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Poultry Housing Tips

Light Traps for Breeder Pullet Houses

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One of the most challenging types of poultry houses to ventilate is a black-out breeder pullet house. In order to obtain optimal breeder performance both light intensity and the number of light hours each day must be precisely controlled. The objective is to limit the birds to eight to ten hours of light each day until they are approximately 20 weeks old. At 20 weeks of age the number of "daylight" hours is increased to about 15 hours. This lighting scheme is used to insure that the breeders reach sexual maturity at the proper time and to help stimulate the onset of egg production.

The problem for pullet producers is that during a significant portion of the year there are more than eight to ten hours of daylight each day. Therefore, in order to control the number of lighted hours, the house must be made light tight. Black curtains can be installed or the side wall made solid. Small cracks and holes in the ceiling, side wall and end walls must be patched to prevent even the smallest amount of light from entering the house. Furthermore, light traps must be installed over all air inlet and exhaust openings to allow air to enter and leave the house without letting light in at the same time.

Light traps are boxes typically constructed of black plastic or metal vanes which direct air entering or exiting a house through a series of short turns. Light traps take advantage of the fact that air can turn corners while light rays travel in a straight line. Each turn reduces the amount of light that makes it through the light trap.

The effectiveness of a light trap in reducing light transmission depends on a variety of factors. These include vane spacing, light trap thickness, construction materials, as well as the number and severity of curves the air must travel through. It is next to impossible to determine how good a job a light trap will do just by looking at it. Two light traps can appear very similar, but slight differences in vane spacing or construction can make dramatic differences in their ability to reduce light transmission.

Along with reducing light transmission, light traps reduce exhaust fan performance. Drawing air through an opening in the side wall is relatively easy for a fan to do. But, if we put a light trap in that opening and force the air through a series of turns to exclude light, more fan energy is required. More turns require more fan energy and lower the amount of air moved by the fans. In fact, in many black-out pullet houses fan capacity is reduced 50% or more because of overly restrictive light traps. Again, like judging light transmission, determining how restrictive a light trap is when it comes to air flow is virtually impossible just by looking at it.

So, how should producers select a light trap for their fans and air inlets? Manufacturers have little or no data on the ability of their light traps to limit light transmission and/or how restrictive their light traps are to air flow. The data which is available must be viewed with some degree of scepticism considering they are produced by the manufacturer and not by an independent test facility. Because of the lack of reliable information on light trap performance, many pullet houses do not function as well as they should. Often the houses are brighter than desirable leading to breeder production problems. In other cases, the light traps restrict fan performance to such a degree that it is difficult to keep the pullets cool during hot weather and fan motors frequently fail.

To solve this dilemma the University of Georgia Biological and Agricultural Engineering Department recently conducted tests to determine the light transmission and air flow characteristics of most of the commercially available light traps. The objective of the study was to provide an accurate light transmission rating of each light trap along with recommendations of how many square feet of the light trap is required to insure adequate fan performance.

One of the problems with evaluating light traps is that there is no definitive answer as to how dark a pullet house should be. Some literature indicates that the maximum light intensity during the dark period of the day should be 0.05 foot candles. But, some breeder managers believe that a light intensity of 0.2 foot candles is acceptable (equivalent to 20 watt light bulbs in the typical broiler house) while others believe that it has to be much darker, 0.002 foot candles (you can not see your hand in front of your face). Since there is little agreement as to how dark a pullet house should be, it was decided to provide a light reduction ratio for each type of light trap. The ratio would allow breeder managers to know how much light could be expected in their houses relative to each light trap tested. For instance, direct sunlight on a summer day is approximately 10,000 foot candles, shade is about 5,000 foot candles. If a breeder manager felt that 0.05 foot candles of light was acceptable he would want to install a light trap that could reduce light intensity by a factor of 200,000.

Light Reduction Factor =Maximum Outside Light Intensity / Desired Inside Light Intensity
=10,000 foot candles / 0.05 foot candles
=200,000

The light reduction factor was determined by installing a 48" X 48" sample of nine different commercially available light traps in a wall of a light tight environmental chamber. High intensity flood lights were placed directly in front of each light trap. Nine light intensity measurements were taken at the outside surface of the light trap as well as inside the environmental chamber, 2" from the light trap. The light intensity 2" from the outside surface of the light trap (approximately 3,500 foot candles) was divided by the light intensity measured 2" from the inside surface of the light trap and the light reduction factor was determined. Once the light reduction factor was determined it was possible to calculate the light intensity inside a black-out pullet house when the outside light intensity was 10,000 foot candles (Table 1).

