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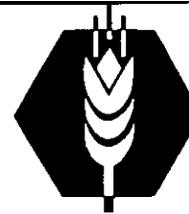
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Dust Control for Grain Elevators

*Comprehensive Illustrated Papers
Presented at the
Grain Dust Control Seminar*

**May 7-8, 1981
Sheraton St. Louis Hotel
St. Louis, Missouri**

**Conducted by the
National Grain &
Feed Association**

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Chapter 11

Dust Control for Grain Dryers

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ABSTRACT

The author discusses dust control from the perspective of grain dryers. He describes the evolution of grain dryers and details the principles under which today's dryers operate, illustrating the various configurations available. He reviews the sections of federal air pollution control regulations that pertain to emissions from grain dryers. He analyzes the type and quantities of particulate emissions from grain dryers and the factors that affect emission levels.

Mr. Appold presents descriptions of the major types of grain dryers currently available, focusing primarily on the modifications and design innovations made by dryer manufacturers to comply with air pollution control requirements. The author describes the design principles under which dryers operate and the unique characteristics of each. He also discusses several major types of grain dryer dust control devices, most of which operate on the principle that allows emitted air from the dryer to pass through a filter media before entering the atmosphere. He reviews the effect of filtering upon various dryer parameters, such as the effect on airflow rates, dust plugging, grain dust recirculation, energy consumption and power requirements, insulation properties, grain quality and precleaning to limit foreign material.

Dust Control for Grain Dryers

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Public interest in environmental pollution problems resulted in major political pressures across the country during the early 1970's. It became very apparent, then, that in order for grain facilities to operate their drying equipment, modifications or new equipment designed to meet the established new air pollution regulations would have to be installed.

Increased restrictive standards set up to control various air pollutants necessitated retrofitting and replacement.

Over the last few years, the grain industry has been able to accomplish this task. In most cases we satisfy any state requirements. However, there still existed a major problem on many of the old open type dryers in which owners had a considerable investment. In attempting to make this equipment usable, a number of different methods were tried, each of which contributed something toward the solution of this problem.

Grain dryers present a different problem for pollution control because of the large volumes of air exhausted from the dryer, large cross-sectional area of the exhaust, low specific gravity of the emitted dust and the high moisture content of the exhaust. Materials emitted from the dryers, although relatively large or very light and difficult to collect, and the rate of emission are primarily dependent upon the type of grain, foreign material in the grain and the dryer configuration.

The following information presented in this report will deal mainly with grain dryer problems:

- II. Grain Dryer Evolution
- III. History of Laws Regulating Dryer Controls
- IV. Particulate and Emission Analysis
- V. Control Devices for Existing Dryers
- VI. Control Devices for New Dryers
- VII. Effects of Filtering
 - A. Airflow Rates
 - B. Dust Plug and Excess Cake
 - C. Filter Media
 - D. Recirculation
 - E. Energy
 - F. Insulation
 - G. Grain Quality
 - H. Pre-Cleaning
- VIII. Factors to consider when retrofitting old equipment and selecting new
- IX. Conclusions

II. Grain Dryer Evolution

A basic knowledge of the purpose and functioning of drying grain is essential to a thorough understanding of the application of modern grain dryers in drying and processing different varieties and types of grain.

Grain drying is as old as grain itself—except that in the beginning time was not as much a factor, and labor was very inexpensive. Therefore, it was economically sound to let any type of grain dry in the field. This drying was facilitated by cutting and stacking the stalks in the field when the crop was fairly close to the moisture desired. Then, if weather conditions were ideal, a couple of weeks would suffice to prepare to thresh wheat or harvest corn and put it into storage. But, many times the weather conditions would necessitate leaving the stalks in the field as long as three months. Often the crop would be a total loss. The hazards of this method frequently meant a complete loss of all potential profit for the farmer. There is no dryer made today that will dry any better than nature dried under ideal conditions. Unfortunately, the conditions which nature offered at best were unpredictable. Even though the moisture was reduced, the loss in the fields from birds, rodents and handling ran as high as 10% to 15%.

As the cost of labor went up, farmers found it much cheaper to use automated machinery such as a combine and a corn-picker. The nature of this machinery is such that the grain must be harvested at a high moisture to prevent loss in the combining operation or the picking operation. Thus, it becomes essential to have some kind of an artificial dryer.

