MANAGEMENT AND MAINTENANCE OF COOL PADS AND FANS

Mr. Peter Mathews *Australasian Agricultural Services*

A fully equipped tunnel ventilated broiler shed built in 2012 will result in an investment in the vicinity of $600,000.00, with a capacity of approximately 50,000 broilers and 5.3 batches per annum will produce 265,000 broilers per annum.

The proportion of the floor, heating and ventilation equipment, controller and electrical control cabinets will represent the investment of around $175,000.00 or $3.50 per bird. This is a significant amount of money, but in so many cases regular maintenance and proper equipment management, at a fraction of the investment cost, will be overlooked or not applied properly which can result in ongoing high operation costs, reduction in optimum flock performance and good financial return's, and in some cases significant costs to yourself.

The subject of this paper is related to the management & maintenance of cool pads & fans, which come into play usually in the latter period of the grow-out and during hot weather, and are extremely critical to the outcome of the batch but during all aspects of growing from shed preparation for brooding thru to catch-out and cleaning, management and maintenance are critical to maximising performance from the flock being farmed. I will mention a number of aspects of this later in the presentation.

In the first instance, prior to the shed and equipment being commenced, proper planning of the requirements of the fans and cool pads should be made to ensure you will provide the correct number of fans to meet the required air speed, and from this calculation the required cool pad sizing and tunnel inlet area to ensure correct static pressure can be maintained which in the long run will mean that the performance and efficient running costs of the fans will be maximised.

Always keep in mind some basic questions and principles, such as asking for BESS Laboratory (University of Illinois) fan performance data that will show fan performance at various static pressures, a minimum of 25 pascals should be used, and also look at information of fan performance for cfm/watt. Electricity will be an ongoing cost increase and with around a total of 18 – 20hp being used for tunnel fans per shed is an item where you can keep operating costs at a minimum.

Check that the cool pad sizing and cool pad area is calculated based on fan performance at a minimum of 25 pascals. Cool pad type should be 45/15 flute with 150mm depth. The inlet area into the shed should be between 80% to 85% of the cool pad area to ensure that static pressure is not compromised with too little an opening.

The industry has been building, and converting older broiler sheds to tunnel ventilation for over 20 years now and I would suspect that some of these sheds have not had cool pads replaced, fan belts and pulleys not replaced and with older style tunnel inlet curtains being used, pulleys, cables and the curtains themselves poorly maintained resulting in not providing the correct inlet area and hence putting higher static pressure on the fans.

Being associated with the poultry industry for a very long time it has always concerned me of the difference that is seen in hatchery operations and shed operations when it comes to management and maintenance of equipment, that being incubators and hatchery processing equipment. Hatcheries will have daily, weekly, monthly, and quarterly maintenance programmes with planned part replacements such as V belts, fogging nozzles, and equipment management and servicing being drummed into everyone to ensure maximum chick numbers and quality is achieved.

If we start by looking at fan management and maintenance we are all aware that the environment that the fans are operating in has feathers and litter material which will be drawn towards the fans and as most sheds will have safety mesh for the fans, so a simple operation is to keep the mesh free of feathers, in particular during hot weather periods when temperatures can rise quickly and you are looking for maximum cooling, this should be done daily and only requires a good quality floor broom.

There have been reports that say that on occasions when fan mesh is not cleaned, up to a 30% loss in fan performance can occur.

If using fans with shutters these also should be brushed if accessible daily but if not, cleaned as regularly as possible, and fully serviced and cleaned each batch.

Fan belts are the connecting point between the motor and the performance of the fan, at a cost of around $30.00 you should look at a regular replacement of them but at least check them for wear and clean them every batch and at the same time check pulleys for wearing and alignment, as well as check the motor operation for bearing noise and cleaning.

A loss of fan capacity of 25% is not unheard of with worn fan belts and the flow on from this can de disastrous!

You can purchase an electric tachometer to check fan speed to see how your fans are performing.

With some Controllers you have the option to be able to rotate tunnel fans from being minimum/tunnel fans to only tunnel fans which allows you to even out total fan run times over a period of say a year.

Cool pad system maintenance is a combination of both the system itself and the pads. Poor management and maintenance of the cool pad system and the pads will impact significantly with the performance of your fans in relation to increasing static pressure that they will operate under.

All systems operate with a pump which requires regular maintenance and servicing, water distribution which requires regular maintenance during the batch so you should have systems that are easily accessible to clean, with proper operation of the water distribution this will improve the performance of the pads themselves and help keep them clean. As important as the water distribution is the cleaning and flushing of the sump or bottom pipes as this water is drawn back up to the distribution to combine with the incoming water supply to be distributed to the pads.

In relation to the management and maintenance of the pads themselves, again, as with fans, regular cleaning of the pads is paramount especially during hot weather. In some areas it may be a significant advantage to have housing with shade cloth out from the cool pad area to reduce dust, grass seeds etc which will clog the pads. The first significant factor related to the pads is the water source that is being used, if issues occur with calcification of the pads you may need to treat the water that is being sourced. A water quality test should be carried out if you are concerned or are seeing this issue.

Reputable cool pad suppliers will provide you with products that can be used to contain water quality issues as well as materials that can be safely used for cleaning, these can also be sourced through equipment suppliers.
Pads will not last forever and again it is a replacement item that you should allow for after a period, or at the first sign of a reduction in temperature drop, or reduced air speed, or increase in shed static pressure, if regular maintenance and good management is used.

