GRAIN QUALITY CONSIDERATIONS

Fine materials and dust are frequent sources of complaints by foreign buyers. The soft starch in the corn kernel is powdered as a result of impacts during repeated handling between U.S. farms and the processing plant of the foreign buyer. [Hill et. al., 1979]. The fine powder created, clings to the surface of the kernel, giving it a gray or whitish appearance. During movement of the grain stream this fine powder becomes airborne, creating emission problems. The lower the moisture content of the grain the more readily it breaks and the more dust that is created during subsequent handling. High temperature rapid drying also adds to the breakage susceptibility creating more breakage and therefore more dust. The use of water is effective in suppressing the dust. This temporarily solves the problem of dust emission, although EPA testified that they did not believe that the prohibition of water as a dust suppressant would necessarily increase dust emissions. [U. S. House of Representatives, 1993].

However, the use of oil and water does not remove the dust, but only serves to conceal its presence. In the case of water the effect is temporary since the water is reabsorbed by the kernel and the dust again becomes a free agent. In the case of oil the dust may be retained for a much longer time period, attached to the individual kernels.[2] However, in neither case is the quality of the grain improved in the sense of its intrinsic properties, its milling attributes, or its end-use value. The dust is still present and the problems created for milling by excessive dust and less than whole kernels remains. If pneumatic systems are used to physically remove dust and not return it to the grain stream, quality would be improved throughout the market channel and in the final processing plant, but the improvement in quality would be insignificant since only a small proportion of dust in the grain is actually removed and additional dust is created during subsequent handling. No technology removes all dust and some that is removed is re-introduced.

Many millers have specified that neither oil or water may be added to grain. Negative effects on milling and flour quality from the addition of oil have been reported from a study conducted by a commercial miller. [Reid, 1987] A representative of U.S. Wheat Associates stated that "Oil has adverse effects on flour yield and color, both important factors in determining the profitability of the milling operation. Oil can also cause bacteria and other undesirable particulate materials to adhere to the wheat kernel, particularly in the crease of the kernel, and therefore reportedly can raise bacteria counts in flour. Because some of the oil is detectable in the resulting flour, it may have adverse effects on the quality of the end product. Also many products are now made from whole grain, which include all the oil sprayed onto the wheat". [U.S. Wheat Associates, 1993]. However, conclusions from analysis conducted by Lai et al. [1986] indicated that "functional properties of grain, as measured by SRW wheat milling, baking, and cake making, were not altered as a result of oil treatments". Several millers and processors have taken a conservative approach, refusing to accept grain if oil has been applied. "A number of U.S. flour millers, both large and small, prohibit the use of oil dust suppressants on the wheat they buy. For example, one of the largest U.S. baking companies stipulates in their contract terms that no oil is to be added to the wheat from which their flour is milled. A major U.S. brewing company has a

[2] Most of the research material available for this study related to the use of food-grade oil, without differentiation to mineral or soybean oil. Differentiations between mineral and soybean oil within this report were only made when specifically supported by research results.

nearly identical contract term: no oil is to be added to the malting barley which they buy. Each of these domestic buyers of grain, and its products, has identified negative impacts of oil additives on end-use quality. U.S. Wheat Associates is concerned that the elimination of water for dust control will result in increased use of oil and a deterioration of the quality reputation of U.S. wheat exports". [Jacobson,1993].

The addition of water has an additional effect upon quality of the grain. Considerable research has been conducted to evaluate the effect of rewetting grain on its storability, mold growth, and accuracy of moisture measurement [Bloome, et. al., 1982].

Sauer et al. [1992] stated that the combination of moisture content, temperature and time determine the storage risk of stored grain. Basically, starch cereal grains with 13.5% moisture or less can be stored without damage from storage fungi. For soybeans the moisture needs to be 12.5% or less for long term safe storage. Table 4 from Sauer et al. [1992] indicates that as moisture content of starchy grain increases, the equilibrium relative humidity also increases and different species of fungi are able to metabolize and grow.

Table 4 shows that as moisture content of starchy grains, such as corn, increases, the equilibrium relative humidity also increases. Depending on the grain temperature, this will create conditions favorable for metabolism first by Aspergillus halophilicus, then A.restrictus and A.glaucus, eventually A.candidus, and A.flavus. A.flavus is one of the fungi species known to produce aflatoxin when certain growth conditions are present.

If grain moisture were to increase by 0.3% points, the relative humidity of the air in equilibrium with the grain goes up by about 2 percentage points. [ASAE,1994]. If moisture content goes up, relative humidity goes up and vice versa. The presence of this additional relative humidity or water activity, can be just enough to create conditions for more rapid fungal growth and metabolism.

Hall [1983] provided rewetted corn samples to FGIS for storage studies for 2 months and 1 year at storage temperatures of 70 to 75°F. Corn samples were in the 14.04 to 16.16% moisture range and 0.2% water was added by weight. Corn total damage was determined after 60 days of storage and found to be higher for the rewetted corn but not significantly higher for 3 of the 4 corn sample sets. For the corn stored for 1 year, the wetted corn had significantly higher total damage than the non-wetted corn. Thus, depending on the initial moisture of the grain, the length of time to be stored and the temperature of the storage conditions, an additional 0.2% water addition, will make conditions more favorable for fungal growth and may or may not result in additional fungal damage being great enough to change the total damage grading factor.

Other factors affecting fungal growth are presence of broken and fine materials, dust, and percentages of non-whole kernels. For the purpose of assessing likelihood of fungal infection, the maximum moisture content present is the controlling factor, rather than the average moisture

(which is measured with normal moisture meters). For this reason, even a small pocket of moist grain will allow fungal growth to start, which by their metabolism reaction, converts starch and oxygen into carbon dioxide with the dangerous by-products of moisture and heat. Thus, once fungal growth starts, the fungi will be able to create enough heat and moisture to make neighboring grain kernels moist enough and warm enough to promote even more fungal growth. Without massive aeration or major cooling, or turning of the grain, fungi left to metabolize will create moist conditions favorable for more and more species of fungi, which may with time consume the starch in the grain. Moderate fungal growth also creates heat and moisture that makes conditions more favorable for insect growth.

An additional concern of adding water relates to the credibility of the official certificate. "The official certificate reflects the quantity and quality of grain that has been properly stowed aboard the vessel. ... Based on existing scale tolerances, the grain loaded should be within 0.05% of the official certificate. The addition of 0.2% of water by weight could possibly increase that figure to as much as 0.25%." [Marshall, 1982].