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Poultry Housing Tips

Fan Performance Laws

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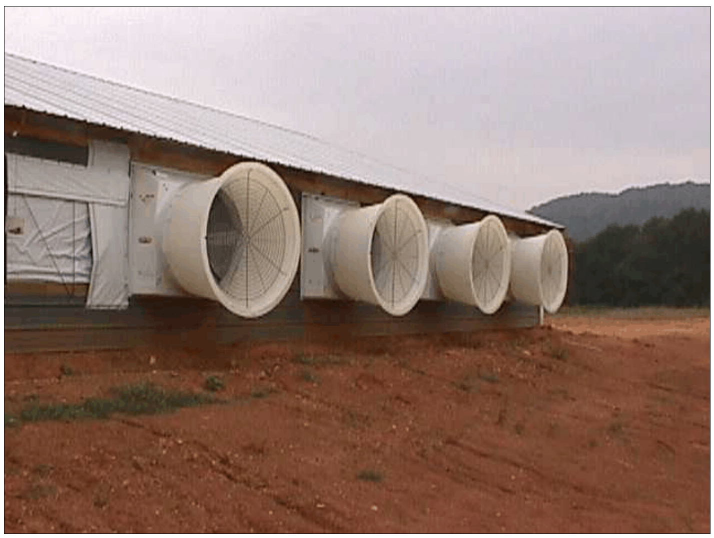

There are very specific "laws" that dictate the relationship between fan speed, air moving capacity, and energy usage for any fan. For instance, fan speed and air moving capacity are proportional. That is, if fan speed is increased 10%, the air moving capacity of the fan will increase roughly 10%. Conversely, if fan speed is decreased 10% , the output of the fan will decrease roughly 10%. A second fan law states that fan power is proportional to the cube of fan speed. As a result, small changes in fan speed can have a dramatic effect on the power used by the fan.

The relationship between fan speed, cfm, and power usage can be seen in the following example. The ACME DDPS50, a 50" fiberglass fan with a discharge cone, typically operates at 468 rpm. When the fan speed is increased 10% to 514 rpm, air moved by the fan increases 10%, but power usage is increased 33% (Table 1). Conversely, if the fan is slowed 18% to 397 rpm, fan output is decreased by 18%, but power usage is decreased roughly 38%. It is important to keep in mind that the same changes in performances would occur with *any* fan as fan speed is changed.

Another performance characteristic that changes with fan speed is the fan's ability to move air under high static pressures. The faster a fan rotates the less performance drops off as static pressure increases. For instance, at 514 rpm, the air moving capacity of the ACME DDPS50 decreases only 13% as static pressure increases from 0.05" to 0.20", while at 397 rpm the air moving capacity of the fan decreases 35% for the same change in static pressure.

	Low speed 397 Rpm	Standard speed (468 Rpm)	High speed (514 Rpm)
Air moving capacity @ 0.05" (cfm)	20,100	23,900	26,400
Power (watts)	710	1,044	1,458

Table 1. Air moving capacity and power vs. Fan speed

Fan manufacturers have for years used fan laws to "tweak" the performance of their fans to meet the demands of their customers. For customers that want a very energy efficient fan, manufacturers will slow a fan a little to produce a fan that moves a little less air, doesn't hold up as well under pressure, but is significantly more energy efficient. Other customers may want to keep their fan numbers to a minimum and are concerned with high static pressures such as in the case of a tunnel-ventilated pullet house with light traps or possibly a tunnel-ventilated broiler house with pads and air deflectors. Manufacturers can speed up the same fan to obtain a fan that moves a little more air and holds up under high pressure better, but the downside is that it will be less energy efficient. It is important to realize that these tweaked fans are the exception rather than a rule. Most fans sold are configured so that they strike an optimal balance between air moving capacity, energy efficiency, and ability to hold up under high static pressures.

Fan speed is typically adjusted by simply changing the size of the fan motor pulley. Smaller pulley, lower fan speeds. Larger pulley, higher fan speeds. Changing the size of the motor pulley is not recommended without contacting the fan manufacturer, because significant problems can be encountered. For instance, in the case of the ACME DDPS50, changing the motor pulley diameter from 2.5" to 2.8" increases fan speed by 10% and power usage increases 33%. Thirty-three percent more power usage means that now a 1 h.p. motor that was originally installed on the fan is unable to provide the necessary power and would have to be replaced with a 1.5 h.p motor. If a larger motor is not installed, the 1 h.p. motor would quickly "burn out" due to its inability to handle the additional load.

Installing a smaller motor pulley also has its own hazards. Changing the motor pulley diameter from 2.5" to 2.3" decreases the fan speed and air moving capacity by 18%. Though the power usage is reduced by 38%, this does not mean that the fan is 38% more efficient. This is because though you are using far less electricity you are moving nearly 20% less air, which means you now have to install 20% more fans to make up for the loss in air moving capacity. The 20% increase in the number of fans installed is not only going to reduce your electricity savings but, also means you have to purchase 20% more fans.

To get a better picture of improved energy efficiency associated with different motor pulley sizes it is crucial to compare fans based on their energy efficiency rating (cfm/watt). This is because energy efficiency is not defined by which fan uses the least amount of power, but which one uses the least amount of power per cubic foot of air per minute moved. As you can see in Figure 1, though putting the smaller pulley on the fan in question decreases power usage 38%, the fan is actually only 20% more energy efficient (28.3 cfm/watt vs. 22.9 cfm/watt).