Also related to the cool pad systems and fan performance is the tunnel inlet system, these could be the older style inlet curtains or the more recently used panel system with rack & pinion or cable operation. A significant advantage with the latter is the fact that wire netting is generally not used with the panel inlet systems but with the curtain system wire netting is usually present and this needs regular cleaning by brushing. With both systems though an actuator or rack and pinion is used and these items require regular servicing and cleaning as well as if cables and pulleys that are used with any of these systems.

To optimise the operation of the fans and cool pad systems, particularly in older sheds and some not so old, is to ensure that the shed is very well sealed, you don't want all the above equipment operating at 100% efficiency but the full benefits not achieved because there are leaks through curtains, if older sheds, minimum vents, doors etc.

The controller, alarm systems, and control cabinet that is used to operate these systems, as well as the other heating and ventilation equipment, should be regularly checked by yourself for obvious issues such as wasp nests, spiders and rodent damage and regularly check or replace batteries in alarms, but any work or further checks has to be done by a qualified electrician.

If you purchase your equipment from quality suppliers, all products should come with assembly, operation and maintenance manuals for the product. Even with very old equipment that you may have on a farm that you have acquired after the equipment has been installed, manuals should be available from various suppliers.

An anemometer, good temperature recorder and a static pressure gauge should be tools that you have, or have access to, so you can monitor air speed from the fans and thru the pads, and into the shed, and temperature drop thru the pads, to regularly check these critical operations. The use of the lights in the shed to check for leaks in other areas of the shed and equipment should also be undertaken regularly.

Minimum stock of spare parts for fans, cool pad pumps and actuators should be kept on site.

A maintenance log and record book should also be kept for each shed to record events related to all equipment and shed operation.

In regards to other equipment, all are very important and proper management and maintenance is as just as important as the fans and cool pad systems mentioned above.

Heaters, feed line and feed fill systems, drinker's, winches and actuators, minimum inlet vents, silos and shed grow-out lights all require proper service management and regular maintenance and replacement. One of the most important equipment items on a farm, the generator, is critical in being maintained and operated under a service management programme.

Experienced service personnel, electricians, and your equipment supplier should be contacted to provide you with assistance to bring your farm up to standard and let you maximise your performance.

A very good web site to visit re the above, including specific's on the impact of poor maintenance as well as information on all aspects of poultry farming operations and fan performance and management is Poultry Housing Tips found at www.poultryventilation.com

Also I would like to acknowledge Bob Cummings from Specialised Farm Services for providing some of the valuable information that assisted in preparing the above.

EFFICIENCY AND PERFORMANCE OF TUNNEL VENTILATION FANS

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Department of Agriculture, Fisheries and Forestry

THE PROBLEM

Efficiency and performance of tunnel ventilation fans will affect air exchange rate, maximum shed air speed, ability to cool the birds, as well as farm profits.

Fan performance relates to the amount of air a fan moves in a given period of time, and is measured in units of cubic meters per hour (m^3/h) or cubic feet per minute (cfm). Every fan has a different performance capability related to its design and features. Using fans with relatively lower air flow capacity is not in itself a problem; it just means that more fans will be required. What can become a problem is if fans don't perform how they were expected to (compared to laboratory tests of fan performance) or if the performance of individual fans decline due to wear, dust accumulation or poor adjustment.

Energy efficiency relates to the amount of air a fan moves per watt of electricity, and is measured in units of cubic meters per hour per watt ($m^3/h/W$) or cubic feet per minute per watt (cfm/W). Installing energy efficient fans is the only way to minimise fan running costs.

Fan performance and efficiency are both affected by operating conditions, especially static pressure. Figure 1 is an example of how fan performance and efficiency change with increasing static pressure. Accumulation of dust and feathers on fan grills, shutters and blades creates an obstruction to airflow and has a similar effect to increasing the static pressure. This in turn reduces performance and efficiency and is why it is important to frequently clean fans.

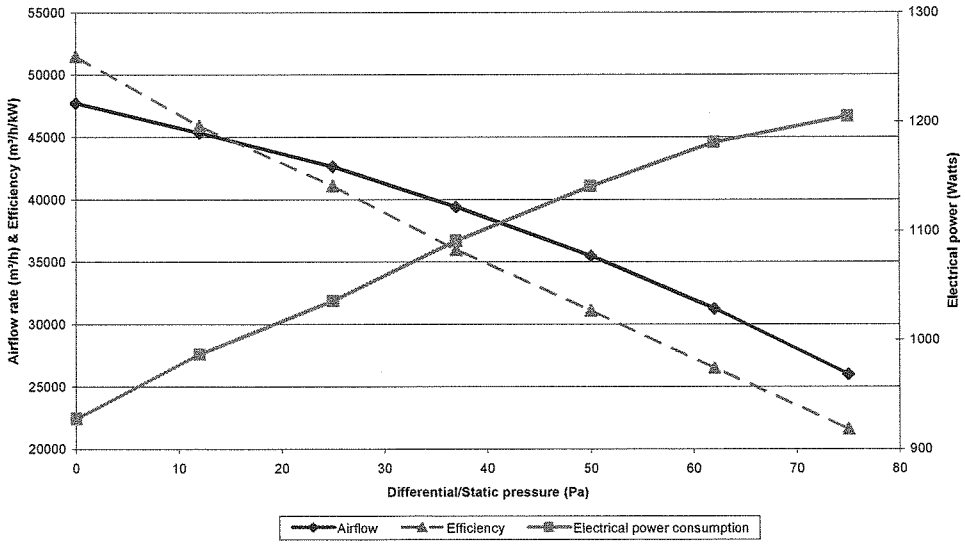


Figure 1. Example of how fan performance, electrical power consumption and efficiency change with static pressure for poultry shed ventilation fans

Fan performance and efficiency are the responsibility of the fan manufacturer, ventilation system designer/installer as well as the poultry farm owner/operator. To get the most out of fans and minimise costs all three parties must contribute equally.

