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Evaporative Cooling System Operation & Maintenance

Michael Czarick, University of Georgia

Introduction

To ensure maximum air exchange, wind speed, and cooling of incoming air during hot weather, it is essential that evaporative cooling pads are kept as clean as possible (Figure 1). Over time algae, dirt, dust, and minerals can clog evaporative cooling pads, making it difficult for the tunnel fans to pull enough air into a house to keep the birds cool and comfortable.

Figure 1. Barn equipped with evaporative cooling pads

The best way to keep pads clean is with proper prevention and pad system management. To maximize bird cooling and pad life, producers need to:

1. ensure there is an adequate amount of water flowing over pad surfaces
2. empty the pad system reservoir frequently, and
3. avoid overuse of chemicals

The importance of water flowing over pad surfaces

Water flowing over the surface of a pad (Figure 2) ensures both proper pad wetting, and equally importantly, it helps clean the pad. Evaporative cooling pad manufacturers generally recommend that a minimum of 0.75 gallons of water flow over each one foot pad every minute (9.3 liters/meter/minute). This means for a 100 foot (30.5m) long pad system, a minimum of 75 gallons (295 liters) of water should flow over and through the pads each minute.

Figure 2. Water flowing over surface of Evaporative Cooling Pad

It is important to realize that this flow rate is roughly ten times the maximum evaporation rate of water from a pad system. Although a pad could be wetted by a much lower flow rate, a far greater volume of water is required to ensure that dirt and dust are constantly flushed from the surfaces and narrow flute channels.

Another important benefit of adequate water flow is the minimization of mineral build-up on pad surfaces. Over time, the accumulation of minerals will tend to reduce the size of the flutes/holes in a pad making it increasingly difficult for the exhaust fans to pull air into and out of a house.

The greater the amount of water flowing over the surface of the pads, the more likely that minerals in the water will be kept in suspension and not accumulate on pad surfaces. Once minerals accumulate to the point where flute/hole size is reduced, it is almost impossible to remove the build-up, either through the use of chemicals and/or scraping, without destroying the pad in the process (Figure 3).

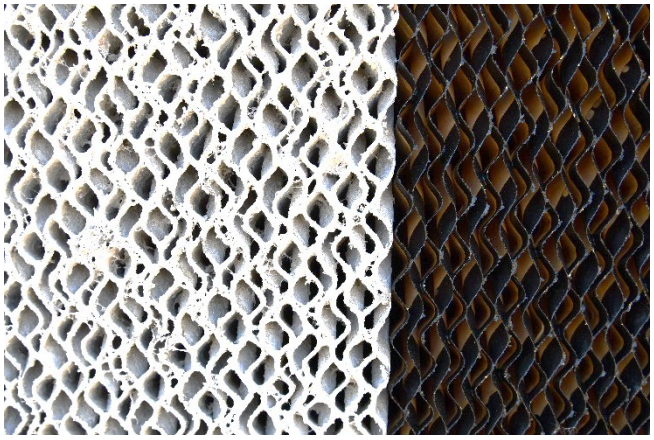

Figure 3. Mineral build-up Vs. New Pad

It is also important to realize that water flowing over a pad does not significantly increase the static pressure the tunnel fans are working against. Research has found that at the recommended water circulation rate of 0.75 gals/min/ft. (9.3 liters/meter/min) the static pressure is only 0.005" greater for a dry pad, which would reduce the air moving capacity of the fans by less than 1%.

It is the accumulation of dirt on and within a pad which can dramatically increase the static pressure the fans are working against, resulting in decreased wind chill effect and larger temperature differences between the pad and fan ends of the house. Furthermore, the dust often contains ammonia which can change the pH of the pads, making them softer over time and reducing their life (Figure 4).

Figure 4. Softened pad surface

Evaluating the amount of water circulating over pads

One of the easiest ways to determine if there is sufficient water circulating over a pad system is to take the top off the distribution system and measure the height the water is spraying up from the holes in the distribution pipe (Figure 5). The height of the water column depends on hole spacing and size. The smaller the holes or the greater the spacing, the higher the water has to spray up to supply the proper amount of water to the pads (Table 1).

