Farm Views

How to Reduce Energy Cost for Grain Drying

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Producers with grain drying facilities usually hedge their bets and start harvest early and mechanically dry part or all of their grain.

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 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% to 15% moisture in about the same amount of time as if the corn were harvested and dried in the bin using natural (unheated) air using about one cubic foot per minute per bushel (cfm/bu) airflow.

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 it is exhausted out the top of the bin. As the air moves through the grain, moisture evaporates from the grain into the passing air. Eventually, the moisture content of the grain nearest the fan comes into equilibrium with the incoming air and no further drying takes place. The drying zone is where moisture is continuing to evaporate into the air. The top of the drying zone is the point at which the relative humidity of the air comes into equilibrium with the wet grain and no more drying can take place. The moisture content of the grain above the drying zone remains unchanged or may be slightly wetted by the saturated air. The drying zone moves through the grain in the direction of airflow as the air continues to remove moisture.

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. Never-the-less, under favorable drying conditions, 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% moisture, 1.25 cfm/bu for corn up to 20% moisture, and 1.5 cfm/bu up to 22% moisture. If the airflow rate is too small to meet the recommendation above, the bin could be partially filled. 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" online at http://cropwatch.unl.edu/archives/2006/Crop21/bin_size.htm

> 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 degrees F to 40 degrees F rise in air temperature.

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 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

Heating the air increases its ability to carry away more water vapor, (heating lowers the relative humidity of the air). 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 degrees F to 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 degrees F to 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 to 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

see GRAIN DRYING on page 11

Use Season-Long Records to Assess Pumping Plant Performance

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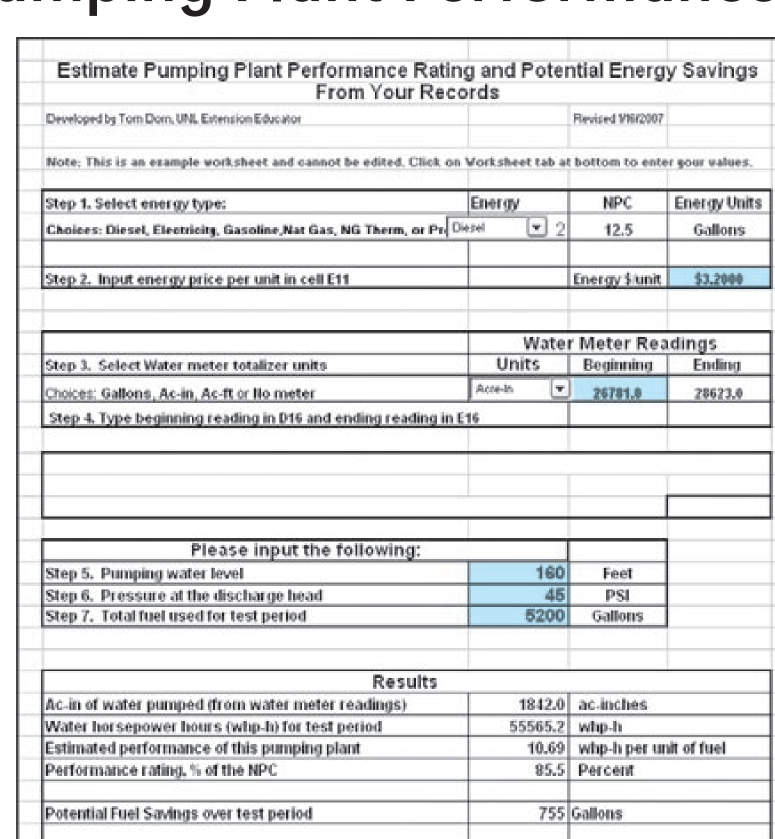
Irrigation season is over for 2008. Now is a good time to analyze the performance of your pumping plant before you lose your receipts for energy purchased and records of water pumped. Poor pump performance can be caused by poor pump design for the current pumping conditions, pumps with excessive wear or are not properly adjusted and/or inefficient power units. If you determine your pumping plant is below par by running a season-long pumping plant analysis, you will have plenty of time to consider your options and schedule a well driller to make necessary repairs or replace worn or mismatched components before next irrigation season.

I have developed an Excel worksheet which is available on the Web at no cost. This worksheet can be found online at http://lancaster.unl.edu/ag/crops/irrigate.shtml under the heading "What Can Be Done About Irrigation Energy Bills" and named Long_Term_Pump.xls. The user can run the worksheet online in most Internet browsers or save it to their computer and open it with Microsoft Excel.

Information necessary to run an analysis includes: the type of energy used for pumping, the price per unit of energy (dollars per gallon, dollars per kWh), the type of water meter installed and the beginning and ending water meter readings. If there is no water meter, the user selects "no meter" and estimates the acres irrigated and the gross inches of water applied. The user then reports the estimated average pumping water level and the average system pressure over the season. Finally the user reports the total fuel (energy) consumption for the season.

The worksheet does all of the calculations necessary to analyze the performance rating of the pumping plant and reports the performance rating as a percentage of the Nebraska Pumping Plant Performance Criteria and estimates the potential savings if a sub-par pumping plant were brought up to the Criteria.

With high energy prices, it is vitally important for irrigators to identify those pumping plants with low efficiencies so you can take corrective action before the 2009 irrigation season. This handy performance calculator makes it easy to spot pumping plants that may require some attention so they can be repaired or redesigned to match the current pumping conditions. Locating and correcting inefficient pumping plants can literally save thousands of dollars per year in energy costs.


Estimate Pumping Plant Performance Rating and Potential Energy Savings From Your Records

Developed by Tom Dorn, UNL Extension Educator — Revised 1/16/2007

Note: This is an example worksheet and cannot be edited. Click on Worksheet tab at bottom to enter your values.

Step 1. Select energy type:	Energy	NPC	Energy Units
Choices: Diesel, Electricity, Gasoline, Nat Gas, NG Therm, or Pr	Diesel 2	12.5	Gallons
Step 2. Input energy price per unit in cell E11		Energy $/unit	$3.2000

	Water Meter Readings		
Step 3. Select Water meter totalizer units	Units	Beginning	Ending
Choices: Gallons, Ac-in, Ac-ft or No meter	Acre-In	26781.0	28623.0
Step 4. Type beginning reading in D16 and ending reading in E16			

Please input the following:		
Step 5. Pumping water level	160	Feet
Step 6. Pressure at the discharge head	45	PSI
Step 7. Total fuel used for test period	5200	Gallons

Results		
Ac-in of water pumped (from water meter readings)	1842.0	ac-inches
Water horsepower hours (whp-h) for test period	55565.2	whp-h
Estimated performance of this pumping plant	10.69	whp-h per unit of fuel
Performance rating, % of the NPC	85.5	Percent
Potential Fuel Savings over test period	755	Gallons
Potential Fuel Cost Savings over test period	$2,415	

You can use this Excel worksheet available free on the web to analyze the performance rating of your pumping plant.