1) *Fan manufacturers* are responsible for ensuring that fan design and selected components (i.e. motor, pulleys, bearings, drive belts) allow the fan to be as efficient as possible while having adequate performance. If the design is lacking to begin with, high efficiencies will never be achieved. Fan manufacturers are also responsible for testing the fans and providing the fan test data to end users.

2) *Suppliers/designers/installers of the shed and ventilation system* must ensure the overall shed and system design will deliver the required ventilation capacity and in-shed air speed while maximising the efficiency of the fans *as installed* in the shed. Ventilation system suppliers should also assist the customer to understand the ventilation system and help them identify the most energy efficient and cost-effective options for their specific situation, including on-going electricity costs to operate the fans.

3) *Farm owners/operator* responsibilities can be divided according to whether they are choosing new fans or are operating existing fans. When choosing new fans, farm owner/operators have the responsibility to select the most energy efficient and cost-effective fans for their specific situation, taking into account ongoing electricity costs. When operating existing fans, farm owner/operators should ensure that the fans and sheds are regularly cleaned, maintained and operated appropriately (i.e. operate the shed at the correct static pressure; clean or replace evaporative cooling pads; and ensure inlet vents are operating properly). Each fan should be regularly checked to ensure that it is operating properly.

WHAT TO LOOK FOR WHEN BUYING NEW VENTILATION FANS

There is a lot to consider when buying new fans: brands, suppliers, supplier's reputation, quality of construction, parts availability, after sales support, warranty and previous experiences with fans. Another important consideration is the energy efficiency of the fan and the total cost of installing and operating the fans for the years to come. **Choosing the right fan could save you thousands of dollars,** but how do you know which fan(s) will be the best for your situation. If you're fitting out a new shed, chances are you'll start with the supplier of the ventilation system or other fittings/equipment for the shed. This is a good place to start because it will likely provide some discounts off fan purchase costs. But it is worth looking at a few more details and asking a few more questions before settling on a fan.

Find out the *energy efficiency* of the fans being offered to you as this will affect how much your fans will cost to run. It's important to look at the fan's energy efficiency when operating at a static pressure that will be representative of normal operating conditions in your sheds, such as 25 Pa. The greater the energy efficiency ($m^3/h/W$), the more air the fan will move for every dollar of electricity and the less it will cost to ventilate your shed.

Another value to consider is the *air flow ratio*, which is a measure of how well a fan maintains its air flow capacity with increasing static pressure (ASABE, 2008; BESS Laboratory; Czarick and Lacy, 1999). As an example, an air flow ratio of 0.6 indicates that the air flow rate of the fan at 50 Pa will be 60% of the air flow rate at 12.5 Pa (40% reduction). Most poultry ventilation fans will have an air flow ratio between 0.5 and 0.85, and ideally fans should have an air flow ratio greater than 0.73 (Czarick, 2006). The air flow ratio is calculated using the following equation:

$$Air\ Flow\ Ratio = \frac{Air\ flow\ @\ 50\ Pa}{Air\ flow\ @\ 12.5\ Pa}$$

Where A*ir flow* is the air flow rate through the fan at the specified static pressure (m^3/h) and *Pa* is the unit for static pressure across the fan (Pascals).

Finally, estimate the costs of purchasing and operating the fans over a length of time, for example 10 years. If your fan supplier cannot help you do this, download the '*Tunnel-Ventilated Broiler House Fan Comparison Spreadsheet 2011*' from http://www.poultryventilation.com/spreadsheets. More information about this spreadsheet is available in Czarick (2008b). This spreadsheet takes into account electricity prices, fan purchase prices, shed dimensions and ventilation

requirements (exchanges per hour or air speed) and the air flow capacity of the fans you're considering. All you need is fan performance data from your fan supplier, preferably based on an available laboratory test report. It is ideal if you can get a copy of the report because it will describe exactly what fan was tested (including model of motor) and the test conditions. Some fans are tested using electrical power conditions not used in Australia (we use 240/415V, 50Hz supply), with electric motors that are not the same as those supplied here, so test results may not be transferable to the models sold in Australia.

For more information about comparing fans on the basis of energy efficiency and air flow ratio, refer to 'Poultry Housing Tips' at http://www.poultryventilation.com (Czarick, 2006, 2012).

Fans available in Australia

We looked at a range of fans that are currently available in Australia to review performance and energy efficiency. Fan data was requested from suppliers of *Munters*, *American Coolair®*, *Hired-Hand®*, *Multifan*, *Fanquip*, *Eurofan*, *Skov*, *Titan Poultry* and *Gigola and Riccardi* brand ventilation fans. Fans were assessed using data—in order of preference—from independent test lab reports, manufacturer's test reports, manufacturer's brochures or data provided by the supplier. Not all of the fan test information provided enough detail about fan configuration or test conditions. Indicative fan purchase prices also obtained and were based on supplying only a small number of fans and **exclude GST, delivery costs, and bulk-purchase discounts**.

