



# Current Report

Division of Agricultural Sciences and Natural Resources • Oklahoma State University

## Storing Moist Wheat at Commercial Elevators in Oklahoma

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### Introduction

The 1999 wheat harvest was delayed often by rain. A potentially serious problem caused by the rain was that wheat placed in storage this summer was often two to four percentage points or higher in moisture than wheat stored during most harvests in the past. Wheat stored at moistures above 12.5 percent may be at risk. Moist grain introduces potential for increased mold, mustiness or odor, sprout damage, insects, and other marketing defects. The higher the moisture and grain temperature, the higher the risk. Excess grain moisture must be reduced as quickly as possible.

### Managing Grain in Bins and Silos with Aeration

For wheat that has been stored at 12.5 percent or higher this summer, several management steps should be taken. Manually operated aeration is the primary tool that should be used. Grain moisture and temperature should be closely monitored while operating aeration fans.

The primary use for aeration in Oklahoma is cooling grain for insect management. Thus, aeration immediately after harvest in Oklahoma has not been recommended during hot summer months because favorable cooling weather is unpredictable at those times. However, when grain is stored at moisture levels above 12.5 percent, summer aeration is advisable to help dry the grain.

As air warms, the relative humidity drops, so the slow, dry airflow during aeration absorbs moisture from the grain, gradually reducing grain moisture. While aeration is typically not used to dry grain, aeration should be used to provide continuous movement of dry air until the grain moisture is lowered to safe storage levels.

### Checking Wheat Temperature and Moisture

Check bins for temperature increases using in-bin or silo thermocouples at least twice each week. If wheat moisture is 15 percent or higher and average grain temperatures are above 85°F, moistures should be checked every two days. If temperatures on one or more thermocouples rise more than

10°F in four days, and continue to rise during aeration, the bin or silo may need to be unloaded to break up the hot spot. However, if the hot temperatures move in the bin or silo in the direction of airflow, continue to aerate and monitor the temperatures until the hot spot moves out of the storage.

If you don't have thermocouples, a portable probe or deep cup thermometer attachment from Seedburo or another grain industry supplier is a good investment.

### Coring Bins or Silos to Sample Grain

In most silos and bins, the normal grain discharge flow creates a center "core" that flows straight down to the unload conveyor hopper in steel bins or the unload spout in silos, creating an inverted cone in the surface grain that gradually increases in diameter. As the unload conveyor runs, the grain on the inverted cone side slopes gradually collapses or sloughs off and slides into the bottom of the cone, where it funnels down the center flow path to the conveyor or gravity spout (Figure 1).

To check your bin or silo moisture profile, core the bin by running the unload conveyor just long enough to pull a core sample from top to bottom, about 45 to 90 seconds. Take a grab sample every five seconds, and seal each grab sample in a zip-lock bag to test for moisture content. Check the moisture profile at all levels in bins or silos.

An estimate of "coring time" can be calculated by using the core diameter as the dimension of the unload conveyor hopper in steel bin floors or gravity spout openings in silos. If the bin or silo has a 12-inch square unload conveyor hopper or spout, the round grain core will be about 12 inches in diameter.

The equation for the volume of a cylinder can be used to calculate approximate core volumes.

$$V_c = 0.785 \times D_c \times D_c \times h$$

Equation 1

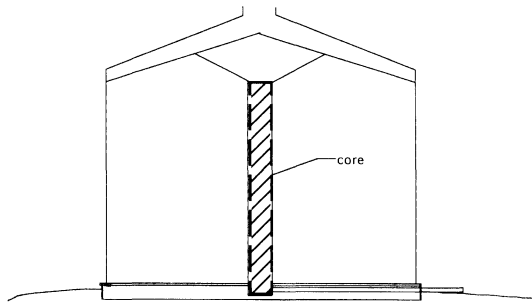
Where:

