Controlled aeration

Controlled aeration is an improved technique for cooling stored grain and preventing deterioration from molds and insects

by Mark E. Casada and Frank H. Arthur

Controlled aeration is an essential part of an effective storage management plan. By automating the fans with a simple reliable control system, fan operation is much easier for the grain storage manager and the aeration process will be more efficient and effective than can be achieved by manual operation.

However, to complete the plan for maintaining grain quality, our old friend SAM is also needed. SAM is an acronym for Sanitation, Aeration, and Monitoring, which highlights the important issues for maintaining stored grain quality.

SAM, FRIEND OF THE STORED GRAIN MANAGER

Sanitation is always important during grain storage, beginning with providing a clean, insect-free facility to receive the grain. Sanitation in storage bins before loading and around the bins at all times is crucial to avoid insect infestation problems. Old grain piles provide a ready source of infestation for stored grain. Several insect generations can develop in old grain when environmental conditions favor insect population growth and development. All trash should be removed from the bin and immediate surroundings before insecticide treatments are applied as pre-binning sprays. After thorough cleaning, the bin surfaces should be sprayed with an approved residual insecticide compatible with the commodity that will be stored in the bin. Some pre-binning sprays are general, while others are for specific grains. Label directions and requirements must be followed when applying insecticides. Avoid adding new insect-free grain to old grain since doing so will probably cancel out the benefits of good sanitation.

Aeration is moving small amounts of air through the grain to reduce the grain temperature. Typical aeration fans do not supply enough airflow to provide useful drying. Recommended specific airflow rates are typically around 0.1 cfm/bu, sometimes higher in special cases including controlled summer aeration, sometimes lower for deep bins. Low flow rates reduce the fan power required to cool the grain while still providing acceptable cooling rates. Low initial fan costs and reduced operating costs make aeration an economical treatment method. An engineer can be consulted to determine fan requirements for specific airflow rates. Controlled aeration is a modification that maximizes the efficiency and effectiveness by using the automatic controller to run the fan only when air temperature is appropriate for cooling.

Monitoring stored grain properly will help ensure that the quality is maintained. We might take for granted that more elaborate monitoring methods are better. However, in practice, any effective monitoring system that is actually used is better than another more complicated one that is not used because it is too cumbersome or too time consuming. Temperatures in stored grain should be monitored at multiple points appropriate for the size of bin. On smaller metal

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bins without permanently installed temperature cables, temperature sensors can be placed in several locations near the top of the grain. For large bins and concrete bins permanently installed systems are best. Insect monitoring using pitfall traps can provide additional early indication of insect problems.

Temperature cables are often spaced so each cable monitors grain in a 10-ft radius. This requires multiple cables for many bins (Figure 1) and is effective for monitoring seasonal temperature changes and the movement of aeration fronts through the grain. When one of these cables is in the core of fines under the fill spout, it can monitor hotspots within the center of that core. However, temperature cables do not provide early detection of hotspots in a full 10-ft radius. Other detection methodologies are under development in research projects, but the only other early detection methods available at present are intensive insect monitoring programs or using more temperature sensors for more thorough bin coverage. Additionally, a well-trained nose is very helpful.

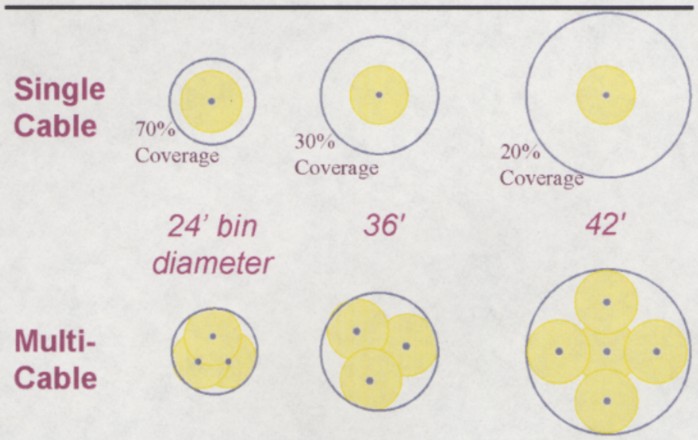

Figure 1. Multiple cables are needed to monitor grain temperature (10-ft radius illustrated).

