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CHAPTER 9

PHYSIOLOGICAL FACTORS IN DRYING AND STORING FARM CROPS

Factors That Determine Safe Storage, Moisture Measurement, Drying Theory, Drying of Specific Crops

MODERN man has learned to store crops in great quantities under more critical conditions, with a very low percentage of storage loss, and at a very low cost relative to the value of the commodity. Stored crops are living material found in *various stages of dormancy*. The object of storage is to maintain this dormancy to the greatest degree and to minimize any changes that may occur with time. Stored crops are subject to *respiration* or reaction with atmospheric oxygen to produce heat, water, and carbon dioxide. Carbohydrate and fats are most subject to this type of change.

Crop materials such as grain are inhabited by various *micro-organisms*, including molds and yeasts. Under certain conditions these organisms thrive by breaking down the grain as a growth media and producing further heat, water, and carbon dioxide through their respiration process. Their contribution to the total respiration rate of the total mass is usually greater than that of the crop itself.

Chemical changes other than respiration also occur, frequently aided by enzymes, the organic catalysts. Some of the common reactions that occur include the change of starches to sugars, fermentation, as well as protein changes to amino acids and other forms. These changes are not generally considered desirable in the uncontrolled state.

Not the least hazard to stored grain is insect damage. Certain species of insects do significant damage to our grain supply in spite of the availability of control measures.

A good general reference on the subject of grain storage is a monograph edited by Anderson and Alcock[1] who have brought together the reviews of several specialists who have in turn summarized the work of many original investigators on the subject of grain storage.

A description of the design and operation of crop driers can be found in Chapter 32 of the 1964 GUIDE AND DATA BOOK.

FACTORS THAT DETERMINE SAFE STORAGE

Moisture Content

High moisture grain deteriorates from several causes, most of them connected with the fact that higher moisture content results in a high equilibrium relative humidity (above 70 percent) of the inter-seed air in the grain. This condition encourages the growth of microflora, particularly the aerobic species of molds. The respiration of the microflora, as well as an increased respiration of the grain itself, due to high moisture content, produces heat and more moisture to further complicate the problem. Such *self-heating* of forage crops stored at too high a moisture content can result in uncontrolled temperature rise to the point of ignition and spontaneous combustion.

Very low moisture (less than 11 percent) grain is not as attractive to insects as *higher moisture grain*; however, insects can also be controlled by the use of insecticide chemicals.

Table 1 lists moisture levels for safe storage of several crops.

Temperature

For safe long-term storage of grain, temperatures in the 40–50 F range are considered most desirable. At this temperature the respiration rate is low if the moisture content of the grain is also at a safe level. Insect activity is also reduced, since most insect species are unable to reproduce at temperatures below 50 F. Lower storage temperatures near 0 F will apparently preserve grain indefinitely, even at high moisture contents; however, no practical means of maintaining such a temperature in large storages has been demonstrated to date.

Higher temperatures generally increase the rate of all chemical reactions; however, enzymic reactions may be stopped at extremely high temperatures, near 200 F. The respiration rate of stored products generally increases with increasing temperature until the temperature is high enough to kill the microflora whose respiration is helping to produce the heat.

Oxygen Supply

As indicated previously, much of the deterioration of high moisture grain stored at ordinary ambient temperatures is caused by respiration processes which require oxygen. If oxygen is excluded from a grain storage, the oxidative respiration of the grain and the aerobic microflora will cease, much as combustion ceases when oxygen is no longer supplied. This can be accomplished in a practical way by placing the grain in a gas-tight structure. It should be emphasized that not all deteriorative changes are halted by lack of oxygen if temperature and moisture content are high. Certain chemical changes and anaerobic fermentation proceed in the absence of oxygen. These are the changes that carry out the ensiling process in high moisture grain and forage crops and give them their

The general responsibility for this chapter is assigned to the ASHRAE-ASAE Intersociety Committee on Plant and Animal Physiology. This Intersociety Committee consists of ASHRAE TC 1.5 and Committee C-18 of the American Society of Agricultural Engineers.