$V_c$  = volume of cylinder

0.785 = the coefficient for area of a circle

$D_c$  = diameter of the core, feet

$h$  = height of core sample, feet



**Figure 1. Grain discharge flow creates a center core in most bins and silos.**

**Example 1:**

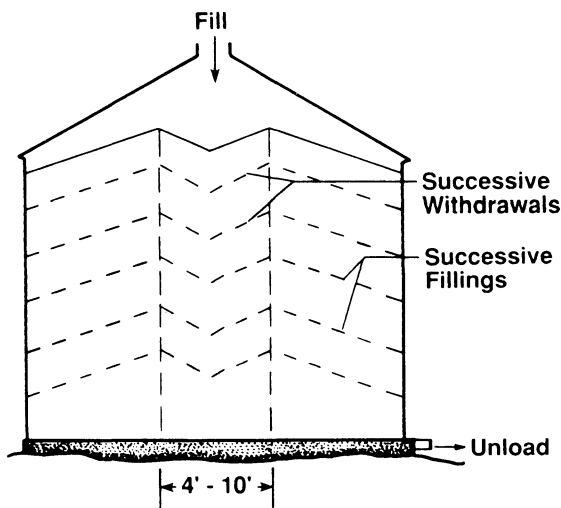
Assume a 78-ft. diameter steel bin with 50-ft sidewalls, a 64-ft grain peak, and a 15-in. x 15-in. unload auger hopper. Assume a 15-in. diameter grain core. Determine the volume per foot of the core.

Using Equation 1,  $V_c = 0.785 \times 1.25 \times 1.25 \times 1 = 1.23 \text{ ft}^3$ ;  $1.23 \text{ ft}^3 \times 0.8 \text{ bu/ft}^3 = 1.0 \text{ bu/ft}$ .

**Coring to Improve Aeration in Steel Bins and Silos**

Most elevator managers and producers fill steel bins to the peak. Peaked grain is hard to manage. Peaked grain is especially hazardous when grain is stored above safe moisture, over 12.5 percent moisture content for wheat. Part of the peak in all bins should be removed by coring the bin. It is important to core bins filled with moist grain, since few steel bins have powered grain spreaders that level the surface and spread the fines and trash.

Coring the bin is done by operating unload conveyors periodically while the bin is being filled to pull down the peak after several feet of new grain is added (Figure 2). Coring during initial filling, will remove a major part of the fines and



**Figure 2. Withdrawals during filling remove most fines from the core.**

foreign material (fm) to improve aeration management.

Coring after the bin is filled (Figure 1) will remove some fm and grain fines from the “spout line,” but not as much as coring while filling. However, lowering the peak and loosening the center of the grain mass will improve aeration airflow. When coring a steel bin after filling is complete, remove about half the peak height, as shown in Figure 1.

During the first coring operation after the bin is filled, to determine when surface grain reaches the conveyor, place several handfuls of confetti or paper scraps on top of the grain peak, then catch grain samples at five-second intervals until the confetti appears (about 45 to 90 seconds, depending on conveyor speed). Keep the samples in sequence to develop a profile of moisture by evenly spaced layers in the bin.

**Warning:** Moist wheat (and other moist grains) respire at a higher rate than dry grain. During respiration, oxygen ( $O_2$ ) is converted to carbon dioxide ( $CO_2$ ), which can create a safety problem for workers entering storage. Extreme caution should be used when entering bins containing moist grain. Bins with moist grain should be checked for low oxygen or high carbon dioxide levels. Before entry, operate the aeration fan system for 30 minutes to an hour to exchange the air in the grain and headspace with fresh air. If bin entry is made to add confetti markers or to probe grain for moisture samples, use the buddy system, with the inside man wearing a safety harness and rope in case of a cave-in or bridging.

**Example 2: Coring steel bins**

Assume the 78-ft diameter steel bin in Example 1 has an unload conveyor with a 6,000-bph (100-bu/min) unloading rate. Assume a 15-in. diameter grain core, 64 ft. high at 1 bu/ft in the core.

Calculate the velocity of grain flowing down the core to the conveyor.

Handling 100 bu/min, the core grain velocity =  $100 \text{ bu/min} / 1 \text{ bu/ft} = 100 \text{ ft/min}$ .

At 64-ft peak height the core flow time is:

$$\frac{64 \text{ ft}}{100 \text{ ft/min}} = 0.64 \text{ min}; 0.64 \text{ min.} \times 60 \text{ sec/min} = 38.4 \text{ seconds.}$$

During coring, when the full height core of 64 ft is removed, with a core volume of 1 bu/ft, about 60 to 70 bushels will be removed each time the bin is cored. This grain can be recycled back into the same bin.

