Poultry Industry Council
for Research and Education

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HEAT STRESS WITH BROILER CHICKENS

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Heat stress is the term used in the poultry industry to describe the bird's reaction to abnormally high temperature. Birds must rid themselves of a significant amount of feed energy as heat. If not enough heat is removed, decreased weight gains, or even death, can result.

There are five modes by which birds get rid of excess body heat:

(1) **Conduction.** Contact of a warm surface with a cooler one will allow heat transfer. Hot birds will try to cool down by touching water pipes or digging into the litter to contact a cool floor. In extreme cases, the breast muscle will develop a pale, cooked appearance after the bird sits for a prolonged period of time.

(2) **Convection.** Moving air over the birds is the most effective way to keep them cool. If air is not moving quickly enough, heat will build up around their bodies. In extreme heat situations, birds are often found dead along walls where air does not circulate efficiently. These birds usually die from heat prostration, and not from lack of oxygen.

(3) **Radiation.** Transfer of heat by electromagnetic means is also important in getting rid of body heat. Birds will raise their wings to allow heat to radiate from areas where feather cover is poor. Note that many leghorns survive well in cages because of poor feathering and a lack of floor litter which permits maximum radiation.

(4) **Excretion** is another means by which to lose heat. Birds will typically double their intake of water during periods of heat stress and thus excrete more hot urine and wetter feces. It is therefore especially important to ensure your barns have an appropriate drinker ratio, clean water filters, and well-adjusted pressure regulators to maximize water delivery during warm weather.

(5) **Evaporation** of water occurs from the surface of the skin and from the respiratory tract. In heat stress conditions, the bird will try to maximize heat loss by panting. Respiration rates may increase as much as tenfold, resulting in excess carbon dioxide (CO_2) loss. In extreme cases, this loss can change blood chemistry leading to death.

Recommendations to Minimize Heat Stress

Bird Density

Do not over crowd summer flocks. The more floor area each bird is given, the more heat energy will dissipate from underneath their bodies, and from the floor litter. Less crowded birds can also move to nearby water lines more freely.

Regardless of bird weight, the maximum recommended bird density is 2.5 kilograms live weight per square foot of barn floor. The following table shows the **minimum** floor area recommendations for typical bird weight categories.

Bird Weight	Recommended Minimum Density	
	Ft^2 / Bird	Kg / Ft^2
1.7 Kg	0.68	2.50
2.0 Kg	0.80	2.50
2.2 Kg	0.88	2.50
2.5 Kg	1.00	2.50
3.5 Kg	1.40	2.50

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Ventilation Air Exchange Rate

Be sure to exchange sufficient air during hot weather. For most broiler chicken facilities, this means a complete air exchange every minute. Air volume calculations should be based on ceiling height minus 1 foot, to account for bird height. Higher ceiling height does not help with summer heat stress since the heat is still kept within the room. ***Therefore, exchange all of the room air every 60 seconds regardless of ceiling height.***

Ventilation calculations can also be based on bird weight. As shown in the following table, minimum summer ventilation rate should range between 7 and 10 CFM per bird.

Bird Weight Category	Minimum Summer Ventilation
1.7 Kg	7.0 CFM / Bird
2.0 Kg	7.5 CFM / Bird
2.2 Kg	8.0 CFM / Bird
2.5 Kg	8.5 CFM / Bird
3.5 Kg	10.0 CFM / Bird

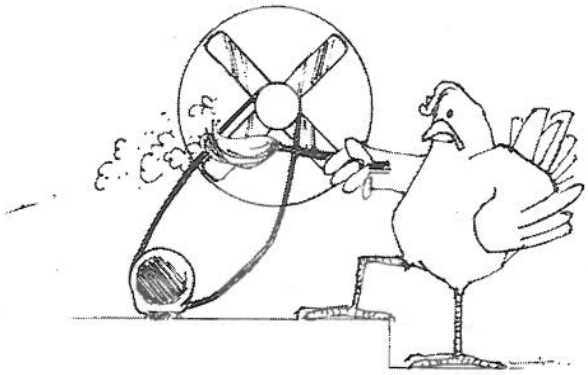
Given the recommended bird density and a standard 8-foot ceiling height, each of these per bird ventilation rates will also result in at least an air change every minute. Note that these rates should be increased proportionally with higher ceilings to ensure that all of the generated heat is removed continuously.

