Heat Build-Up and Condensation in Grain Storage Bins In an effort to uncover the adverse effects of heat and moisture on grains stored inside grain bins, this matter was discussed with Don Castaldo, Ph. D, feed management editor for Watt Publishing in Mt. Morris, Illinois and other professionals in feed grain science. From the book, "Storage Of Cereal Grains and their Products". edited by Clyde M. Christensen and published by the American Association of Cereal Chemists, INC. Exerts taken from this book of studies is the basis for this summary report on effects of heat and moisture to feed grains.

In the storage of grains, a "quite significant proportion of the total losses results from respiration and gradual deterioration of viability, nutritive quality, and end use properties during storage under commercial conditions. Fungal deterioration of grain is a dynamic process that involves a succession of micro-organisms, the breakdown of organic matter to yield carbon dioxide and water, and the generation of heat (Bothast, 1978). Nutrients are lost because of changes in carbohydrates, proteins, lipids and vitamins. Functional properties, including germinability, are lost, and aesthetic changes, including discoloration, caking, and abnormal odors, occur. Also, mycotixins that elicit a toxic response when damaged grain is ingested may be produced.

The principal factors that control grain respiration are moisture, temperature, aeration, and previously history (conditions). We are concerned more about moisture and temperature. The relative humidity of interstitial air in stored grain tends to remain in equilibrium with moisture in the grain. At any level of relative humidity, however, the actual amount of water vapor per cubic foot of air increase with rising temperature. The air in the storage space is in constant motion as a result of diffusion or convection. When air from a warm region in the grain reaches a cooler region, it must give up some of its moisture to the grain in order to maintain equilibrium. This interchange of moisture usually takes place entirely at the vapor phase, but, in extreme instances, warm air reaching a cold region in the storage space may be cooled below the dew point, and water will be condensed on the cold surfaces of the grain or walls of the bin. Moisture is trapped from warmer regions to cooler regions resulting in excess moisture and spoilage. Effects of atmospheric changes in temperature on the storage bin walls and causes temperature gradients in stored bin walls causes temperature gradients in stored grain resulting in translation of moisture and then deteriorative changes resulting from local accumulations of excessive moisture.

When wheat was stored at high moisture contents and temperatures, sucrose, glucodifructose and raffinose contents decreased. Pixton and Hill (1967) reported that storage of sound what for six years reduced the total sugar content, especially the non-reducing sugars. This directly reduces energy levels. McDonald and Milner (1954) concluded that the enzymatic activity that occurs when wheat or wheat germs is stored at high moisture contents results in the production of reducing carbohydrates, which form browning intermediates with available free amino acids. As mentioned previously, moisture content and temperature are the main factors that determine respiration intensity and damage of stored grains and products. Mold are influenced by the initial moisture, temperature, and oxygen concentration. Certain nutritional factors are destroyed in moldy

cereals and feeds. A diet containing moldy oilseed meals may retard the growth of poults. Oxidation of unsaturated fatty acids in damaged grain is involved in the appearance of muscular dystrophy in pigs. In recent years, there have been many reports on the formation of toxic compounds in mold damaged food and feed stuff.

Feed experiments (Fairbanks et al, 1940) showed that swine fed sound corn made more rapid gains and consumed less feed per day and less feed per 100 pound of gain in weight than swine feed moldy corn. According to Trolle and Pendersen (1971), good feeding grain is characterized by high digestibility and biological value of the protein, by the absence of toxins substances (mycotixins, fungicides, etc.). Trole and Pendersen (1971) also reported that in feeding experiments with rats, digestibility of protein in storage damaged barley was normal, but its biological value was low. The damaged barley also had a low NPU. The damaged barley caused serious renal damage in pigs. The renal changes probably resulted from the action of the mycotoxin citinin from penecillium viridicatum Westling.

In vitamin changes on wheat and other grain, Bayfiled and)'Donnel (1945) showed that the higher the moisture content and environment, the greater the loss of Thiamine. Kondo and Okamura (1933 b), founded that unhulled rice stored at a moisture content of more than 10% suffered appreciable losses, but did not parallel the decrease in viability of seed. A few studies have been conducted by commercial four mills on vitamins losses in enriched flour. Results indicate that significant losses of Thiamine may occur during storage and that the extend of the losses, although quite variable, depends considerably on the time and temperature of storage, and upon the moisture content of the flour. High temperatures content of the flour and high moisture content accelerate the rate of Thiamine destruction. The vitamin A activity of yellow corn is of considerable importance in animal feeding and may also be of significance in human nutrition in certain sections of the country where cornmeal is an important item of the diet.