In Example 2, the grain coring/sampling period starts as soon as the first grain is discharged (it takes 5 to 7 seconds for grain to reach the conveyor discharge) and continues for about 40 seconds. If samples are pulled at five-second intervals, you should have eight samples from top to bottom at about 9-ft intervals.

**Example 3: Coring concrete silos**

Base grain flow rates on tunnel belt and leg capacities. Assume a 20-ft diameter, 130-ft grain depth, and an unloading rate of 4,800 bu/hr (80 bu/min) through a 14-in. gravity spout.

Assume a 14-in. (1.17-ft) diameter grain core.  $\text{Volume/foot} = 0.785 \times 1.17 \times 1.17 = 1.08 \text{ cu ft/ft} \times 0.8 \text{ bu/cu ft} = 0.86 \text{ bu/ft}$ .

Handling 80 bu/min at 0.86 bu/ft, the wheat flow velocity is  $80 \text{ bu/min} / 0.86 \text{ bu/ft} = 93 \text{ ft/min}$ . For 130-ft grain depth, the

**Table 1. Approximate aeration fan hours for maintaining grain during the summer in Oklahoma.**

Grain Moisture (%)	Aeration Cooling Air Temperature Preferred (°F)	Aeration Flow Rates (cfm/bu)										
		1/40	1/30	1/20	1/15	1/10	1/8	1/6	1/5	1/4	1/3	1/2
Number of 24-hour days of continuous operation to reach 12.5% moisture content*												
13.0	75-85	16	12	8	6	4	3	2.5	2	1.5	1.25	0.75
13.5	75-85	32	24	16	12	8	6	5	4	3	2.5	1.5
14.0	75-85	48	36	24	18	12	9	7.2	6	4.5	3.6	2.5
14.5	75-85	**	48	32	24	16	12	9	8	6	4.5	3
15.0	75-85	**	**	40	30	20	15	12	10	7.5	6	3.7
15.5	75-85	**	**	**	36	24	18	15	12	9	7.5	4.5

\*\*\*Storing grain above 15.5% moisture content, wet basis, in summer is not recommended

\* Operate 24 hours/day until grain temperature and grain moisture are in safe ranges.

\*\* Not recommended

\*\*\* For grain above 15.5%, operate aeration fans continually until grain can be dried, blended, or moved.

core flow time is 130 ft/93 ft/min = 1.39 min or 60 sec/min x 1.39 min = 83.4 seconds. The core volume of 0.86 bu/ft x 130 ft = 111.8 or 112 bu can be recycled into the same silo.

### Operating Aeration Fans When Drying Moist Grain to Safe Levels

Because of excessive moisture of 1999 wheat in storage in many parts of Oklahoma, it is recommended that **wheat above 13.5 percent moisture be aerated continually**. Aeration fans should be operated non-stop (except during rain) until average grain moisture reaches 13.0 percent. Then operate fans during the coolest parts of the day to reduce the grain temperature. Total time should accumulate to the time periods based on grain moisture and airflow rates recommended in Table 1. During initial cooling, even though daytime temperatures may be hotter than the grain, nighttime cooling should offset hot daytime air temperatures. Moisture evaporation during aeration will keep the grain cooler. The continual flow of fresh air will keep the moist grain from heating spontaneously. Although the wheat may heat slightly above its original storage temperature for a while, as air temperatures drop in late August and September during the later stages of the aeration-drying period, the grain should gradually cool.

After grain moistures drop below 13.0 percent, automatic moisture controllers should be used, if available, to maximize grain cooling. For manually controlled aeration systems, continuous fan operation can be changed to nighttime fan operation as discussed in the next paragraph to take advantage of cool nighttime air temperatures.

**For wheat with moisture levels below 13.5 percent**, if daytime air temperatures are 95 to 100 °F, it may be preferable to operate the fans 12 to 15 hours per day when air temperatures are cooler – from early evening to mid-morning each day. Managers can turn aeration fans on at 6 to 8 p.m. and turn them off about 9 to 10 a.m. the next morning, avoiding the hottest air temperatures during afternoons. This daily on/off cycle of fan operation can be continued each day until the number of 24-hour days of fan time listed in Table 1 are

accumulated. Thus, for grain with moderate moistures above safe storage moisture levels, the grain mass temperature will tend to gradually cool as it dries.