Laboratory testing is the only reliable and accurate way to measure air flow and energy efficiency; however, when fans are installed in poultry sheds, their performance will be less due to in-shed turbulence, obstructions, interference from other fans and less than perfect power supply.

A total of 38 fans were able to be included in our review and are listed in

Appendix 1, including the sources for the data. Air flow rate, energy efficiency at 25 Pa, air flow ratio and purchase price data for the fans are listed in
Appendix 2.

Top 20 fans for energy efficiency at 25 Pa

Energy efficiency of the fans included in our review ranged from 20.1–53.3 $m^3/h/W$. The top twenty fans are listed below in Table 1. Some of the fans are at least 50% more energy efficient than others, which means they would be substantially cheaper to run.

Table 1. Top 20 fans available in Australia for energy efficiency

	Fan Description	Energy Efficiency at 25 Pa ($m^3/h/W$)
1	Titan WM1220/0.75/5B (1 hp)	53.3
2	American Coolair MNBCCE54L (60 Hz) CONE 1 hp	46.2
3	Hired Hand 6603-8010 54" - CONE 1.5 hp	41.1
4	Eurofan 50" butterfly fan 0.75 kW - 1.0 hp, 3 blade CONE (9FJ12.7T-4)	40.6
5	Titan WM1220/1.1/5B (1.5 hp)	39.1
6	Gigola & Riccardi ES-140 R/S 1.0 hp	38.6
7	Titan WM1000/1.1/5B (1.5 hp)	38.3
8	Hired Hand 6603-7403 52" (60 Hz) CONE 1 hp	35.0
9	Titan WM1372/1.5/8B (2 hp)	34.2
10	American Coolair MNBFC60M (60 Hz) CONE 1.5 hp	33.8
11	Munters Euroemme EC-50 (60 Hz, 1 phase) CONE 1hp	33.7
12	American Coolair MNCFE52L (60Hz) 1 hp	33.5
13	Hired Hand 6603-3000 52.5" - CONE 1.5 hp	33.0
14	Hired Hand 6603-6527 52.5" - Butterfly damper (60 Hz) CONE 1 hp	32.8
15	American Coolair MNBFA54L (60 Hz) 1 hp	32.6
16	American Coolair MNBFA48L (60 Hz) 1 hp with CONE?	31.3
17	American Coolair MNBF60M (60 Hz) 1.5 hp	31.2
18	Titan WM1220/1.5/6B (2 hp)	31.1
19	Multifan MF130 0.75 kW (50.5", 1.0 hp, 3 blade) CONE	30.6
20	American Coolair MNCFC52L (60 Hz) CONE 1 hp	30.4

Top 20 fans for 10 year operating costs

The total cost for purchasing and operating fans over a 10 year period was calculated using the '*Tunnel-Ventilated Broiler House Fan Comparison Spreadsheet 2011*' based on the inputs described in

Table 2. Because these inputs may be different to the situation on your farm (or in your new sheds), our conclusions regarding 10 year costs may not be applicable to your situation. It is therefore advisable to access the spreadsheet yourself and use your own input values.

Table 2. Inputs used in the *Tunnel-Ventilated Broiler House Fan Comparison Spreadsheet*

Input description	Metric input	Imperial input
House Length	150 m	492 ft
House Width	15.3 m	50.2 ft
Side Wall Height	2.6 m	8.5 ft
Ceiling Peak Height (Note the ceiling peak height was made the same as the wall height to simulate baffles installed in the shed)	2.6 m	8.5 ft
Open/Dropped Ceiling (o/d) *(note, dropped ceilings are more common in the US)*	o	o
Electricity Rate ($ per kW·h)	$ 0.15	$ 0.15
Estimated Yearly Operating Hours per fan	2,000	2,000
Minimum Design Air Velocity	3.0 m/s	590 ft/min
Minimum recommended fan capacity *(note: this value equals air velocity 3.0 m/s)*	429,625 m^3/hour	252,868 cfm

Total costs for purchasing and operating the fans over a 10 year period ranged from $48,500—$88,620. The top 20 most cost effective fans (based on combined purchase and electricity costs over a 10 year operating period on a per shed basis) are listed in

Table 3. It is interesting that purchase cost makes a relatively small contribution to the total costs for operating the fans over a 10 year period relative to the electricity costs, which are directly related to the energy efficiency.

Table 3. Top 20 fans available in Australia for purchase and electricity costs over a 10 year period