No other grain has any appreciable vitamin A activity. The vitamin A due to corn's content of B-carotene, cryptoxanthin, and neocryptoxanthin. With cornmeal, as much as 34 % of the crude carotene was lost during the first week of storage at 35C degrees (95F) Studies conducted at the University of Illinois showed that corn stored in steel bins for four years contained less than half of the crude carotene of fresh corn (Jones et al, 1943). The cattle disease known as anasarca appears by vitamin A deficiency (Creech and Madesen, 1942: Madesen and Earle, 1947). The disease is manifested by loss of appetite, lameness, marked by swelling of subcutaneous tissues, and defective vision, particularly night blindness. Serious economic losses may result from this disease. The apparent relationship between anasarca and vitamin A deficiency lends considerable practical importance to the loss of vitamin A activity in stored yellow corn. Temperatures exerted more effect on destruction of vitamin A than moisture. It is well-establish that damp grain, when exposed to high dry temperatures, may reduced its nutritive value, breadmaking potential, and germinative power and capacity. Milner and Woodforte (1965) suggested that prolonged heating could lead to degradation of starch to reducing sugars and their interaction with the epsilon group of lysine, thus rendering the limiting amino acid unavailable.

Viability of cereal seeds is conditioned by temperature and humidity of storage (Crocker, 1948. Porter 1949), and Owen (1956). In a study of stored red winter wheat, Bellenger and Godon (1772), the wheat that was less subjected to heat inside 20 concrete silos and allowed to remain cooler, prevented development of fungi and heating of grain and reduced loss in germination and development of fat acidity. Decreased in breadmaking quality of wheat stored at elevated moisture and temperature levels were reported by Pomeranz (et al 1956).

A subsequennt study (Daftary et al, 1970 b) showed that the breakdown of bound lipids is substancially lower in loaf volume and poorer in crumb grain than bread baked from sound flours.

Mixing times of damaged flours were substancially longer than mixing times of doughts from sound flours. Mixing times increased as storage temperatures increased, and as damage to breadmaking potentialities increased. Results of these studies indicate that wheat flour lipids were most susceptible to mold damage and later gluten proteins were destroyed. Pixton (et al 1975) studied viability of wheat stored at different temperatures and found wheat stored at low temperatures remained at about 96 %, but that of wheats sored at ambient temperatures fell to 39% for Manitoba and 14% for Capelle. In regard to other grains, Susuki and Matsumoto (1971) founded that rice stored at room temperature during summer was less palatable after cooking than cooked rice from grain stored at lower temperatures. In this study, after two months, total starch contents decreased and any loss and reducing sugars increased. The changes were accelarated by increases in temperatures and in relative humidity."

Dr. Castaldo related that in his findings the moisture that formed on the sides of the grain bins tended to find the "hot’ spot in the grain and developed into mold. Mold then destroys carbohydrates in the grain resulting in loss of grain energy, amino acids and a reduction in vitamins A,D,E and other. The Grain would need to have a supplement added to bring it back to the proper nutritional levels. Mold also causes mycotoxins (a poison) that harm the liver in animals. Mycotoxins retard the production of bile that aids in the digestion and absorption of fats.

ProTek-ThermCote/IC & Final Finish helps to control the reaction of heat and cold o the metal skin to control condensation and control mold formation. along with forming a heat barrier to protect the grain from high heat, ProTek-ThermCote/IC helps control the formation of mold that causes a loss of vitamins and creates toxins that reduce the absorption of fat by the livestock. In dollars and cents, ProTek-ThemCote/IC could save money in the loss of vitamins requiring more supplements and protects the dollar investment on the hoof by allowing livestock to absorb and maintain fat controlling the development of toxins that damage the liver and other related animal health problems resulting from moldy grains.

With ProTek-USA's complete line of products we can help to save the nutrients I stored grains, protected the physical facilities from natural acid and weathering deterioration.