#### Example 4:

How many hours will aeration fans need to run at 1/10 cfm/bu for 13.5 percent moisture wheat to accumulate eight days of fan operation, if fans are turned on at 8 p.m. and off at 10 a.m. each day? Then, how many “drying” days of part-time fan operation will be required?

From Table 1, recommended total daily fan time for 13.5 percent wheat using 1/10 cfm/bu is 8 days x 24 hours per day = 192 hours of operation.

Fan hours from 8 p.m. to 10 a.m. = 14 hours/day.

192 total hours = 13.7 days = about 14 “drying” days, or two weeks.  
14 hours/day

Run fans 14 hours/ day for two weeks.

Direction of airflow (suction or pressure) is not important. The primary objective is to keep fresh air moving through moist grain daily (except during rain).

Even though normal aeration (1/12 to 1/9 cfm/bu for steel bins; 1/30 to 1/15 cfm/bu for concrete silos) is not designed to dry grain, continuous movement of fresh dry air through moist wheat will slowly reduce its moisture to safer storage levels while minimizing spontaneous heating. During summer aeration, about 1/2 percent of moisture is removed from 12 percent grain during one cooling cycle. A “cooling cycle” is the amount of time required to cool the entire grain mass from one temperature to another, such as from an average grain temperature of 93°F to 78°F.

At 1/10 cfm/bu (typical aeration for steel bins), about 80 to 90 hours are required to pass one cooling cycle through a bin filled level with the eaves. If the bin is peaked, an additional 40 to 60 percent or more fan time is needed, or 120 to 140 hours. Coring to pull peaks down 1/3 to 1/2 their height should cut cooling back to 100 to 110 hours per cooling cycle.

For grain stored above 12.5 percent, more moisture will be removed during a specified aeration time such as four days

(96 hours) than from 12.0 percent or drier grain. For example, when aerating 14 percent wheat, about 0.7 percent moisture should be removed when aerated continuously at 1/10 cfm/bu for four days. During additional four-day aeration periods, the amount of moisture removal will gradually reduce for each period, such as 0.65 percent moisture loss during the second cycle; 0.6 percent during the third cycle, etc. Thus, if 14 percent wheat is aerated for 12 days (three four-day aeration cycles), about 1.95 percent moisture loss would be expected, and the final moisture should be about 12 percent.

Table 1 lists approximate aeration fan hours required to keep moist grain from heating while gradually reducing the grain to a safe moisture level. This table lists the number of complete 24-hour days of aeration recommended.

Thus, 14 percent wheat should be dried to 12.0 percent with 12 days of continuous or accumulated aeration time at 1/10 cfm/bu. The same moisture removal should occur in six days at 1/5 cfm/bu, or 18 days at 1/15 cfm/bu.

**Example 5:**

Wheat at 15.0 percent moisture is stored in a steel bin with aeration at 1/10 cfm/bu. Coring has lowered peak height by 1/4. From Table 1, recommended aeration time for 15.0 percent wheat at 1/10 cfm/bu is 20 days. Total fan hours at 24 hours per day x 20 days = 480 hours.

With the bin peak lowered 1/4 by coring, estimate about 120 hours per aeration cycle; 480 fan hours is the equivalent of 480/120 = 4.0 cooling cycles. If 0.75 percent moisture is

removed during the first cycle, and 0.05 percent less during each following cycle, the average grain moisture after 20 days continuous aeration (four aeration cycles) would be about  $15.0 - (0.75 - 0.70 - 0.65 - 0.6) = 15.0 - 2.7 = 12.3$  percent.

**Estimating Aeration Fan Airflow Rates**

Many managers do not have airflow capacity ratings for their aeration fans on silos and grain bins. Airflow capacity is needed to estimate how long to run fans to reduce grain moisture to safe storage levels while keeping the grain from spontaneous heating.