It is interesting to note that the difference between the energy efficiency of the standard fan and slowed version decreases as static pressure increases. This is because the slowed fan has more difficulty in moving air at higher static pressures. As a result, the air moving capacity of the slowed fan decreases faster than the standard fan as the static pressure increases (Figure 2). The end result is that though the fan is 24% more energy efficient at 0.05" of pressure, it is only 12% more efficient at a static pressure 0.15" which is not an uncommon pressure in a house with dirty evaporative cooling pads and fan shutters.

Many producers have effectively changed the size of their motor pulleys and don't even realize it. As fan belts wear they become thinner and ride lower in the motor pulley, effectively reducing the size of the motor pulley. As a result, over time, the fan spins slower and slower, increasing its energy efficiency but reducing its air moving capacity, especially at higher static pressures. A 10% to 15% reduction in air moving capacity may not seem like much but when it is hot and you have large birds it can reduce the wind chill effect by three degrees or more.

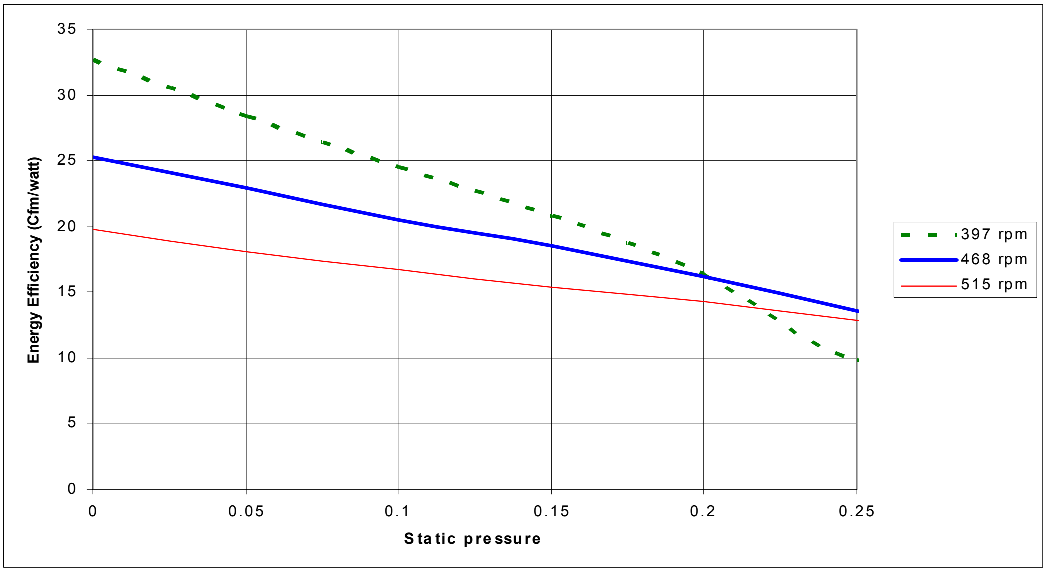

Figure 1. Energy efficiency Vs. Static Pressure

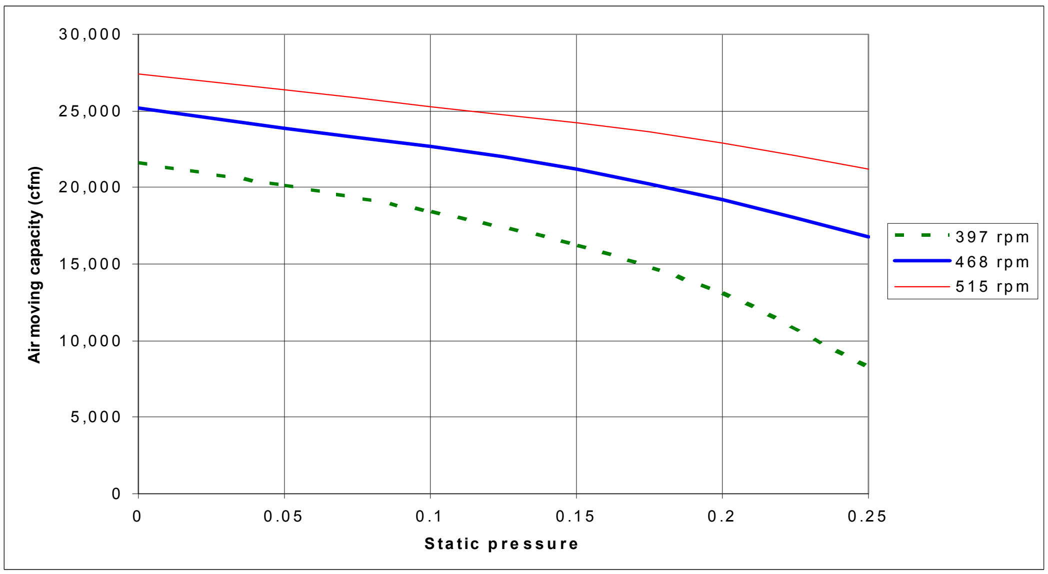

Figure 2. Air moving capacity Vs. Static pressure

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