Figure 5. Measuring water column height

Table 1. Minimum water column height based on water distribution system hole size and spacing

Holes Size Inches	Spacing Inches	Minimum Water Column Height		Holes Size cm	Spacing cm	Minimum Water Column Height
1/8	4	16 inches		0.3	10.2	40.6 cm
1/8	3	12 inches		0.3	7.6	30.5 cm
1/8	2 3/4	11 inches		0.3	7.0	27.9 cm
1/8	2	8 inches		0.3	5.1	20.3 cm
5/32	4	6 inches		0.4	10.2	15.2 cm

A quick way to see if the right amount of water is circulating over the pads, is to simply place your hand on the pad with your thumb, extended downward, and raised slightly from the surface of the pad (Figure 6). When the circulation pump and all the tunnel fans are operating there should ideally be a pencil sized stream of water flowing from the tip of your thumb. If there is just a slow drip of water, then the dirt and minerals will build up more quickly on pad surfaces.

Figure 6. Checking for water flow over pad surface

The use of interval timers increases dirt and mineral build-up on the surface of pads

Controlling circulation pumps using a ten-minute interval timer has become fairly common, however research has shown that it provides very little benefit. Although the surface of the pad may dry a little while the circulation pump is not operating, the interior of the pad, which produces the vast majority of the cooling, will remain wet for ten minutes or longer after a circulation pump is turned off (Figure 7).

Since the interior of the pad is still wet, during hot, humid weather, it will produce the same level of air cooling and humidity whether the circulation pump is actively moving water over the pad or has been off five to ten minutes. To significantly change the temperature and humidity of the incoming air with an interval timer, the pump typically needs to operate less than one minute or stay off roughly 15 minutes or more (Figure 8).

Figure 7. Pad surface is dry, interior is still wet

Figure 8. Effect of use of interval timer (2 min on/8 min off) on incoming air temperature

Bird cooling will likely be sufficient when using an interval time to control circulation pumps, however it will contribute to mineral and dirt build-up on the pad. Continuous water flow helps keep the pad clean. Limiting the amount of time water flows over the pad increases the amount of mineral and dirt build-up. With the pump off, the outer part of the pad dries, and minerals and dirt precipitate out onto the pad surface (Figure 9).

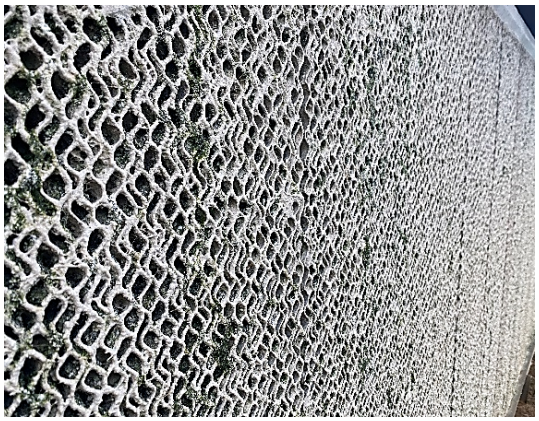

Figure 9. Mineral and algae pad on an evaporative cooling pad

If the circulation pump turns on for a couple of minutes, it is not long enough for the minerals/dirt to be removed from the surface, but it is long enough for additional mineral/dirt-laden water to cover the pad surface; when the water evaporates more dirt and minerals are left behind. When the process is repeated over days, weeks, months and years the dirt and minerals have built up to the point where the pads start to clog and air flow is reduced.

The best way to avoid this situation is to set the pads to operate based on a house temperature of approximately 85^{o}F (29^{o}c). Though they may cycle on and off from time to time, the frequency will be far less than experienced using a ten-minute timer, and as a result mineral build-up will be minimized.

Importance of water reservoir flushing

One of the best ways to keep pads clean is to empty and refill evaporative cooling system reservoirs frequently (Figure 10). Tens of thousands of gallons of water can evaporate from a turkey house's evaporative cooling system each week during hot weather.

Figure 10. Dirt and mineral build-up in pad system reservoir

A potential problem lies in the fact that only pure water evaporates from the evaporative cooling pads. Any minerals and/or contaminates in the water do not. Over time, as these contaminants concentrate in the water, they can become corrosive and turn the pads to mush, or settle out on the pads and turn them into rock.

The typical six-inch evaporative cooling pad system (60' to 100' long) (18m to 30m) holds between 120 and 200 gallons (450-750L) of water. Over the course of the day, between 500 and 2,500 gallons (1900-9500L) of water can evaporate from each of a house's two pad systems. This means that each day the concentration of any minerals or contaminates in the water can increase five to ten fold. Over the course of a month the concentration of minerals or contaminates can increase well over 100 fold! So, a producer can have good water with a relatively low mineral content but by the end of a flock be circulating a highly concentrated mineral solution over their pads.

