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Poultry Housing Tips

Getting More Out of Your Pad System's Circulation Pumps

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It is fairly common knowledge that air speed, and therefore cooling, in a tunnel house is affected by the amount of static pressure the tunnel fans are required to work against. As static pressure increases, the amount of air moved by tunnel fans decreases, reducing wind speed and the associated wind chill effect. What many producers might not be aware of is that just as high static air pressure reduces the amount wind-chill effect, evaporative cooling pad circulation pumps working under excessive water pressure can significantly reduce water flow over evaporative cooling pads and thus the amount of cooling produced by the pads.

To insure that six-inch evaporative cooling pads remain uniformly wet on the hottest of days, as well as to keep dust and mineral build-up to a minimum, it is important that a pad system's circulation pump is capable of moving a minimum of 0.75 gallons per minute per linear foot of pad length (GPM/ft). A pump's ability to deliver the required amount of water is determined to a large extent by the amount of pressure the pump is forced to work against. Quite simply, as pressure is increased, the amount of water circulated by the pump decreases. If the pressure becomes excessive the amount of water flowing over the pad will decrease to the point where dry spots and streaking occur, significantly reducing the amount of cooling produced by the pads.

With fans we measure pressure in terms of inches of water column, with pumps pressure is typically measured in feet of water column, more commonly referred to as feet of head pressure (2.31 feet of head pressure is equal to 1 psi). If a pump has to lift water up one foot, it is said to be working against one foot of head pressure. Therefore, when a sump pump moves water from the top of the sump to the distribution pipe at the top of a five-foot tall pad, it is working against a head pressure of approximately six feet.

Type of Fitting	1 ½" Diameter PVC Pipe	2" Diameter PVC Pipe
90 Degree Elbow	0.6'	0.2'
45 Degree Elbow	0.3'	0.1'
T- Fitting - flow through	0.3'	0.1'
Open Ball Valve	0.1'	0.02'
Open Gate Valve	0.1'	0.04'

Table 1. Pressure head (water column) associated with different PVC fittings (40 - 50 GPM).

In a 50-foot long six-inch pad system with five-foot tall pads the circulation pump on each side of the house should be capable of circulating a minimum of 38 gallons per minute (50' X 0.75 GPM/ft = 38 GPM). At first it may seem logical to assume the pump will only be working against a head pressure of six feet. But in fact the pressure the sump pump is working against is much greater. This is because it takes a significant amount of effort to move the water through filters, elbows, and valves, as well as through the 50-foot long distribution pipe. In Table 1 the approximate pressure generated by moving water through different types of fittings is listed. It is important to keep in mind that the values listed in Table 1 increase as flow rate increases.

By far the greatest pressure that most circulation pumps are working against is that generated by moving water through the filter. Most circulation systems use some type of 1 ½" T-Filter with between a 12 and 30 mesh filter to insure that the holes in the distribution system do not become clogged with trash (Figure 1). The pressure drop across the T-filters in most distribution systems ranges between eight and 12 feet of head (Table 2). The precise amount of pressure is primarily affected by flow rate, filter size, and condition of filter.

Filter Type (mesh size = 30)	1 ½" Diameter Pipe			2" Diameter Pipe		
	30 GPM	40 GPM	50 GPM	30 GPM	40 GPM	50 GPM
Vu-Flow T - Filter	6.9'	9.2'	12.7'	4.6'	6.9'	9.2'
Vu-Flow L-Filter	4'	5.8'	7.8'	2.3'	4'	5.3'
Hypro T-Filter	6.4	8.1	10'	-	-	-
Ron-Vic T- Filter	6.9'	9.2'	11'	-	-	-

Table 2. Pressure head (water column) associated with typical evaporative cooling pad system filters

Figure 1. 1 ½" T-Filter

In the typical 50' system the water moves from the sump, then through a T- fitting where a spigot is attached for bleed-off, then through an open ball valve, a 90º elbow, a T-filter, then down the distribution pipe. The total pressure the pump is working against can be determined by simply adding up pressure generated by moving water through each of the system components which can be determined from Tables 1 and 2. One component which is not listed in Tables 1 and 2 is the distribution pipe. The actual pressure required to move water down the distribution pipe can be fairly difficult to determine. Though it will change from system to system it is best to assume that you need approximately