The following equation can be used for estimating fan airflow (USDA, M.R.R. #178, 1960):

Fan HP = CFM x static pressure (inches w.c.)/3,000 **Equation 2**

Where:

HP = horsepower

CFM = cubic feet per minute

w.c. = inches of water column

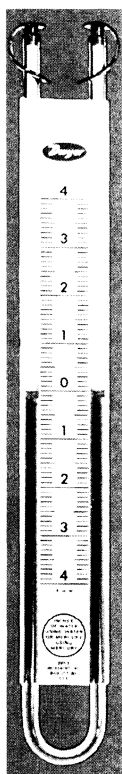
Equation 2 can be rearranged as:

CFM = Fan HP x 3,000/in. w.c. **Equation 3**

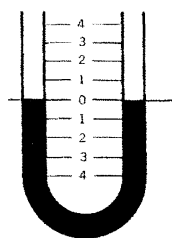
A manometer, Figure 3, is needed to check fan static pressure. Manometers can be made from a U-shaped length of clear plastic tubing (e.g., 1/4-inch ID) taped to a yardstick or ruler, filled with water to a selected level. One end of the tubing is pushed through a hole in the aeration fan duct; the other end of the tube is open to the outside air.

**Example 6:**

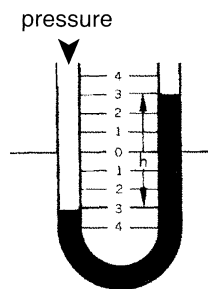
A 195,000-bu bin filled with wheat has two 25-HP centrifugal aeration blowers. Without fans running, the water level in both tubes of a homemade manometer is at 10 inches on the yardstick scale. With fans running, the water moves to 6.25 inches on one side and 13.75 inches on the other leg of the U-tube. The static pressure is the combined difference of the two water levels, 13.75 in. - 6.25 in. = 7.5 in. w.c.



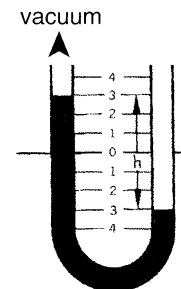
**Figure 3. Manometer.**



3-a. In its simplest form the manometer is a U-tube about half-filled with liquid (water or a special oil), thus the term “inches of water column (w.c.)” With both ends of the tube open, the liquid is at the same height in each leg.



3-b. When positive pressure is applied to one leg, the liquid is forced down in that leg and up in the other. The difference in height, “h,” which is the sum of the readings above and below zero, indicates the pressure, 6 in. w.c.



3-c. When a vacuum is applied to one leg, the liquid rises in that leg and falls in the other. The difference in height, “h,” which is the sum of the readings above and below zero, indicates the amount of vacuum, 6 in. w.c.

Using Equation 3:

$$\text{Total CFM} = 2 \times 25 \text{ HP} \times 3,000/7.5 \text{ in. w.c.} = 50 \times 3,000/7.5 = 20,000 \text{ cfm.}$$

The bin holds 195,000 bu, so 20,000 cfm/195,000 bu = 0.102, or about 1/10 cfm/bu for wheat.

#### Example 7:

The same bin holds 185,000 bu of corn. The static pressure on the fans is 4.0 in. w.c. Calculate the airflow rate.

$$\text{Total CFM} = 2 \times 25 \text{ HP} \times 3,000/4 \text{ in. w.c.} = 50 \times 3,000/4.0 = 37,500 \text{ cfm.}$$

The airflow rate would be 37,500/185,000 = 0.2028, or about 1/5 cfm/bu for corn.

If no airflow data are available and no estimates can be made, operate the fans daily (during the cooler part of the day) from August through October. Monitor grain until temperatures are at least below 70°F (preferably below 60°F), or until grain moisture reaches 12.5 percent.

Keep in mind that the information in this bulletin provides estimates and guidelines based on experience. Your storage system may actually have more or less airflow than calculated in these examples. Probe or core the grain to check moisture every three to four days – more frequently toward the end of the aeration period. If Table 1 lists 20 days of fan time and your average wheat moisture drops from 14.5 to 12.5 percent in 15 days, shut the fans off until cool weather, then cool the wheat to 60°F or lower.