All dryers produced today for the purpose of drying grain operate on basically the same principle: heat to vaporize the moisture and air to remove it. Also, the air is warmed to reduce the humidity so that each cubic foot of air can pick up more moisture. Actually, it would be feasible to dry with air at the same temperature as the outside air if it were dehumidified. The least expensive method of dehumidifying air is to raise the air temperature.

The first commercial dryer was manufactured around 1898 and used steam as its source of heat. The first direct heat dryer was manufactured by the O.W. Randolph Company around 1915. Although not the controlled piece of equipment that is manufactured today, the system used coal and had very few means of controlling the temperature. Yet it was still one of the first and most successful types of commercial dryers. Many of these dryers were manufactured in the 1920s and operated successfully for some time.

New designs and ideas allowed other manufacturers to come out with new products and equipment with which to compete in the grain drying business satisfactorily. For example, many attempts have been made to speed up grain drying processes. In other experiments, grain dryer capacity can be increased by using higher drying air temperatures, but the quality of the dried grain is generally lower. Of the several factors important in drying design, the first and primary one is the design of the grain column. There are many different types of grain columns with various methods for introducing the air. Other concerns must be for structural strength, for uniform flow of grain and air, and of course, for cost.

Of the many sizes, shapes and configurations of dryers, there are only three basic continuous flow types: cross-flow, concurrent flow, and counter-flow. In a cross-flow dryer, the drying air flow is perpendicular to the flow of grain; in a concurrent flow dryer, the air flow is in the

same direction as the grain; in a counter-flow dryer, the air flow is in the opposite direction to the movement of the grain as shown in Figure 1.

The majority of grain dryers used today are of the cross-flow type. There are two basic designs utilized in the cross-flow dryer. The first is rack configuration, and the second is column configuration. Examples of each of these are shown in Figure 2. Figures 3 and 4 show actual dryers depicting rack and column design.

Wet grain is introduced at the top of this type of dryer, flows downward in a continuous stream, and exits at the bottom. Hot air blown through the grain bed evaporates the excess moisture. Grain up to 22% moisture can be reduced to 14% or 15% in one pass through the dryer. Grains are sometimes received with up to 38% to 40% moisture. Moisture content this high requires a very slow grain movement through this system.

During the drying process, light dust and chaff can become carried from the dryer with the exhausted air. The potential quantity of dust depends largely on the type and model of dryer along with grain conditions. In a column dryer, where the grain flows in a column between two perforated metal sheets from the top to the bottom, most of the dust is trapped in the grain and never reaches the outside of the dryer. Figure 5 shows a section of a column dryer.

A rack dryer contains ducts or racks around which grain and hot air must flow. It also has large openings to the atmosphere. In some cases, an opening as much as 16 square inches allows easy passage of beeswing and hulls, a major portion of dryer polluting emissions, to escape. These large emission areas are eliminated in a column dryer by the common perforated openings. The rack dryer is much more open because the air does not pass through these perforated metal sheets. Figure 6 shows an inside cut-away view of a typical rack dryer, with grain in column and air duct openings that allow air flow. Because of this, a rack dryer can have up to as much as ten times more emissions than a column dryer, drying under the same conditions. Approximate air flow requirements for grain dryers are as follows:

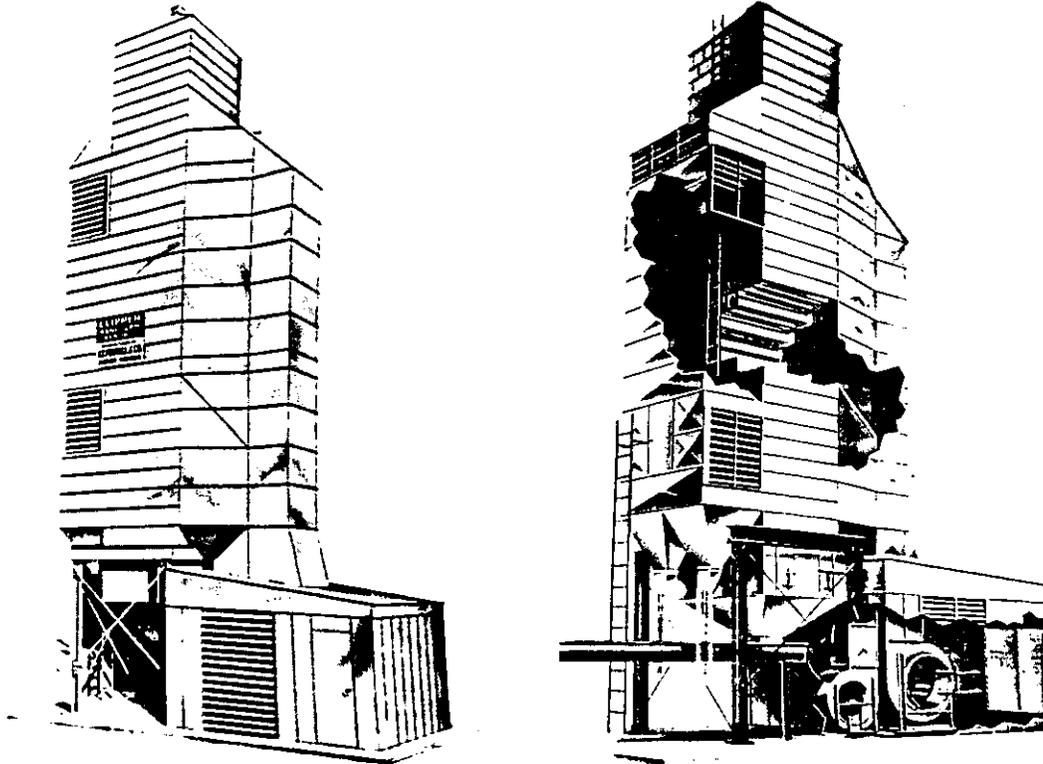
1. Column dryer-100 cfm/bushel/hour
2. Rack dryer - 70 cfm/bushel/hour

The amount of dust generated in grain drying is dependent upon the following:

1. Type of dryer
2. Model of dryer
3. Type of grain being dried
4. Amount of entrapped foreign material in the grain

Although other sources such as coal, electricity, steam, biomass and "Bunker C" fuel oil have been used in the past, common sources of fuels

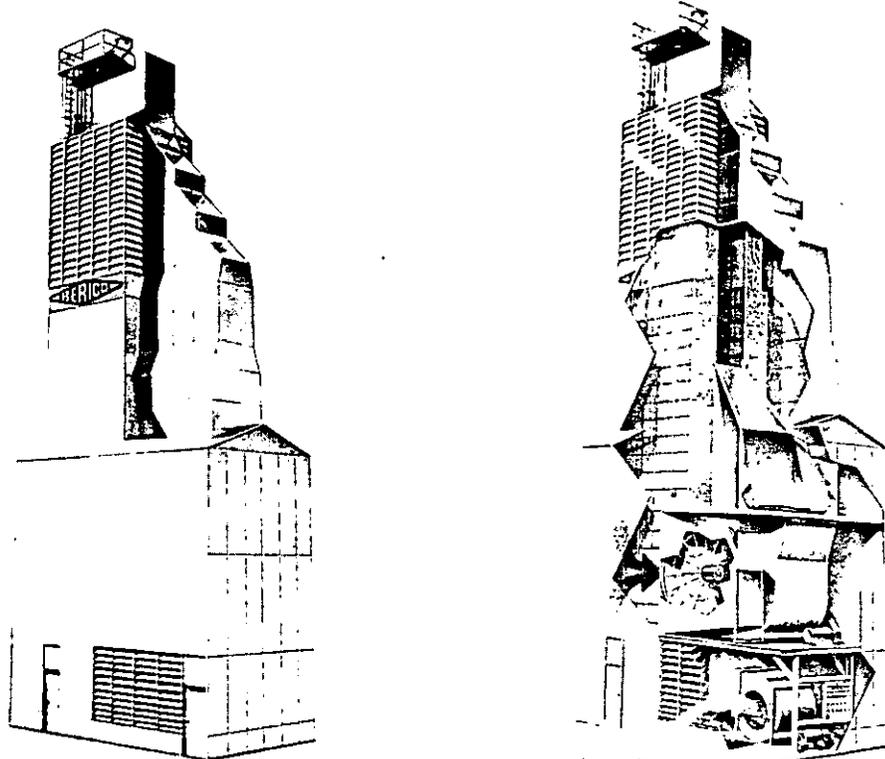
Figure 3
Typical Rack Dryer



Outside View

Inside Cutaway

Figure 4
Typical Column Dryer



Outside View

Inside Cutaway