2' of head pressure at the entrance to the distribution pipe to get the water down the pipe and to spray up the necessary height. Once we add up all system components, we find the pump in our 50' system will be working against a head pressure of approximately 18' (Table 3)

We can determine if the pump in our system is capable of moving 38 gals/min at 18' of head pressure by a graph of its water flow vs. head pressure. The performance graph below is for a ½ hp pump used in many of today's commercial systems. From the graph below it can be seen that at a head pressure of 18' the pump in our system will pump approximately 38 gals/min, so we should have just enough water flowing to the pad.

System Components	Pressure Head
From sump to top of pad	6'
90 degree elbow	0.6'
T - Fitting	0.3'
Open Ball Valve	0.1'
T- Filter	9'
50' of distribution pipe	2'
Total Head Pressure	18'

Table 3. Total head pressure for 50' pad system

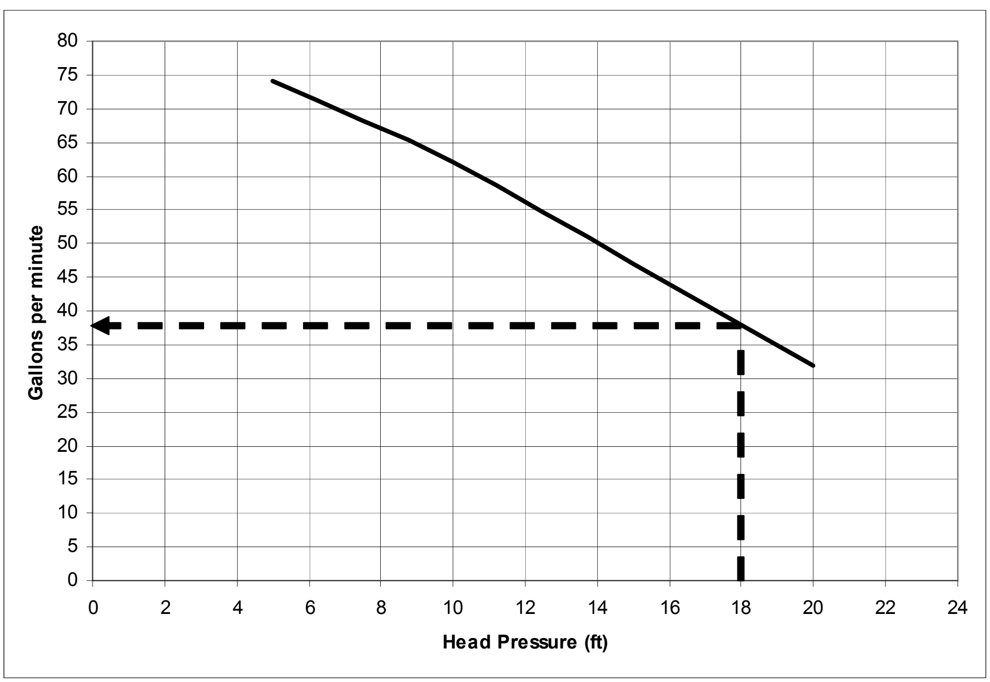

Figure 2. Water flow vs. Head Pressure for popular ½ hp submersible pump.

But what if we had a longer system? For instance, for a 65-foot system we need a pump capable of moving approximately 49 gals/min (0.75 X 65' of system = 49 gpm). If we used the same pump and filter it would still only move 38 gal/min. We could install a larger pump, which of course would increase both initial investment, as well as operating costs. But possibly a more cost effective solution would be to attack the part of the distribution system that is causing the majority of the work in the first place, namely the filter. Of course we can't remove it, but we can look at installing a different type or size of filter. For instance, from Table 2, it can be seen that the L-filter has a significantly lower pressure drop than the T-Filter (Figure 3). In fact, for a 65-foot system switching from an T-Filter to a L-Filter would decrease the pressure the circulation pump is working against by approximately five feet of head, dropping our total head pressure to 13 feet, and increasing our pump output to 52 gals/min. In actuality, it would probably not increase the water flow to 52 gals/min, because as we decrease the pressure the pump is working against it moves more water, which in turn increases the pressure drop across the filter by approximately two feet. The end result is that we will not get 52 gals/min, but rather closer to 48 gals/min, which should be just adequate.