	Fan Description	Fans required	Purchase cost ($)	10 year Electricity ($)	Total cost over 10 years ($)
1	Titan WM1220/0.75/5B (1 hp)	16	21,600	26,900	48,500
2	Hired Hand 6603-8010 54" - CONE 1.5 hp	11	16,104	34,200	50,304
3	Hired Hand 6603-7403 52" (60 Hz) CONE 1 hp	11	12,463	41,200	53,663
4	American Coolair MNBCCE54L (60 Hz) CONE 1 hp	12	22,656	31,400	54,056
5	Titan WM1220/1.1/5B (1.5 hp)	13	18,330	36,700	55,030
6	Hired Hand 6603-6527 52.5" - Butterfly damper (60 Hz) CONE 1 hp	11	13,182	43,900	57,082
7	Titan WM1000/1.1/5B (1.5 hp)	18	21,600	35,600	57,200
8	Eurofan 50" butterfly fan 0.75 kW - 1.0 hp, 3 blade CONE (9FJ12.7T-4)	15	15,795	42,000	57,795
9	Munters Euroemme EC-50 (60 Hz, 1 phase) CONE 1 hp	14	15,414	44,800	60,214
10	Eurofan 50" butterfly fan 1.1 kW - 1.5 hp, 6 blades CONE (9FJ12.7T-3)	10	10,530	50,300	60,830
11	Eurofan 50" axial fan 1.1 kW - 1.5 hp, 6 blades (9FJ12.7)	11	9,163	51,900	61,063
12	Multifan MF130 0.75 kW (50.5", 1.0 hp, 3 blade) CONE	14	12,460	49,100	61,560
13	Titan WM1372/1.5/8B (2 hp)	10	18,700	43,500	62,200
14	Skov 1400 Cone 1.5 hp (3ph airflow, 1ph effic)	11	9,900	52,500	62,400
15	Hired Hand 6603-3000 52.5" - CONE 1.5 hp	12	18,505	44,400	62,905
16	Titan WM1220/1.5/6B (2 hp)	11	16,060	46,900	62,960
17	Multifan MF130 1.12 kW (50.5", 1.5 hp, 3 blade) CONE	12	10,680	52,700	63,380
18	Eurofan 36" axial fan 0.4 kW - 0.75 hp 6 blade (9FJ9.1)	29	15,370	49,100	64,470
19	Munters Euroemme EC-50 CONE 1.5 hp	11	12,331	52,500	64,831
20	Titan WM1372/2.2/8B (3 hp)	8	15,600	50,400	66,000

What's the take home message when purchasing new fans

Reviewing a range of fans available in Australia has shown that some fans are substantially more energy efficient than others and can greatly reduce operating costs. By choosing one of the most energy efficient fans, there is potential to save $20,000–$40,000 per shed in the first 10 years of operation.

Comparing fans and estimating costs can be a challenging task, but the '*Tunnel-Ventilated Broiler House Fan Comparison Spreadsheet 2011*' makes it possible. Airflow and efficiency data is available for most fans and you will need to input your specific shed details and get accurate pricing from fan suppliers, including delivery, installation and discounts for bulk purchases.

EXISTING FANS...WHAT CAN YOU DO?

If you already have ventilation fans, you might be wondering how energy efficient they are and what you can do to check that they're still moving the right amount of air. While fan performance (referring to air flow rate) and efficiency are frequently referred to hand-in-hand, performance may decline as the drive belts and pulleys wear but at the same time the fan may become more energy efficient (Czarick, 2010). For this reason, you need to be clear about the result you're after—maintaining airflow or improving energy efficiency.

The only maintenance we suggest is that required to keep the fan operating like it did when it was new. There may be things that can be modified on fans to increase/decrease air flow rate or improve energy efficiency, such as fitting more energy efficient motors, changing motor size, altering pulley ratios or blade angles, but these would best be discussed with your fan supplier. The results from such modification in terms of air flow rate, energy efficiency, air flow ratio and wear rates of fan components cannot easily be predicted or measured.

Fans do not just 'get old' and lose performance. An average tunnel ventilation fan operates about 1500-2500 hours per year, with some fans operating much more. Components in the fan may wear or fail, such as the belts, belt tensioners, pulleys, bearings and shutters, so these need to be maintained, adjusted or replaced as required. When properly maintained, there is no reason why a fan that is ten or more years old will not have similar performance and efficiency as it did when nearly new. It is also important to frequently clean dust off safety grills, blades and shutters. Accumulated dust can reduce fan performance by more than 20% (Donald and Campbell, 2004; Simmons and Lott, 1997). Accumulated dust will also reduce fan efficiency.

There are a few checks you can do on your fans to make sure they are operating as you'd expect them to; that is, just like new. After all, your shed and ventilation system were designed to provide the correct amount of ventilation and air speed when all fans were new and operating at peak performance.

How to evaluate fan performance

There are a several checks and measurements for evaluating ventilation fans:

- measure air flow rate;
- measure power consumption;
- measure blade speed (revolutions per minute, rpm);
- visually inspect belts for wear and tension,
- inspect and measure pulleys for wear and alignment;
- check shutters are operating properly; and
- check for worn bearings.

The first step before measuring fan airflow, power consumption or blade speed (rpm) is to establish good testing conditions. This requires cleaning fans (so you're assessing the fan and not the effects of dust on the fan) and ideally performing the checks on belts, pulleys and shutters. It's then a good idea to make the fans operate under 'normal' conditions by allowing them to warm up for at least 15-20 minutes and setting the shed static pressure to be about 25 Pa (or at least what you would consider to be normal operating pressure for your shed). Regardless of what conditions you choose, make sure you can repeat the conditions in your other sheds, or during later tests. If possible, it's a good idea to do this testing between batches and avoid days that are windy or excessively cold or hot.

Measuring airflow and power consumption on individual fans is complex, time consuming, requires special equipment and is unlikely to provide useful or reliable information for poultry farm owner/operators. Belt and pulley wear can be assessed visually by observing where the belt is riding in the pulley. Detailed information on how to do this is provided by Czarick (2008a) and Czarick and Fairchild (2004). An alternative is to use belt and sheave gauges (Carlisle Sheave Gauges, part no. 102495, Carlisle Power Transmission Products Inc., Springfield MO, USA,

http://www.cptbelts.com/tools/sheavegauge/index.html), which can be acquired from bearing suppliers, and are used to quantify belt and pulley wear.