If the water circulating over a pad is of poor quality, minerals can build up to harmful levels in relatively short order. The higher the concentration of minerals in the water circulating over the pads, the more likely they will precipitate on the surface of the pad. This will restrict the flow of air into a house, resulting in hotter birds and higher electricity bills.

In some turkey growing areas, water with a high pH is a problem not only for alkaline birds, but the pads as well. The pH of the water should be between 6 (slightly acidic) and 8 (slightly caustic). High pH (alkalinity) is associated with bicarbonates, carbonates, sulfates, or hydroxides that are found at various levels in many sources of well water. When water evaporates from the cool cells, these components can become concentrated in the circulation system, resulting in a pH increase. Without flushing the tank, the pH of the water will become caustic enough to destroy the cellulose in the pads or the resins which provide rigidity to the evaporative cooling pads. The paper may start to look fluffy like cotton or there may be no firmness to the pads, causing them to slump out of the frames (Figure 11). It will be worse in areas of the pads that dry out first.

Figure 11. Pads losing rigidity due to high Ph water

Other contaminates often linked to alkalinity are calcium and magnesium. These minerals tend to settle out onto evaporative cooling pads, basically turning them into rock and clogging the airways (Figure 12).

One option for reducing hardness is a water softener which removes these minerals and replaces them with sodium in the water. Another option is to add an acid to the water to lower the pH. Lowering the pH to 7 or slightly lower, increases the solubility of calcium and neutralizes bicarbonates, resulting in fewer “scale” deposits on the pads. You will need to make sure that the pH does not go much below 7 or you can harm the pad.

Figure 12. Mineral build-up on exterior and interior pad surfaces

Keep in mind that adding acid also adds nutrients to the water which can promote algae growth. Therefore, it is important to have a good water sanitation program that provides a chlorine residual of 3 to 5 ppm in the fresh water supply. This does not mean you should pour bleach (sodium hypochlorite) directly into a circulation tank. The momentary high concentration of chlorine will dramatically reduce pad life.

Figure 13. Dumping pad system reservoir

Correct water treatment can vary significantly from farm to farm, therefore it is important to consult a water quality specialist before purchasing or installing any water treatment system. Once you have a recommendation, check with the manufacturer to ensure the treatment will not adversely affect pad life.

For water that has been softened or has had chemicals added to it, there is still the same amount of dissolved minerals in the water. This water cannot be evaporated indefinitely. You will still need to dump the circulation tank from time to time (Figure 13). Remember each time the pump shuts off, everything in the water will tend to be deposited on the pads. The cleaner the water, the cleaner the pads.

Other naturally occurring components in water that can concentrate over time in circulation systems are sodium chloride (salt), and iron. Salt is naturally corrosive and when levels increase drastically, damage can occur. Iron becomes a problem as it creates a food supply for iron-loving bacteria; the resulting thick biofilm (slime) can clog cool cells. A good water sanitation program can help prevent this problem, benefitting both the pads, and the birds.

Of course, the best solution to the above problems would be to properly treat the water coming from the well. This would not only benefit the birds but it would also significantly increase pad life. But, often water treatment can be very expensive. Simply flushing the circulation system occasionally can help to minimize the problem until a proper water treatment option can be employed. In some cases, a water treatment system may only partially treat the water; thus, there will still be the need for flushing an evaporative cooling system from time to time.

Even if you have good water quality, flushing your system occasionally is still important. Over the course of a month, millions of cubic feet of air will move through a house's pad systems. The wetted pads can act like air filters cleaning the air as it enters the house. The problem is that anything that is cleaned from the air (dust, biological material) ends up in the evaporative cooling system water.

Figure 14. Algae growth on damaged pads

As these materials build up over time, we can end up essentially circulating "pond water" over the pads, resulting in a buildup of algae. Though there are chemicals that can be added to a pad system to help control algae, the fact remains that if a system is flushed on a regular basis, there will be no "food" for the algae (Figure 14).

How often an evaporative system should be emptied depends on the quality of the water on a farm. If you have average water quality, a pad system should ideally be dumped a couple of times a week when the weather is hot and the pads are running long hours. During milder times of the year or if you have very good water quality, once every other week will typically prove sufficient. In areas with very poor water quality, daily dumping of the pad system reservoirs may be required.