## Managing Non-aerated Bins and Silos with Thermocouples

Many silos and some grain bins do not have aeration fans. For bins and silos filled with moist grain that have thermocouples, each bin or silo should be cored initially to determine the moisture profile of grain vertically in the center of the bin. Use coring sample procedures discussed earlier.

Once the centerline moisture profile is recorded, monitor the grain temperatures every 24 to 48 hours. If a hot spot begins to develop, such as a 5 to 10°F temperature rise in two or three days on one or more thermocouples, pull another core sample to check and confirm the hot spot, if near the center of the bin.

If the hot spot grain temperature is higher than 10 to 15°F above the average of the other thermocouples, the bin or silo should be “turned” or unloaded and transferred to an empty storage unit. The transfer operation will normally break up hot spots due to the funneling action. Inspect the empty bin to see if a “soldier” or molded mass of grain remains in a solid mass in the bin or silo.

## Managing Non-aerated Bins and Silos Without Thermocouples

For bins or silos without temperature cables or aeration, use the coring method for sampling temperature and moisture outlined above to develop the grain moisture profile for each silo or bin. If the grain moisture in any part of a bin or silo is higher than 13.0 percent, the grain should be monitored by pulling a full depth core at three- to four-day intervals. Check samples for hot grain, then bag the grain in plastic zip-lock bags for moisture tests.

If the silo or bin has one or more layers of very moist grain

(15 percent or higher), it may be advisable to turn the silo or bin immediately. Turning mixes layers of moist and drier grain due to sloughing and sliding of grain down the inverted cone to the core pulled down by the unload conveyor.

The grain in the receiving silo or bin will be a much better mix than the grain in layers in the original storage. After turning, pull another core profile in the new bin immediately and determine the moisture ranges in the mixed grain mass.

## Blending Moist and Dry Wheat

Moisture of mixed or blended wheat will gradually equalize by moisture conduction from wet to dry kernel contact, as well as by interstitial moisture humidity from the wetter wheat being absorbed by the drier wheat. However, equilibration of differential moistures is a lengthy process, requiring several weeks. Although kernels with three- to five percent difference or more will equalize to within 0.75 to 1.0 percent, complete equalization never occurs.

If dry grain is available, it may be desirable to blend moist grain with dry grain to develop a desirable final moisture content, especially in silo operations. The ratio of blend can be calculated using the following equation.

$$BG = \frac{X \times MG + Y \times DG}{X + Y} \quad \text{Equation 4}$$

Where:

MG = moist grain moisture content, %

DG = dry grain moisture content, %

BG = blended grain moisture content, %

X = number of units of moist grain

Y = number of units of dry grain

Equation 4 can be rewritten to solve for Y as follows:

$$Y = \frac{X(BG-MG)}{(DG-BG)} \quad \text{Equation 5}$$

#### Example 8:

If a silo of 14.2 percent wheat is blended with 11 percent wheat at a ratio of one unit of 14.2 percent wheat to three units of 11 percent wheat, what is the blended moisture content? If the ratio is two units of 14.2 percent wheat to three units of 11 percent wheat, what is the blended moisture?

Using Equation 4, determine the blended moisture, BG per 1 unit of 14.2 percent wheat;

$$BG = \frac{1.0 \times 14.2 + 3 \times 11.0}{1 + 3} = \frac{14.2 + 33}{4} = \frac{47.2}{4} = 11.8\%$$

Using Equation 4, determine the blended moisture, BG per two units of 14.2 percent wheat;

$$BG = \frac{2.0 \times 14.2 + 3 \times 11.0}{2 + 3} = \frac{28.4 + 33}{5} = \frac{61.4}{5} = 12.28\% \text{ or about } 12.3\%$$

#### Example 9:

If the desired blend is 12.0 percent, what ratio of 11.0 percent wheat should be used per unit of 14.25 percent

wheat? How many units of 10.2 percent wheat are needed per two units of 14.25 percent wheat to obtain a 12.0 percent wheat blend?

Using Equation 5, determine the number of units of 11 percent wheat to get 12.0 percent blended wheat:

$$Y = 1.0 \times \frac{(12 - 14.25)}{11 - 12} = \frac{-2.25}{-1.0} = 2.25$$

2.25 units of 11 percent wheat per unit of 14.25 percent wheat, or 2.25:1 ratio.