Measuring fan rotational speed

Measuring fan rotational speed (revolutions per minute, rpm) with an electronic tachometer is the easiest and most reliable way to check that your fans are performing the way they should. Rotational speed is directly related to air flow rate and will give a good indication of how worn belts and sheaves are affecting fan performance. Measuring fan rotational speed takes only a few seconds per fan. Detailed instructions are provided by Czarick and Fairchild (2004). A tachometer can be purchased for under $100 (even cheaper on *ebay™*). The way to use the tachometer is to stand to the side of the fan so as not to block the airflow, point the tachometer at the blades and take a reading. The reading on the tachometer will be in blade counts per minute. To calculate rpm, divide the blade counts reading by the number of blades on the fan. For example, if the tachometer is reading 2928 and the fan has 6 blades:

$$Rotational\ speed\ (rpm) = \frac{blade\ counts\ per\ minute}{number\ of\ \ fan\ blades} = \frac{2928}{6} = 488\ rpm$$

The rpm reading can be compared to manufacturer's specifications or test data (at 25 Pa) if it is available. We've found that even relatively new fans in sheds do not have the same rotational speed as specified by manufacturers. This could be due to the expected air flow rate reduction that happens when fans are installed in poultry sheds (compared to the laboratory testing wind tunnel) rather than an indication of the fan being worn. We recommend that if you take the time to measure fan rotational speed, it is worth recording the values. If this testing is performed regularly (say every batch), you will be able to see the history of each fan's performance and be able to see if the performance suddenly declines, indicating a problem worth further investigation.

Is it cost effective to replace old fans with more efficient ones?

If you've identified that the fans on your sheds are not very energy efficient, could it be cost effective to replace them with a more energy efficient fan? The answer depends on:

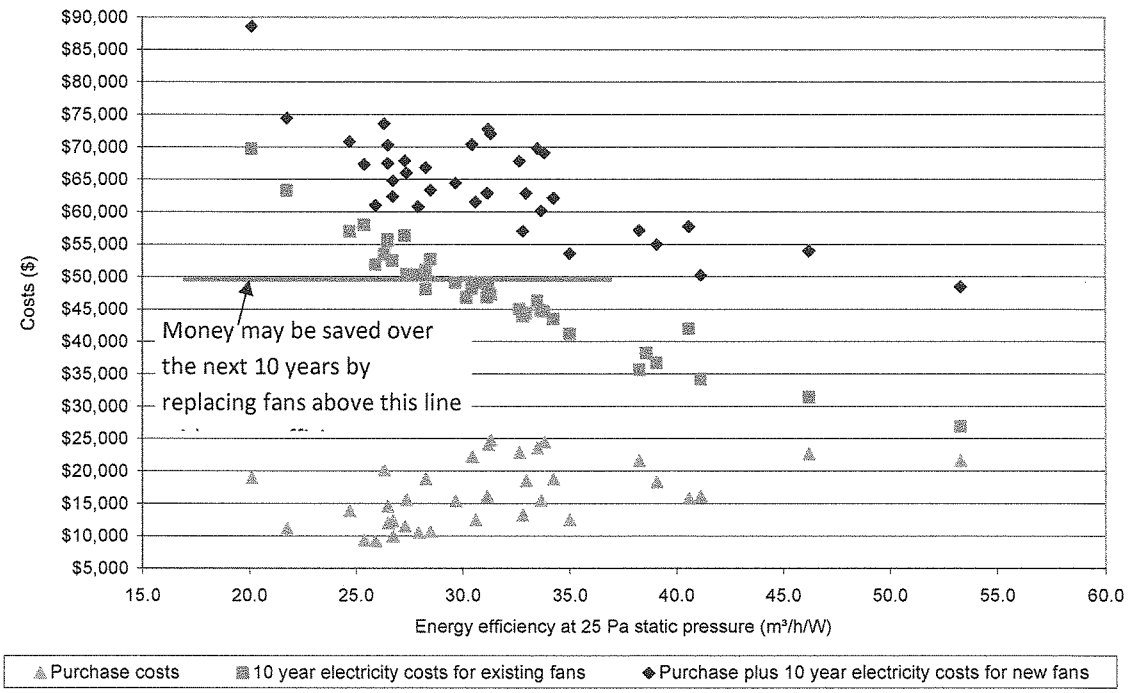
- what fans you have, and what condition they're in;
- what fan you want to change to;
- your electricity rate ($ per kWh); and
- your financial situation (i.e. if you need to borrow money to replace the fans).

We compared the electricity costs over 10 years for existing fans to the combined purchase and electricity cost over 10 years for new fans using the '*Tunnel-Ventilated Broiler House Fan Comparison Spreadsheet 2011*'. Figure 2 displays the respective costs for new and existing fans for each of the fans in our review (costs based on the input scenario in

Table 2). Each of the dots represents a different fan, which you might be able to identify from the energy efficiency values listed in
Appendix 2 and operating costs in

Table 3.

We



found that unless you had one of the least energy efficient fans, and were going to replace them with one of the most efficient fans, the change over was not likely to be cost effective. This is especially the case considering that the costs we used for the new fans did not include delivery or installation costs, or costs to make structural changes to the back end of the shed if the new fans were a different size.