Although the actual exhaust capacity of a particular fan can vary depending on make and model, the following table can be used as a guideline for fans required to achieve a given air exchange rate. More specific values can be obtained from your fan's manufacturer.

Fan Diameter	Estimated Capacity*
18"	3,000 CFM
20"	4,000 CFM
24"	5,500 CFM
36"	10,000 CFM
48"	20,000 CFM
54"	25,000 CFM

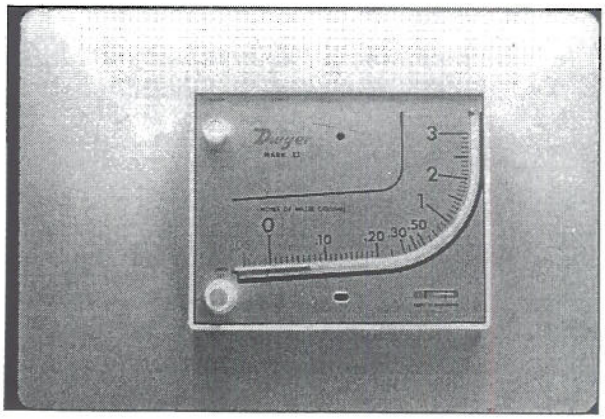
- *capacity estimated for static pressure of 0.05" water gauge*

Note: dirty exhaust fan shutters or a loose belt can reduce its output capacity by more than 30%. Therefore, it is extremely important to ensure that all exhaust fans (and even the air intake screening) are thoroughly cleaned between each group of birds. Also ensure belt driven fans are adjusted properly.



Ventilation Air Intake

For exhaust fans to be effective, they must have an adequate, unrestricted supply of fresh outside air. The minimum net air intake opening needs to be at least 1.5 ft^2 for every 1000 CFM of exhaust fan capacity. An opening as large as 2.0 ft^2 per 1000 CFM is preferred to ensure all of the studs, hood framing and screening have been accounted for. The inlet baffle opening can be adjusted to create the static pressure (room vacuum) required to create the best air flow pattern for that specific building. A static pressure gauge and a seasonal smoke test can be helpful for fine tuning the air inlet settings. In fact, all rooms should be equipped with a static pressure gauge to assist in obtaining the correct settings. Generally, a static pressure level between 0.04 and 0.06 inches of water is required for good summer air flow. Higher static pressure levels tend to prevent the airflow from circulating properly down at bird level and force most of the air to travel rapidly across the room near the ceiling with little benefit to the birds.



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Air Flow Pattern

Ensure that there is good air speed down at bird level. The correct static pressure is the first step in this ventilation check. A smoke test or air velocity meter will verify the presence or absence of good air speed at bird level. Research indicates that not only is the convective heat loss greater with faster moving air around the birds, it also makes them feel like it is cooler than actual thermometer readings. A normal cross flow ventilation system will yield an average air speed over the birds in the range of 100 feet per minute (2 km/h) and make them feel like it is 0.3°C cooler. Since the incoming air speed is fastest at the air inlet and slows down as it mixes and moves across the building towards the exhaust fans, wider buildings will have a greater variation in air speed near bird level. This may result in less cooling potential for birds on the exhaust fan side of the building. The posts and beams in a 2-storey building can disrupt an otherwise good air circulation pattern and also slow air movement over the birds.