Don't over use pads

Evaporative cooling pads should not be used when outside air temperature is below 80°F (26°c). Whenever outside air temperature is below 80°F (26°c), the relative humidity (Rh) is usually above 80%. When 80% Rh air is drawn through an evaporative cooling pad, very little cooling is produced and the relative humidity of the incoming air will tend to rise to near saturation, which can lead to increased bird heat stress (Figure 15).

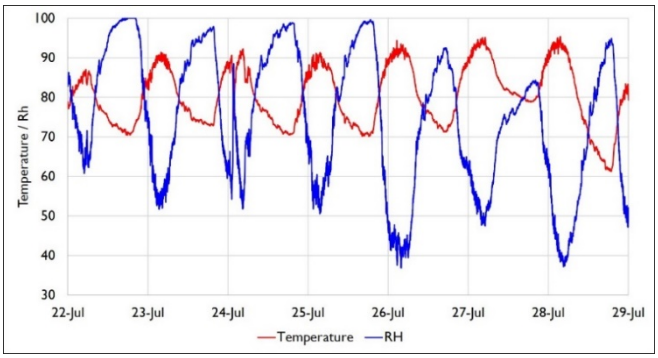

Figure 15. Outside temperature and relative humidity during hot weather

To complicate matters, many producers may be operating their evaporative cooling hours when the outside temperature is well below 80°F (26°c) and not even be aware of it. In the early morning, with all the fans running and older birds in the house, there will be approximately a three-degree temperature rise as the air moves from the tunnel inlet to the fans. If a producer has their evaporative cooling set at 80°F (26°c) and the sensor controlling the evaporative cooling pads is near the tunnel fans, the pads will come on when the outside temperature is only 77°F (25°c). The net result is that you could have evaporative cooling pads operating all night long in a house, saturating the incoming air with moisture all night long.

Not only does the overuse of evaporative cooling pads harm the birds directly, it can indirectly increase heat stress by increasing algae growth which can clog evaporative cooling pads, reducing house air exchange rates and air speed (Figure 16).

If a pad is allowed to dry at night, algae growth can be kept to a minimum. But the lower a pad system is set to operate, the more likely the pads will stay damp through the night, allowing the algae to continue to grow. Setting pad systems to operate closer to 85°F (29°c) will not only keep house humidity to manageable levels, but it will also typically result in the system turning off a little after sunset and preventing them from operating all night long.

Figure 16. Severe algae growth

Keeping evaporative cooling pads clean is all about prevention. Once pads become clogged with minerals and dirt, it becomes very difficult to bring them back to their original condition. By simply keeping water flowing over the surface of the pads when they are in use, dumping reservoirs frequently, and limiting use to when house temperatures are in the mid-eighties, bird cooling as well as pad life will be maximized.

Pad Cleaning Basics

Though the preceding pad management tips will reduce the rate at which dirt, dust, and minerals build up on pads, they will not eliminate the need for a thorough cleaning at least a couple of times each season. Below are some basic steps for cleaning pads.

Once again, it comes down to prevention. After a pad has become clogged with dirt and minerals, it is essentially impossible to bring it back to like-new performance (Figure 17). Cleaning a pad system twice a year will not only make the task easier, but it will ensure pad life and performance will be maximized.

Figure 17. Pads replaced due to excessive mineral build up

Pad Cleaning Basics

1. Use a high-volume, **low-pressure** water hose to maximize hole / flute cleaning. DO NOT use high-pressure washers as they can damage pad surfaces.
2. Pads should be cleaned from both sides, starting from the top and moving to the bottom.
3. When using a cleaning solution, make sure that the product has been approved by the pad manufacturer and follow label directions. Quaternary ammonia products are typically recommended.
4. Flush water distribution pipe weekly during periods of heavy use (Figure 18).
5. Make sure the reservoir is emptied and thoroughly cleaned after the pads have been cleaned.

Figure 18. Flushing water distribution pipe

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Aviagen Turkeys, Inc.
31186 Midland Trail, East • Lewisburg, West Virginia 24901• USA
Tel: +1 304 793 2680 • Fax: +1 304 793 2684
turkeysinc@aviagen.com

Aviagen Turkeys Ltd
Chowley Five, Chowley Oak Business Park • Tattenhall, Cheshire CH3 9GA • UK
Tel: +44 (0) 1829 772020 • Fax: +44 (0) 1829 772059
turkeysltd@aviagen.com

Web: www.aviagenturkeys.com