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Dryeration - A Corn Drying Process

PROGRESS REPORT

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A new process of drying shelled corn, called dryeration, has been developed by Agricultural Marketing Service and Purdue University research engineers. The process is a combination of drying and aeration. Dryeration promises improved market quality in artificially dried corn while at the same time increasing the drying capacity of continuous-flow and batch dryers.

The dryeration process was tested on a preliminary basis in the fall of 1962 and was further evaluated in a full testing program in 1963. Research is continuing, to substantiate current findings and to resolve problems encountered in the process.

Overheating shelled corn during drying or removing moisture too fast can increase breakage, impair milling properties, and increase the susceptibility of the dried corn to molds and insect damage during storage. Dried corn is often brittle and easily broken; small pieces of broken corn and fines frequently cause the corn to be downgraded. If corn has been too hot in the drying process, separation of starch, oil, gluten, and fiber in the wet milling process becomes difficult, if not impossible, with current milling methods.

U.S. DEPARTMENT OF AGRICULTURE•AGRICULTURAL MARKETING SERVICE
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Effective July 1, 1964, the responsibility for this research was transferred from the Agricultural Marketing Service to the Agricultural Research Service.

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Practices That Reduce Damage

Corn drying studies started in 1959 and extending over the last 5 crop years were directed toward developing methods of operating batch and continuous-flow dryers that would produce dried corn of acceptable market quality. The results of these studies suggest three practices that will help prevent the damage attributed to drying.

1. Stop rapid drying when corn reaches moisture level of 16 to 18 percent. This practice helps in two ways. First, moving the corn out of the dryer at moisture content of 16 to 18 percent helps prevent excessive grain temperatures that lower milling quality. As corn approaches moisture levels normal for storage, the rate of moisture evaporation decreases and the corn temperature increases. Second, interrupting the drying process when the kernel moisture content is 16 to 18 percent limits the formation of stress cracks in the corn, thus reducing its tendency to break when handled. (Stress cracks are fissures in the endosperm of the kernel caused by rapid drying or rapid cooling; stress cracks contribute to breakage of corn during handling[1/].)

2. Allow the hot corn to temper and steam itself before cooling. If cooling is delayed until after a tempering period, the number of stress cracks is reduced and the dried corn is less brittle. In tests completed, either passing steam through the freshly dried corn or placing the hot corn in a container and allowing it to form its own "steam" was effective in reducing stress cracks.

3. Cool the corn slowly. Rapid cooling, especially if done immediately after rapid drying, also adds to the stress in the corn kernels and increases stress crack formation. Slow cooling with low airflow rates reduces stress in the kernels in addition to assuring maximum moisture reduction during cooling.

The Dryeration Process

The three practices found to reduce damage from drying were combined into the process called dryeration. The process works this way (fig. 1): The corn is dried in a batch or continuous-flow dryer to a moisture level of 16 to 18 percent at fairly high air temperatures (200° F. and above). It is transferred immediately without cooling to a temporary storage bin equipped for aeration. The corn is allowed to set for a few hours and "steam" or temper itself before aeration is started. Cooling is accomplished in about 12 hours with airflow rates of around 1/2 cubic foot per minute per bushel. At these low airflow rates nearly all the heat in the corn is utilized to further dry the grain, and it is possible to reduce the moisture content 2 to 3 percent during the 12 hours of cooling.

The dryeration bin used in the tests was a hopper-bottomed bulk-feed tank with a false floor arrangement to hold the corn above the hopper (fig. 1).

1/ Thompson, Ralph A., and Foster, George H. Stress Cracks and Breakage in Artificially Dried Grain. U. S. Dept. Agr., Mktg. Res. Rpt. No. 631 Oct. 1963.