MECHANICS OF CONTROLLED AERATION

Cooling grain provides additional assurance against mold problems when storing dry grain. It is important to cool grain before winter to prevent moisture migration and wet spots. Additionally, cooling grain is usually the first line of defense against insect infestations. Table 1 shows typical responses of stored grain insects to temperature. These insect responses produce important temperature requirements that guide the planning process for controlled aeration. It is important to note that aeration does not kill insects, it modifies the storage environment so that conditions are less conducive to population increase.

Table 1. **Temperature and typical stored grain insects**

80 → 90°F (30°C)	Optimum for population growth
below 75°F (24°C)	Helpful to slow population growth
below 60°F (16°C)	Generally stops population growth
below 50°F (10°C)	Leads to eventual death of storage insects
below 40°F (4°C)	Winter storage (stops moisture migration)
below 0°F (–18°C)	Required for quick kill of storage insects

Controlled aeration takes advantage of short periods of favorable weather even if they occur at night while you sleep (which they often do). A simple temperature controller like that in Figure 2 will turn on fans whenever the temperature is below the threshold for the current cooling cycle. A second thermostat can be added to also provide a lower limit to aeration temperatures. More elaborate (and expensive) controllers are available commercially. With a controller, fans operate only with the most favorable air temperatures producing more efficient cooling. This also helps reduce weight loss from drying that is common with conventional aeration.

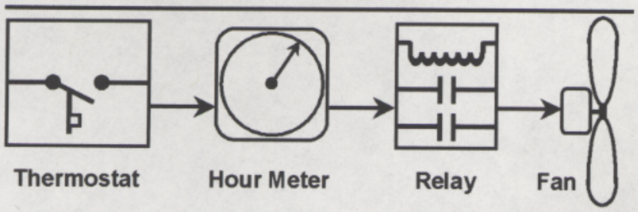

Figure 2. Control fans with a thermostat/relay and use an hour meter to log fan run time.

The thermostat is set to the first target temperature immediately after loading the bin. That first target would typically be 60°F, cooler if the weather allows. For summer harvest in warmer climates, the first target is 70 to 75°F to slow the insect population growth until cooler weather arrives. Higher airflow rates (0.2 cfm/bu minimum) are usually needed during summer aeration to take full advantage of short periods of cool temperatures. After the 60°F cycle is completed, reset the thermostat to about 40°F—the final winter temperature in many cases (a little higher in very warm climates). In cold climates one more cycle may be needed to bring the grain down to 30°F or slightly lower, although a controller can often achieve the lower temperature in only one winter cycle. The hour meter keeps track of fan run time and the temperature monitoring system clearly shows when each cooling front has passed through the grain. After the last cycle is completed the fan opening should be sealed to prevent insect entry and reduce unwanted air currents through the bin.

With controlled aeration, the interaction between air temperature and humidity may have greater effect than with conventional aeration. Evaporative heating caused by moist air rewetting grain can become a problem during summer aeration if the fan runs mostly at night when humidity is high. A humidity controller that locks out the highest humidities (above 90% relative humidity) would be ideal. Unfortunately, reliable inexpensive humidity controllers don't exist. This is only an important issue with night fan operation during summer aeration. For those infrequent cases, the operator can shut off the fans anytime substantial rain or fog is expected to produce humidities near 100% for the entire night—just be sure the system is turned back on for the next night. Also, when marginal temperatures exist during summer with pressure aeration systems, it is important to measure the temperature rise of the air going through the fan and set the controller so that air entering the grain is below 75°F.

The simple controller shown in Figure 2 is an inexpensive way to automate fans. The benefits of controlled aeration should accrue quickly. When used as described above these controllers can be expected to pay for themselves in the first year of operation.

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