895 watts of power to drive a fan prop not 746 watts....for all practical purposes it is a 1.2 HP motor. The fans in Figure 1 that are using over 1,100 watts of power generally have power factors over 1.0.

Figure 3 shows the nameplate of a fan motor. Though it is a 1 HP motor, with a service factor of 1.3 it can be loaded is if it was a 1.3 HP motor. It is very important to note that it if is fully loaded it can produce more power to drive the fan than a 1 HP motor, but that also means that it can/will draw more amps and use more power than a 1 HP motor. It is important to keep in mind that if you replaced a 1.3 service factor fan motor with a 1.0 service factor, there is a good chance that the motor will overheat and shut off.

University of Illinois Department of Agricultural Engineering
BESS Lab

Project Number: 00245

Test Date: September 21, 2000

Fan
- *Make*: Acme
- *Model #*: BDR54J-C
- *Manufacturer*: Acme
- *Blade Size*: 54" dia.
- *Orifice Dia.*: 54.5"

Blade
- *Number*: 4
- *Shape*: propeller
- *Material*: galvanized blade
- *Pitch*: -
- *Clearance*: 0.3"

Shutter
- *Material*: aluminum
- *# of Doors*: 14 per column
- *# of Columns*: 2
- *Door Length*: 28.3"
- *Location*: intake

Other Attachments:
Discharge cone 25.5" deep, 54.5" i.d., 67" o.d.

Motor
- *Make*: AO Smith
- *Model #*: K56A40B83
- *H.P.*: 1
- *Amps*: 11.0/5.5
- *Volts*: 115/208-230
- *RPM*: 1725
- *S.F.*: 1.3

Drive
- *Drive Pulley Dia.* *3.4" o.d* AK34
- *Axle Pulley Dia.*: 14.3" AK144

Housing
- *Material*: galvanized steel
- *Intake Area*: 57.8" x 58.3"
- *Discharge Area*: 54.5" dia.
- *Depth*: 29" top, 14" bottom

Guards
- *Description*: wire
- *Spacing*: 2" concentric
- *Location*: exhaust

Figure 4. Description of fan tested.

Another factor that affects fan motor power usage is that fans are designed to deliver the specified amount of power under worst case conditions (high temperatures, low air velocity over the motor, etc). When operating under more normal conditions the power usage would typically be lower. How much lower would depend on precisely how the fan motor was designed.

As you can see, there are a wide variety of factors that end up determining the amount of power a fan with a 1 HP motor will use. Though the motor nameplate can provide some idea of power usage, the only way to actually determine the amount of power a fan will use is from fan test laboratories such as BESS labs at the University of Illinois (www.bess.uiuc.edu). Fan test data will include a wide variety of information about the fan (Figure 4) as well as the amount of air the fan moves along with the energy efficiency rating (cfm/watt) at various static pressures (Figure 5). To determine power usage of a specific fan simply divide the amount of air moved by the fan (i.e, cfm @ 0.10") by the energy efficiency rating (i.e, cfm/watt@0.10") of the fan.

TEST RESULTS

ACME BDR54J-C

Test: 00245

Fan description:
54" belt drive, 1 hp AO Smith K56A40B83 motor, galvanized steel slant housing, aluminum shutter, guard and discharge cone

Static Pressure in. water	Speed rpm	Airflow cfm	Efficiency cfm/Watt
0.00	425	27,500	27.5
0.05	424	26,100	24.2
0.10	423	24,500	21.4
0.15	421	22,700	18.9
0.20	418	20,500	16.2
0.25	417	17,900	13.3
0.30	416	14,800	10.7

Figure 5. Fan performance test results.

For example, from the fan performance test results seen in Figure 4, the 54" fan with a 1 HP motor will move 24,500 cfm and has an energy efficiency rating of 21.4 cfm/watt @0.10" pressure. When we divide 24,500 cfm by 21.4 cfm/watt we find that the fan will use 1,145 watts of power to move the 24,500 cfm of air @0.10" pressure.

But...the fact is, from an energy efficiency standpoint, the amount of energy used by a fan is actually not a good measure of its overall energy efficiency. It is not how much power a fan uses, but rather how much power it takes to move a cubic foot of air. For instance, it is not necessarily a problem if a Fan A uses 20% more power than Fan B, if it moves at least 20% more air. It is not any different than an automobile...it's not how much gas a car uses, but rather how much it uses relative to the distance traveled. The question a person trying to chose a fan should be asking is how much air can be moved with each watt of power used. The higher the cfm/watt...the higher the energy efficiency of the fan.

Purchasing an energy efficient fan is actually quite simple. Ignore the size of the motor, and compare fans based on how much air they move at the maximum expected operating static pressure (see https://www.poultryventilation.com/tips/vol22/n8) and their energy efficiency rating (which should be at least 20.8 cfm/watt @ 0.10" static pressure). A listing of the best performing tunnel fans tested by BESS Laboratory can be found www.poultryventilation.com (https://www.poultryventilation.com/tips/vol26/n1).

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