Air Speed at Bird Level

If the air speed over the birds can be increased to 300 feet per minute (6 km/h), the birds will feel like it is approximately 2°C cooler than actual. This can be accomplished with circulation fans, providing they do not interfere with the rapid exchange of all room air. This can also be done by adding a deflector board along an existing inlet or adding another air inlet to specifically direct air down over the birds. Tunnel ventilation is another summertime option that can create a wall of air moving along the length of the building at 250 to 300 feet per minute (5 - 6 km/h).

Evaporative Cooling

Heat can be removed from either the air or the birds by adding water then using the heat energy generated inside the building to evaporate it [approximately 1000 BTUH of energy is required to evaporate every pound of water (0.45 litres)]. This new water vapour increases the barn humidity, therefore evaporative cooling is only effective if the outside humidity is relatively low (no more than 70%).

The two most common forms of evaporative cooling systems are low pressure water sprinkling / misting and high pressure misting. With low pressure sprinklers or misters, small water droplets are sprayed into the room air from each nozzle. A good percentage of this water does evaporate into the air mass with the remainder reaching the birds. Water evaporating into the barn air lowers the air temperature at the expense of a little higher relative humidity. When the birds feel the shower, they tend to perk up, stretch and may head towards a drinker for some more water. These are good responses for combating heat stress. The key strategy with low pressure sprinklers is to provide short showers (less than 1 minute) followed by 10 to 20 minutes off time to allow the water on the birds to evaporate into the air, and remove body heat in the process.

With high pressure misting, very fine nozzles are spaced along the air inlet to atomize the water and thus increase the rate of evaporation into the incoming fresh air stream. The goal with a high pressure system is to evaporate a larger amount of water into the room air and not wet the birds or the litter. This strategy will maximize the air temperature drop with a corresponding higher humidity increase. Similar to low pressure systems, high pressure misting should be operated on an intermittent basis to prevent localized saturation and ensure an over-all reasonable level of humidity is maintained.

Depending on the type of system installed and the number of nozzles employed, it is possible to drop the air temperature 1°C to 3°C with a humidity increase of 5 to 15%. Regardless of the system, it is extremely important that room humidity does not rise over 80%, or the birds will have great difficulty expelling respired moisture into the barn air.

Other Building Considerations

- Ensure the attic space is well ventilated such that it is not a heat sink sitting on top of the building.
- Paint the roof white to minimize absorption of the sun's energy.
- Keep the grass mowed all around the building to prevent heat retention and ensure the best air movement possible.
- Consider long term shading of the air inlet if possible.

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Other Management Considerations

- Acclimatize the birds to possible heat stress between 3 and 4 weeks of age. This is done by simply allowing the barn temperature to increase for a number of hours to give the birds a bit of heat stress and help them adapt to this type of stress when they are heavier.
- Increase the light level in the pen prior to operating large diameter fans or tunnel ventilation doors. This will reduce the fear response and subsequent piling.
- Dim or turn off the lights during the hot hours of the day.
- Withhold feed from early morning until early evening during periods of heat stress.
- During hot weather, slowly walk the birds to promote air movement between them and release heat trapped underneath. This also encourages movement towards the drinkers.

Summary

Periods of heat stress can occur at any time during the summer months. If the birds happen to be close to market weight, they will be affected. The two biggest problems are reduced weight gain and increased mortality. However, heat stress can be minimized with a well ventilated facility and good barn management practices.

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HEAT STRESS SURVEY

During the summer of 2003, a comprehensive heat stress survey was conducted in Ontario. Sixty three broiler farms, representing 260 pens, were included. The producers completed questionnaires and were interviewed, and their barn ventilation systems were evaluated. The extent of heat stress losses during the previous two years, and the possible contributing risk factors were assessed in this study. Approximately eleven percent of the buildings experienced some degree of heat stress losses.

The main contributing factors included;

- High bird density
- Inadequate ventilation or deficiencies in the ventilation system
- Poorly insulated or under-ventilated attic space

If interested in a copy of the complete survey results, please contact Dr. Sanei.

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