Figure 2. Chart showing 10 year fan costs—electricity costs and electricity plus purchase costs—plotted against energy efficiency

Our investigation was general so if you're considering replacing your fans, you should conduct your own cost analysis and discuss the matter with the relevant fan suppliers. Cost effectiveness of replacing fans may be improved if the existing fans require major or costly maintenance, if it is possible to modify the existing fans to make them equal to a more efficient model in the same product range (for example changing to a smaller electric motor or changing blades in consultation with your fan supplier), or if you are considering replacing only a few of the most used fans.

CONCLUSIONS

Fan operating costs are directly linked to energy efficiency, so it is worthwhile installing energy efficient fans if you have the opportunity to do so. The difference in operating costs between an energy efficient fan and a less efficient fan could be as much as $20,000–$40,000 per shed over 10 years. It is important to choose an energy efficient fan right from the start because it is unlikely to be cost effective to change fans later on. Not installing energy efficient fans will cost you money in the long run and reduce your profit.

The best way to check that your ventilation fans are performing adequately is to measure fan rotational speed. This check only takes a few seconds per fan but will tell you a lot about the fans condition. It is recommended to record the values and re-check rotational speed every batch, or every few batches to identify when fan performance declines. Frequent cleaning and maintenance will ensure that fan performance and efficiency are not compromised.

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Appendix 1. Data sources for fan performance and efficiency

Fan Model	Data Source
Hired Hand 6603-7403 52" 1 hp (60hz)	BESS test 02466
Hired Hand 6603-6527 52.5" - 1 hp, butterfly damper (60 Hz)	BESS test 05334
Hired Hand 6603-3000 52.5" - 1.5 hp	BESS test 07090
Hired Hand 6603-8010 54" - 1.5 hp	BESS test 08257a
Munters Euroemme EM50 - 1hp	Munters test 01078
Munters Euroemme EM50 - 1.5hp	Munters test 3031
Munters Euroemme EC-50 1hp (60Hz, 1 phase)	Munters brochure (2005)
Munters Euroemme EC-50 1.5hp	Munters test (150704)
American Coolair MNBF60M (60Hz)	BESS test 09248
American Coolair MNBFC60M (60Hz)	BESS test 09257
American Coolair MNBFA54L (60Hz) (1Hp)	American Coolair brochure (Jan 2010)
American Coolair MNBFA54M (60Hz) (1.5 Hp)	American Coolair brochure (Jan 2010)
American Coolair MNBFA54N (60Hz) (2hp)	American Coolair brochure (Jan 2010)
American Coolair MNBFA48L (60Hz) (1hp)	American Coolair brochure (Jan 2010)
American Coolair MNCFC52L (60Hz)	American Coolair brochure (Oct 2007)
American Coolair MNBCCE54L (60 Hz)	American Coolair brochure (Nov 2010)
American Coolair MNCFE52L (60Hz)	BESS test 99160
Titan WM1000/1.1/5B (1.5 hp)	Titan-direct communication
Titan WM1000/1.5/6B (2 hp)	Titan-direct communication
Titan WM1220/0.75/5B (1 hp)	Titan-direct communication
Titan WM1220/1.1/5B (1.5 hp)	Titan-direct communication
Titan WM1220/1.5/6B (2 hp)	Titan-direct communication
Titan WM1220/2.2/8B (3 hp)	Titan-direct communication
Titan WM1372/1.5/8B (2 hp)	Titan-direct communication
Titan WM1372/2.2/8B (3 hp)	Titan-direct communication
Multifan MF130 0.75kW (50.5", 1.0hp, 3 blade)	BESS test 12123
Multifan MF130 1.12 kW (50.5", 1.5 hp, 3 blade)	BESS test 12126
Multifan MF130 0.75 kW (50.5", 1.0 hp, 3 blade) with CONE	BESS test 12136
Multifan MF130 1.12 kW (50.5", 1.5 hp, 3 blade) with CONE	BESS test 12138
Skov DB1400 1hp (60hz, 1 Phase)	Munters test 01078
Skov 1400 Cone 1.5hp (3ph air flow, 1ph effic)	Munters test 150704
Eurofan 36" axial fan 0.4kW - 0.75 hp (9FJ9.1)	KEY Laboratory, China Ag. University test (tested up to 34 Pa only)
Eurofan 50" axial fan 1.1kW- 1.5 hp (9FJ12.7)	KEY Laboratory, China Ag. University test (1/12/2008) (tested up to 44 Pa only)
Eurofan 50" butterfly fan with cone 0.75kW - 1.0 hp (9FJ12.7T-4)	KEY Laboratory, China Ag. University test (30/6/2009) (tested up to 30 Pa only)
Eurofan 50" butterfly fan with cone 1.1 kW - 1.5 hp (9FJ12.7T-3)	KEY Laboratory, China Ag. University test (30/6/2009) (tested up to 44 Pa only)
Gigola and Riccardi ES-140 R/S 1.0 hp	Gigola Elostar Brochure (unknown if grills/shutters fitted or if 3 phase 50 Hz)
Gigola and Riccardi ES-140 R/S 1.5 hp	Gigola Elostar Brochure (unknown if grills/shutters fitted or if 3 phase 50 Hz)
Gigola and Riccardi ES-120 R/S 1.0 hp	Gigola Elostar Brochure (unknown if grills/shutters fitted or if 3 phase 50 Hz)

Appendix 2. Air flow, energy efficiency, air flow ratio and purchase cost for fans

