How to Reduce Energy Cost for Grain Drying

Tom Dorn
UNL Extension Educator

With energy prices up dramatically in recent years, grain producers are asking how to reduce the cost of drying grain on the farm. We will discuss some methods to reduce energy cost for grain drying and suggest some management techniques that result in maintaining grain quality.

It goes without saying, the least cost method of drying corn is to let the grain dry naturally in the field for as long as possible. Given good drying conditions (low humidity, wind and warm temperatures), corn can lose one-third to one-half point of moisture per day. At this drying rate, the corn would dry naturally in the field from 18–15 percent moisture in about the same amount of time as if the corn were harvested and dried in the bin using natural (unheated) air with an airflow of one cubic foot per minute per bushel (1 cfm/bu) airflow. Producers with grain drying facilities usually hedge their bets and protect against the possibility of adverse weather later in the fall and start harvest early and mechanically dry part or all of their grain.

Grain Drying 101

All mechanical grain drying systems use a fan to push air through the grain mass. The time required to dry grain is a function of the initial and final moisture content of the grain, the rate of airflow through the grain (cubic feet per minute per bushel, cfm/bu) and the air properties, temperature and initial humidity level.

In deep-bed drying systems (in-bin drying), air is normally pushed through the grain from the bottom of the bin and is exhausted out the top of the bin. As the air moves through the grain, moisture evaporates from the grain into the passing airstream. Eventually, the moisture content of the grain on the bottom of the bin (the first grain the air passes through) comes into equilibrium with the incoming air and no further drying takes place. The zone where moisture is evaporating into the air is called the drying zone. The bottom of the drying zone is the depth where the last bit of moisture is being evaporated from the grain into the airstream under the current air property conditions. The top of the drying zone is the point at which air passing through the grain has picked up all the moisture it can hold and no more drying can take place. The moisture content of the grain above (downstream from) the drying zone remains unchanged or may be slightly wetted by the saturated air passing by. The drying zone moves through the grain in the direction of airflow.

Natural Air Drying

Natural air drying uses unheated air to dry grain. It can take several days to several weeks to dry a bin of corn using natural air. Nevertheless, natural air drying can be the least expensive drying method and usually results in the highest quality grain of any mechanical drying method. The minimum recommended airflow rate in Nebraska for in-bin natural air drying of corn is 1.0 cfm/bu for corn up to 18 percent moisture, 1.25 cfm/bu for corn up to 20 percent moisture and 1.5 cfm/bu up to 22 percent moisture.

If the airflow rate is too small to meet the recommendation above when the bin is full, the bin should be partially filled when drying grain. The shallower grain depth results in less static pressure for the fan to overcome, which translates into more airflow output (cfm) from the fan. Since partially filling the bin results in fewer bushels in the bin, you are pushing more cfm through fewer bushels, thus significantly increasing cfm/bu. For information on reducing grain depth to speed drying, see the Sept. 8, 2006 Crop Watch article *Reduce Grain Depth to Save Time/Energy When Drying Grain,* http://cropwatch.unl.edu/archives/2006/Crop21/bin_size.htm

Stirring System Management When Drying with Natural Air

Research has found stirring grain being dried with natural air actually prolongs the time required to dry the grain because it disrupts the drying zone, resulting in exhaust air leaving the grain mass less saturated. Considering the long drying times associated with natural air drying, continuous stirring can also cause significant damage to the grain and results in costly wear to the stirring device.

If a stirring device is installed in a bin being dried by natural (unheated) air, the stirring device should be run during the filling period to reduce the pack factor from the filling operation, to redistribute fines and to level the grain. Stirring should then be discontinued to allow a drying zone to develop in the grain. Since the bottom of the bin will be somewhat over-dried by the time the drying zone approaches the top of the bin, a final stirring just before the drying zone is pushed completely through the bin will help to equalize the moisture content of the grain in the bin.

Heated Air Drying

Weather reports use the term relative humidity when describing the degree of moisture saturation in the air given the current temperature. For example, if air is 37% relative humidity, it is holding 37% as much water vapor as it could hold at that temperature. The hotter the air temperature, the more total water vapor the air can hold. When ambient air is heated, its relative humidity is reduced so it is able to pick up more moisture from the grain per unit volume air passing through the bin.

When adding supplemental heat, the relationship between temperature rise and relative humidity is not linear. **Table 1** presents the effect on the relative humidity when adding supplemental heat. All values shown in the table assume the dew point temperature (a measure of the absolute water vapor content of the air) is a constant 41.4 degrees F.