There were dramatic differences in the ability of the different light traps tested to restrict light. The least effective at restricting light transmission was a four inch evaporative cooling pad, allowing more than five foot candles of light on a bright summer day. The most effective was the plastic ACME light trap, allowing only 0.0005 foot candles of light, more than a 10,000 fold difference. It is important to note that a fairly large difference in the light reduction factor is required to produce a noticeable difference in light transmission. Therefore, light traps with less than a 10 fold difference in light reduction factor would likely produce very similar light intensities in the field and can probably be viewed as the same (i.e, Dandy, Gigola, metal ACME, four inch evaporative cooling pads.)

Light intensities listed in Table 1 would only exist very near the light trap. As you move farther from the light trap, the light intensity would decrease rapidly, just as the light from a single bulb at one end of a darkened house would have a diminishing effect as you move away from the bulb. With the darker light traps there would be little difference between the light intensity near the light traps and the rest of the house. But, with some of the brighter light traps there could be significant differences in light intensity throughout the house which would result in different levels of light stimulation for the birds which could produce performance problems.

It is important to note that the precise light reduction factor for any of the light traps tested would be significantly affected by light trap maintenance. If the surfaces of the light trap were to become covered with lightly colored dust, the light reduction factor would be decreased. Furthermore, the projected summer light intensity levels in Table 1 are a worst case scenario assuming direct sunlight is shining upon the light trap. Inside light intensity could be reduced through the addition of structure to shade the light traps from direct sunlight. The amount of reduction would be determined by the type and size of the shade structure, but it is doubtful that the addition of a shade structure would increase the amount of reduction by more than a factor of 10.

Type of Light Trap	Light Reduction Factor	Maximum Light Intensity Measured at Light Trap (foot candles)
4" Evaporative Cooling Pad (45º X 45º)	1,900	5.3
Dandy (Black-Air $_{T.M.}$)	2,300	4.4
Acme (Metal)	8,000	1.3
Munters (MI-T-Dark $_{T.M.}$)	2,100,000	0.005
Dayton	180,000	0.06
Acme (Plastic)	21,000,000	0.0005
W.W.F. Light Deflector	11,000	0.9
Gigola (Night Air - 97 $_{T.M.}$)	5,000	2.0
Dandy (Black Majic $_{T.M.}$)	3,100,000	0.003
General Shelters (Light Eliminator $_{T.M.}$)	4,700,000	0.002

Table 1. Light Trap Light Reduction Factors.

The second phase of the study was to determine how restrictive each light trap was to air flow. For this study the light traps were taken to the Hired Hand Manufacturing fan test facility in Bremen, Alabama. In the fan test chamber, it was possible to determine precisely the amount of static pressure generated as air passed through the light traps at different speeds. A higher static pressure at the same air velocity means that the light trap is more restrictive to air flow, and therefore fan performance would be sacrificed. For instance, some light traps were very easy to pull air through, only generating a static pressure of 0.05" when air passed through them at a velocity of 500 ft/min. Others were much more restrictive, generating a static pressure of over 0.20" at the same air velocity. This much of a difference in static pressure could mean a 20% or more decrease in fan efficiency. From these tests static pressure curves for each of the light traps tested were determined. These curves and test results from the various light traps installed on the same 36" fan were then used to come up with light trap area recommendations.

The first step in designing a black-out pullet house ventilation system is determining the number of fans required. We want to have enough fan capacity to be able to close the side wall curtains on a hot summer afternoon and know there will be enough air exchange and velocity to keep the birds relatively cool. To accomplish this goal a 40' X 400' pullet house should have approximately 96,000 cfm of exhaust fan capacity. A 40' X 500' house would need 120,000 cfm of exhaust fan capacity. Since the exhaust fans have to pull air through both inlet and exhaust light traps we know the fans are going to be working under very high static pressures. For this reason we calculate how many fans we need based on how much air they move at a static pressure of 0.15" rather than the standard 0.05"used for other poultry houses.

There can be differences in how fans perform under high static pressure that will impact how many fans are necessary to provide 96,000 cfm. The following example comparing two different fan models illustrates this point.