Figure 3. L-Filter

The effect of switching from a T-filter to an L-Filter was tested on a broiler farm near Athens. The producer was having trouble getting his 65-foot, six-inch pad systems to wet properly on very hot days. The system had an 1 ½" distribution pipe with 1/8" holes 2 3/4" on center with the circulation pump located at the end of the system. When the top of the distribution system was taken off he was only getting 12 inches of water column height at the pump end of the system and only two inches at the far end of the system. To obtain the recommended 0.75 gals/min of water flow there should have been approximately 12 inches water column at the far end of the system.

The T-filter was replaced with an L-Filter and water column heights at the two ends of the system was rechecked. At the pump end of the system the water column height was increased to 22 inches and six inches at the far end. Though not ideal, the amount of streaking was dramatically reduced and cooling was increased by approximately two degrees (Figures 4 and 5).

To obtain more uniform water flow along the length of the pad, the pump should have been placed in the center of the system. The downside of placing the pump in the center of the system is that it is very difficult to use a L-filter. To minimize the filter pressure in systems with the pump in the center there are a number of options, the simplest of which would be to install a two-inch T-Filter. Though the two-inch T-filter would not drop the pressure to an ideal level it would definitely help by decreasing the head pressure by approximately two to three feet. A better solution, though slightly more expensive would be to install two, 1 1/2" T-filters (one for each end), in the system. Since water flow through each of the filters is cut in half, pressure would be substantially reduced. The other advantage of using either a 2-inch T-filter or two 1 ½" T-filters is that surface area of the filters is dramatically increased, increasing the time between cleanings.

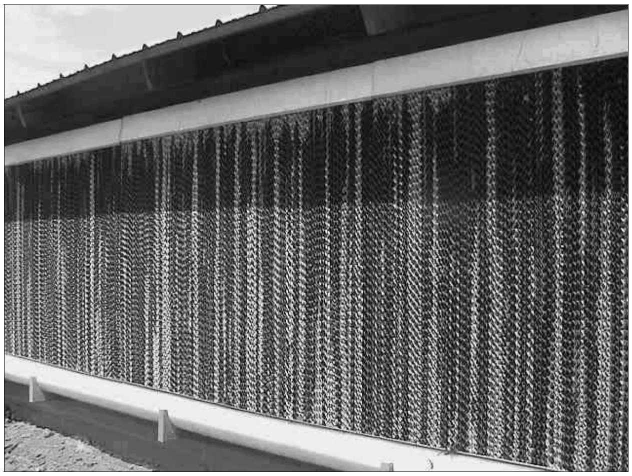

Figure 4. 65' System with T-filter

Figure 5. 65' System with L-filter

If you have an existing system that you do not feel is wetting the pads properly, consider the following:

1) Make sure the filters are clean
2) Check the mesh size of your filter. Mesh size is defined by the number of screen wires per inch. The larger the mesh size the finer the mesh. You may want to decrease your mesh screen size to a 20 or possibly a 12.
3) Make sure the pump impeller is clean and not worn.
4) If you have T-filter consider installing a L-filter.
5) Though removing the filter though may help in the short term it can cause major problems in the future as holes in the distribution pipe begin to clog. It is also important to note that most of the restriction caused by water filters is not due to the filter but rather the filter housing.
6) For longer systems it may be necessary to switch to a centrifugal pump. Most centrifugal pumps are far superior to submersible pumps when it comes to moving water under pressure. The downside to centrifugal pumps is that if they are not installed properly they may loose their prime, leading to dry pads and a burned out pump (Figure 6).
7) Make sure that distribution pipe is clean. Sludge and sand can build up in the distribution pipe over time increasing water pressure the pump is forced to work against.

Michael Czarick
Extension Engineer
(706) 542-9041 542-1886 (FAX)
mczarick@engr.uga.edu
www.poultryventilation.com

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Figure 6. Centrifugal Pump