Fan Model	Air flow rate (m^3/h)				Energy efficiency $m^3/h/W$ @ 25 Pa	Air flow ratio	Purchase price ($ excl. GST)
	12.5 Pa	25 Pa	37.5 Pa	50 Pa			
Hired Hand 6603-7403 52" 1 hp (60hz)	46,553	43,665	40,946	37,548	35.0	0.81	$1,133
Hired Hand 6603-6527 52.5" - 1 hp Butterfly damper (60 Hz)	46,720	43,665	39,925	35,850	32.8	0.77	$1,198
Hired Hand 6603-3000 52.5" - 1.5 hp	43,665	40,605	37,038	32,790	33.0	0.75	$1,542
Hired Hand 6603-8010 54" - 1.5 hp	45,363	42,645	39,417	35,509	41.1	0.78	$1,464
Munters Euroemme EM50 - 1hp	32,978	30,786	27,713	24,365	26.5	0.74	$908
Munters Euroemme EM50 - 1.5hp	40,042	38,272	36,028	33,717	21.8	0.84	$931
Munters Euroemme EC-50 1hp (60Hz, 1 phase)	38,590	35,870	32,640	28,560	33.7	0.74	$1,101
Munters Euroemme EC-50 1.5hp	44,401	42,526	40,451	38,018	26.7	0.86	$1,121
American Coolair MNBF60M (60Hz)	49,470	46,070	41,310	34,340	31.2	0.69	$2,189
American Coolair MNBFC60M (60Hz)	54,400	50,320	44,880	36,890	33.8	0.68	$2,445
American Coolair MNBFA54L (60Hz) (1Hp)	40,236	37,655	34,690	29,998	32.6	0.75	$1,758
American Coolair MNBFA54M (60Hz) (1.5 Hp)	45,042	42,720	40,294	37,303	26.3	0.83	$1,830
American Coolair MNBFA54N (60Hz) (2Hp)	48,875	46,711	44,529	42,090	20.1	0.86	$1,892
American Coolair MNBFA48L (60Hz) (1Hp)	31,387	29,053	26,651	23,774	31.3	0.76	$1,458
American Coolair MNCFC52L (60Hz)	41,310	37,570	33,150	26,350	30.4	0.64	$1,708
American Coolair MNBCCE54L (60 Hz)	43,494	40,266	36,019	30,752	46.2	0.71	$1,888
American Coolair MNCFE52L (60Hz)	35,530	32,300	28,050	21,590	33.5	0.61	$1,470
Titan WM1000/1.1/5B (1.5 hp)	26,215	25,254	24,289	23,169	38.3	0.88	$1,200
Titan WM1000/1.5/6B (2 hp)	31,273	30,258	29,224	27,979	28.3	0.89	$1,250
Titan WM1220/0.75/5B (1 hp)	31,431	29,851	28,036	25,225	53.3	0.8	$1,350
Titan WM1220/1.1/5B (1.5 hp)	39,013	36,738	34,459	31,820	39.1	0.82	$1,410
Titan WM1220/1.5/6B (2 hp)	45,835	44,222	42,206	39,661	31.1	0.87	$1,460
Titan WM1220/2.2/8B (3 hp)	53,269	52,135	50,612	48,657	24.7	0.91	$1,540
Titan WM1372/1.5/8B (2 hp)	52,207	49,636	46,800	42,894	34.2	0.82	$1,870
Titan WM1372/2.2/8B (3 hp)	58,600	57,495	56,350	54,478	27.4	0.93	$1,950
Multifan MF130 0.75kW (50.5", 1.0hp, 3 blade)	35,400	32,100	27,200	22,500	27.3	0.64	$720
Multifan MF130 1.12 kW (50.5", 1.5 hp, 3 blade)	40,200	37,800	34,600	30,600	25.4	0.76	$720
Multifan MF130 0.75 kW (50.5", 1.0 hp, 3 blade) with CONE	38,800	35,800	32,400	28,200	30.6	0.73	$890
Multifan MF130 1.12 kW (50.5", 1.5 hp, 3 blade) with CONE	44,100	41,700	38,900	36,100	28.5	0.82	$890
Skov DB1400 1hp (60hz, 1 Phase)	33,100	30,658	28,200	24,400	26.5	0.74	$750
Skov 1400 Cone 1.5hp (3ph air flow, 1ph effic)	44,401	42,526	40,451	38,018	26.7	0.86	$900
Eurofan 36" axial fan 0.4kW - 0.75 hp (9FJ9.1)	17,556	16,735	15,113	Not available	29.7		$530
Eurofan 50" axial fan 1.1kW- 1.5 hp (9FJ12.7)	41,897	40,759	39,547	36,764	25.9	0.88	$833
Eurofan 50" butterfly fan with cone 0.75kW - 1.0 hp (9FJ12.7T-4)	40,234	37,849	30,611	Not available	40.6		$1,053
Eurofan 50" butterfly fan with cone 1.1 kW - 1.5 hp (9FJ12.7T-3)	48,353	46,829	45,126	42,919	27.9	0.89	$1,053
Gigola and Riccardi ES-140 R/S 1.0 hp	35,344	32,808	30,272	Not available	38.6		Not supplied
Gigola and Riccardi ES-140 R/S 1.5 hp	38,580	36,208	33,836	Not available	30.2		Not supplied
Gigola and Riccardi ES-120 R/S 1.0 hp	25,579	24,040	22,502	Not available	28.3		Not supplied