Use Equation 5 to determine the number of units of 10.2 percent wheat to get 12.0 percent blended wheat per two units of 14.25 percent wheat:

$$Y = 2.0 \times \frac{(12 - 14.25)}{10.2 - 12} = 2 \times \frac{-2.25}{-1.8} = \frac{-4.5}{-1.8} = 2.5$$

Y = 2.5 units of 10.2 percent wheat per two units of 14.25 percent wheat;

This is a 2.5:2 or 1.25:1 blending ratio of 10.25 percent to 14.25 percent wheat.

## Calculating Moisture Shrink and Cost of Aeration

The cost of summer aeration depends on the initial grain moisture, the airflow rate, the efficiency of the aeration motors, and the cost of electricity used during aeration. The approximate cost of summer aeration at airflow rates of 1/10 cfm/ bu are listed in Table 2. Moisture shrinkage is an important factor in determining the cost of aeration, as water evaporation reduces cooling time of moist grain during summer aeration.

As illustrated by the two sets of moisture conditions in Example 10, the difference in the percent grain moisture change and actual grain moisture weight shrinkage (percent

**Table 2. Grain moisture removed versus costs of aeration at 1/10 cfm/bu airflow rates.**

Grain moisture	Aeration fan time		Electricity Cents/bu.	Shrinkage Cents/bu.	Total Cost Cents/bu.
	days	hours			
12.5	0	0	0	0	0
13.0	4	96	0.15	1.7	1.85
13.5	8	192	0.30	3.4	3.7
14.0	12	288	0.45	5.1	5.55
14.5	16	384	0.60	6.8	7.4
15.0	20	480	0.75	8.5	9.25
15.5	24	576	0.90	10.2	11.1

grain weight per percent moisture content) becomes more pronounced at higher levels of final moisture content.

Percent grain moisture change is not the same as percent weight change when grain dries. The equation to calculate moisture shrink is:

$$1 - \frac{(100\% - \text{IMC})}{(100\% - \text{FMC})} \quad \text{Equation 6}$$

where:

IMC = initial grain moisture content, %

FMC = final grain moisture content, %

### Example 10:

Determine the moisture shrink ratio for 15.0 percent grain dried to 10.0 percent and compare to 20.0 percent grain dried to 15.0 percent, where the reduction is 5.0 percentage points of moisture for each situation.

Using Equation 6, when 15.0 percent moisture dries to 10.0 percent, the moisture change is 5.0 percent, but the weight change due to the moisture loss is:

$$1 - \frac{(100 - 15)}{(100 - 10)} = 1 - \frac{85}{90} = 1 - 0.9444 = 0.0556 = 5.56\%$$

Thus, the percent weight change per percentage point of moisture change for a % FMC = 10.0 percent, is 5.56%/5.0% = 1.112 percent, or about 1.11 percent weight change per 1.0 percent grain moisture change at 10.0 percent FMC.

For 20.0 percent IMC grain reduced to 15.0 percent FMC, a 5.0 percent reduction, the weight change is:

$$1 - \frac{(100 - 20)}{(100 - 15)} = 1 - \frac{80}{85} = 1 - 0.9412 = 0.0588 = 5.88\%$$

Thus, the percent weight change per percentage point of moisture change for a % FMC = 15.0 percent, is 5.88%/5.0% = 1.176 percent, or about 1.18 percent weight change per 1.0 percent grain moisture change at 15.0 percent FMC.

Terminal and export elevator discounts for damage often run one to two percent of damage over a threshold (five percent to seven percent). The percentage of damage includes both field damage and storage damage. Since many elevators may receive wheat with sprout damage in 1999, damage discounts may be triggered with the addition of relatively small amounts of storage damage.

Discounts for high moisture grain often run one cent per 0.1 percent above the terminal or export market threshold of 13 percent or 13.5 percent. High moisture wheat which goes out of condition and develops a sour or musty odor will be considered U.S. Sample Grade. Sample grade wheat must often be sold for livestock feed use at severe discounts. In general, the risks of moisture related discounts justify the costs of summer aeration when grain moisture exceeds 12.5 percent.

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