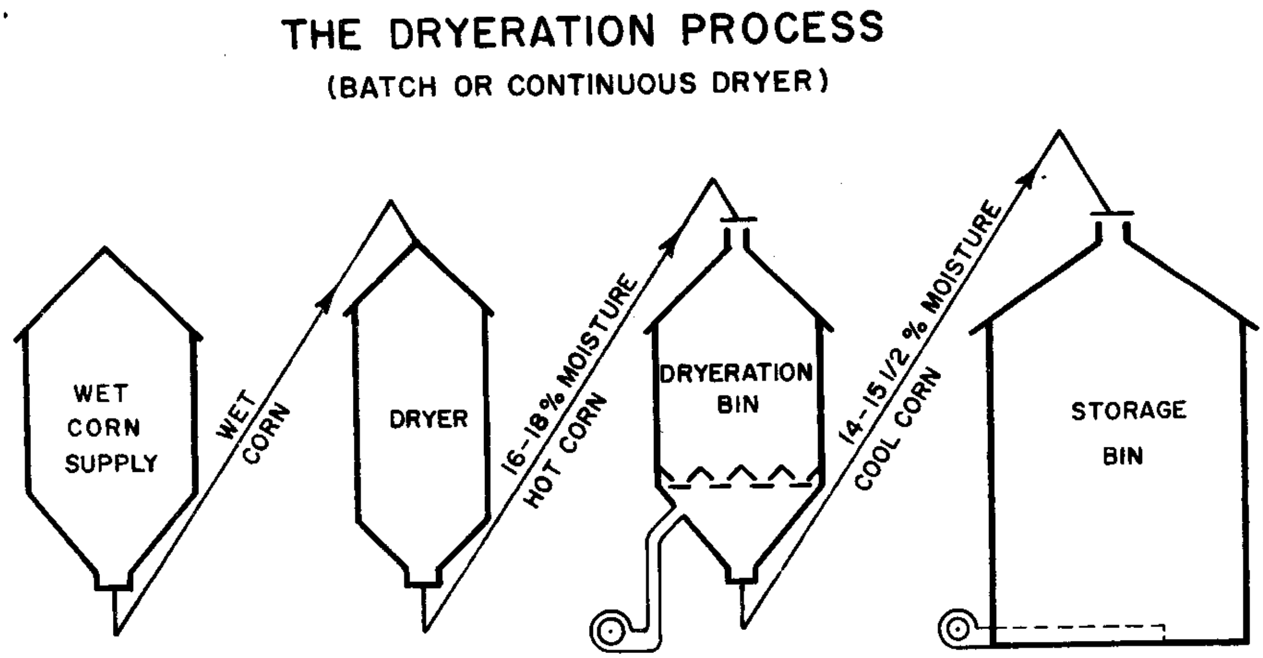

Figure 1.--The dryeration process. Either a batch- or continuous-type dryer can be used

The air was forced into the hopper, up through the grain, and out the filling hatch on top. Dried lots were accumulated in the bin and aeration was delayed until the bin was full, or nearly full, of hot corn. The first corn dried (that at the bottom of the bin) was the first corn cooled. The last corn dried (that at the top of the bin) had ample time to temper by the time the cooling front reached it. Thus, all the corn had approximately the same tempering period, a key reason for moving the air upward. The cooled corn was moved to the storage bin the next morning before the day's drying was started.

Water vapor from the hot corn condensed on the steel walls and roof of the dryeration bin. Condensation could probably be reduced by insulating the bin or by additional ventilation over the top of the corn. Pulling the air downward would also help, but would require that the start of cooling be delayed to allow time for tempering the last corn put in the bin. Connecting the fan to the top of the bin and exhausting from the space between the grain surface and the bin roof might also reduce condensation. At this time, however, the condensation problem appears too severe to recommend cooling the corn in the bin where it is stored. Where the separate dryeration bin was used and the corn was moved after cooling, any corn that was wet by condensation running down the bin walls or dripping off the roof was sufficiently mixed with the dry corn that no storage problem resulted.

The extra handling required to move the corn into and out of the dryeration bin is a disadvantage to using this process. Where adequate grain handling equipment is available this may not be much of a problem. In a drying operation running 24 hours per day, two dryeration bins are needed if cooling is done on a batch basis. A continuous process of cooling (counter-flow type) has been suggested. With a suitable unloading device, cooled corn could be taken off the bottom while hot corn is being added at the top. With proper sizing of the bin and the aeration fan, adequate tempering time could be provided.

The dryeration process appears to have these advantages:

1. It permits use of high drying-air temperatures, 200^{o} F. and above, to remove rapidly most of the excess water from the corn.

2. It eliminates the need for reserving part of the holding capacity of a continuous-flow dryer for cooling and eliminates the cooling period in batch drying. This can greatly increase the drying capacity.

3. It produces a dried product with minimum damage. Heated air drying is stopped before excessive corn temperatures are reached. In tests completed, the tempering period and slow cooling cut in half the number of kernels showing severe stress cracks.