40' X 400' Pullet House (Required exhaust fan capacity = 96,000 cfm @ 0.15" static pressure)

Fan #1
0.00" = 18,500 cfm
0.05" = 16,900 cfm
0.10" = 15,000 cfm
0.15" = 12,900 cfm

Fans Required = 96,000 cfm / 12,900 cfm
= 7.45 fans (7 - 48" fans + 1- 36" fan)

Fan #2
0.00" = 20,400 cfm
0.05" = 19,400 cfm
0.10" = 18,200 cfm
0.15" = 16,900 cfm

Fans required = 96,000 cfm / 16900 cfm
= 5.7 fans (six 48" fans)

Both the fans used in this example are of slant wall construction and cost about the same. But as you can see there is a significant difference in the number of fans required. You can set yourself up for problems if you ignore fan test data and assume all 48" fans are the same and move 20,000 cfm. If the fans did move 20,000 cfm at 0.15" pressure, a 40' X 400' pullet house would require only five 48" fans. But, if the fans were of the #1 variety, you would end up moving about 40% less air that what is required. Would your birds die? Probably not, but they could be heat stressed possibly leading to uniformity and fertility problems.

To keep equipment cost to a minimum, it is better to use 48" fans rather than 36" fans. Though 48" fans move about twice the air as a comparable 36" fan, they do not cost twice as much. Add to this the reduced wiring and installation costs associated with installing half as many fans and installing 48" fans makes good economic sense.

With the number of fans determined it is now possible to calculate how much light trap is required. If you use the light trap areas described in Table 2, the total static pressure that the fans would be working against would be approximately 0.15", and as a result the fans would move the required amount of air. If you install less light trap than recommended, the static pressure would be higher and the fan performance would be reduced.

Light Trap	Light Reduction Factor	Exhaust Fan Light Trap Requirements (cfm per square foot)	Inlet Light Trap Requirements (cfm per square foot)
Dandy (Black-Air $_{T.M.}$)	2,300	850	575
Acme (Metal)	8,000	800	550
Munters (MI-T-Dark $_{T.M.}$)	2,100,000	750	500
Dayton	180,000	700	500
Acme (Plastic)	21,000,000	700	475
W.W.F. Light Deflector	11,000	600	425
Gigola (Night Air - 97 $_{T.M.}$)	5,000	550	375
Dandy (Black Majic $_{T.M.}$)	3,100,000	500	350
General Shelters (Light Eliminator $_{T.M.}$)	4,700,000	400	275

Table 2. Light Trap Requirements.

The light traps in Table 2 are listed in order of resistance. The light trap at the top of the table is the least resistive to air flow and the one at the bottom is the most resistive to air flow. Models that are more restrictive require that more square feet of light trap be installed in order for the static pressure (work required by the fans to pull air though the trap) to be the same as the least restrictive light traps.

Example:
40' X 400' Pullet house (Six 48" fans @ 16,900 cfm per fan)
Exhaust fan light traps (Black -Air$_{T.M.}$) = 16,900/850 cfm per square foot = 19.9 square feet of light trap per fan

Since the light trap is sold in 56" X 56" units (21.8 square feet) we would install one light trap per fan. The extra light trap area would lower the static pressure, thereby slightly increasing exhaust fan performance.

Exhaust fan light traps (Light Eliminator$_{T.M.}$) = 16,900/400 cfm per square foot= 42.2 square feet of light trap per fan

For illustration purposes, let's compare two of the light traps listed in the table. The Light Eliminator$_{T.M.}$ light trap is much darker, in fact more than 2,000 times darker than the Black-Air$_{T.M.}$ light trap, and as a result is more resistive to air flow. The static pressure can be decreased by pulling the air through the light trap more slowly, which requires having more light trap area per cfm of exhaust fan capacity. By using one square foot of light trap per 400 cfm, the force required by the fan to pull air through this light trap would be the same as pulling air through the Black-Air$_{T.M.}$ light trap at a rate of 800 cfm per square foot. Since, the Light Eliminator$_{T.M.}$ light trap is also sold in 56" X 56" units (21.8 square feet) approximately two light traps per fan would be required.

If we tried to cut corners and install only one 56" X 56" light trap, fan performance would be reduced dramatically. Instead of each fan moving the planned 16,900 cfm, the fan would move less than 11,000 cfm. The increased static pressure the fans would be working against would increase power usage by as much as 15%. The increased power demand would significantly increase possible problems of motors overloading.

Installing a 56" X 56" light trap on a fan is fairly simple, installing two 56" X 56" light traps on a fan is a little more involved. When multiple light traps per fan are required a false wall in which the light traps can be installed must be built four feet or more from the exhaust fans. This enables the exhaust fans to pull air from more than one light trap.