A rough rule of thumb is the relative humidity drops by one-half for each 20 degrees F rise in temperature. For example, natural air at 60 degrees F and 50% relative humidity will have a relative humidity of 25% if heated to 80 degrees F. Adding another 20 degrees F to raise the temperature from 80 degrees F to 100 degrees F cuts the relative humidity by about half again and results in a drop to 13.5%. The third 20 degrees F rise to 120 degrees F lowers the relative humidity by about half again to 7.6%. The notable point is the second 20 degrees F increment of added heat results in half as much reduction in relative humidity (half of half) and the third increment results in only one-eighth as much reduction (half of half of half). To minimize energy cost for drying grain, keep the temperature rise to a moderate level. The biggest savings in drying time versus energy input for in-bin drying systems is achieved with the first 20-40 degrees F rise in air temperature.

Table 1. Effect on relative humidity of raising the temperature of air.

Air Temperature	Relative Humidity
50	72
60	50
70	35
80	25
90	18
100	13.5
110	10
120	7.6
130	6
140	4

Assumptions: Elevation 1,000 feet. Dew point 41.4 degrees F.

High Speed — High Capacity Dryers

High speed batch or continuous flow dryers have the highest bushel capacity per hour of any of the systems mentioned in this article. Temperature, grain bed depth and airflow rates are vastly different in high speed, high-capacity dryers compared to deep-bed, in-bin drying systems. Air temperatures of 120-140 degrees F are typical in high-capacity dryers. Column widths of grain being dried are measured in inches (10–20 inches) in batch or continuous flow dryers as opposed to feet (4–20 feet) for in-bin drying systems. Airflow rates of 50–100 cfm/bu are common in high speed dryers as opposed to 1.25-2.5 cfm/bu for deep-bed, in-bin systems.

There are two limiting factors that affect the efficiency of high-capacity systems. The first limiting factor is the rate moisture can migrate from the interior of the kernels to the surface where it can evaporate into the air stream. The second limiting factor is the short contact time the air stream has with the grain. High volumes of very hot and dry air moving through shallow beds of grain result in the air leaving the grain mass much less saturated compared to deep-bed, in-bin drying systems. This is reflected in higher energy cost per point of moisture removed per bushel as compared to in-bin systems. Some high-capacity dryers recover some energy by channeling the air used to cool the grain back into the drying chamber air stream or by re-circulating a high percentage of the previously heated air back through the grain mass.

High temperatures and uneven moisture content within the kernel result in a much higher incidence of stress cracks as compared to in-bin drying. Stress cracks created in the dryer result in a much higher percentage of broken kernels upon subsequent grain handling.

Dryeration

A variation using high-capacity dryers is known as dryeration. Dryeration is the name given to a system where hot grain is removed from the high-speed dryer a point or two above desired storage moisture then transferred to a bin where it is allowed to temper for four to six hours before starting the fan for final cooling. The final one or two points of moisture are easily removed in the process of cooling the grain because the moisture deep inside the kernels has had time to redistribute during the tempering period. This method of grain drying increases the throughput capacity of the dryer and results in higher quality grain with fewer stress cracks than drying followed by rapid cooling.

Combination Drying

Another intermediate system using both the high-temperature dryer and in-bin aeration is called combination drying. With combination drying, you "take the edge off" high moisture corn by drying the grain to 20–22 percent moisture with the high-temp, high-speed dryer and then move the grain hot to a bin where the aeration fan can push at least two cfm/bu of unheated air through the grain mass to complete the process. This cuts the reliance on heat and decreases the load on the high-speed dryer even more than dryeration. It also cuts the energy cost if the heating fuel is the higher cost energy source.

If you have been completely drying and initially cooling your corn in the high-speed dryer but have bins equipped with mesh floors and high-capacity aeration fans, either dryeration or combination drying can result in faster throughput, higher-quality grain and lower energy costs.

UNL Researcher Seeks Alfalfa Fields to Study Pocket Gophers

Photo by Dallas Virchow

Stephen Vantassel, UNL wildlife project coordinator, is finishing up a research project to determine the most efficient trapping method for controlling pocket gophers. He is looking for area farmers willing to give him permission to trap pocket gophers on their non-irrigated alfalfa fields.

To be included in the study, fields must have pocket gophers present and have had no pocket gopher control measures (of any kind) for at least one year. The study site must be accessible by a vehicle. Stephen is looking for fields (ten acres minimum) within a 1-1/2 hour drive of Lincoln. If you would be willing to help Stephen with this study, please contact him at 472-8961.