There are a number of advantages to using a false wall for exhaust fan light traps. During the spring, winter and fall when not all the fans are being used there is more light trap available for those few fans which are operating to draw air from, lowers the static pressure and increases fan performance. The false wall also makes it much easier to clean and maintain light traps and fans as well as reduces light transmission through the light trap.

To keep the total static pressure within desired limits, the amount of inlet light trap must be increased over that used on the exhaust fans by approximately 150%. Though it is possible to increase the area of exhaust fan light trap and proportionally decrease the amount of inlet light trap, it is typically easier and less expensive to install more inlet light trap than fan light trap because inlet light trap can be installed simply and easily in the side wall of the house.

Example:
40' X 400' Pullet house (Six 48" fans @ 16,900 cfm per fan)

Inlet light traps (Black -Air$_{T.M.}$)	= 16,900 / 575 cfm per square foot
	= 29.4 square feet of light trap per fan
Total inlet light traps	= 29.4 square feet of light trap per fan X 6 fans
	= 176 square feet of ligh trap
	= 8, 56" X 56" light traps (approx.)
Inlet light traps (Light Eliminator$_{T.M.}$)	= 16,900 / 275 cfm per square foot
	= 61.5 square feet of light trap per fan
Total inlet light traps	= 61.5 square feet of light trap per fan X 6 fans
	= 17, 56" X 56" light traps (approx.)

The following table is a summary of the light trap requirements for a 40' X 400' black-out pullet house. The number of light traps listed in the table are determined by dividing the light trap area required by the area of the light traps typically sold by the manufacturer. If a fraction of a light trap was required, it was rounded up to the next whole number.

As can be seen in Table 3 the brightest light traps tended to be the least restrictive to air flow, and therefore less of this light trap would be required. Though the darker light traps are generally more restrictive to air flow, there is not always a direct relationship between darkness and restriction to air flow. Some of the darkest light traps (with light reduction factors of over one million) are only slightly more restrictive than the brightest light traps. Other dark light traps (light reduction factors of over one million) are so restrictive to air flow that approximately twice as much of this trap is needed to insure adequate exhaust fan performance.

Light Trap Type	Light Reduction Factor	Light Intensity at L.T.	Exhaust Light Traps (area-ft^2)	Exhaust Light Trap (number)	Inlet Light Trap Area (area- ft^2)	Inlet Light Trap (number)
Dandy (Black-Air $_{T.M.}$) 56" X 56"	2,300	4.4 f.c.	119	6	176	8
Acme (Metal) 60" X 60"	8,000	1.3	127	6	184	8
Munters (MI-T-Dark $_{T.M.}$) 60" X 60"	2,100,000	0.005	135	6	203	9
Dayton 56" X 56"	180,000	0.06	145	7	203	10
Acme (Plastic) 60" X 60"	21,000,000	0.0005	145	6	213	9
W.W.F. Light Deflector 48" X 48"	11,000	0.09	169	11	239	15
Gigola (Night Air - 97$_{T.M.}$) 56" X 56"	5,000	2.0	184	9	270	13
Dandy (Black Majic $_{T.M.}$) 56" X 56"	3,100,000	0.003	203	10	290	14
General Shelters (Light Eliminator $_{T.M.}$) 56" X 56"	4,700,000	0.002	254	12	369	17

Table 3. Light Trap Requirements for a 40' X 400' Pullet House

Though Table 3 can be useful in comparing light traps, other factors must be taken into account. Some light traps due to their construction may require more maintenance and therefore may be less desirable. Also, just because more light trap area would be required for some of the more restrictive light traps, does not mean these light traps are undesirable. They may in fact be less expensive to use due to the fact that the cost of an individual light trap may be significantly lower. Furthermore, some light traps come ready to install, while for others, a box has to be constructed to hold the light trap, increasing their cost.

One final note on light trap installation. Generally, it is less expensive to build a tunnel-ventilated black-out pullet house than a traditional cross ventilated pullet house. The inlet light traps can be grouped at one end of the house for use during warm weather and opened or closed through the use of a short curtain. Exhaust fans can be grouped at the opposite end of the house. Smaller adjustable side wall air inlets can be installed along the side walls for use during cold weather in conjunction with the 48" fans. More details of black-out pullet house construction and operation will be covered in future newsletters.

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