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Humidity Control in Seed Storage

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HUMIDITY CONTROL IN SEED STORAGE [1/]

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The storage of certain seeds, whether for just a few weeks or for preservation from season to season, has long been of interest to the air conditioning engineer. Many seed varieties are sensitive to changes in atmospheric moisture and deteriorate rapidly if exposed to excessive humidity conditions. They may develop mold or fungus growth, change color, germinate prematurely, become susceptible to heavy insect infestation, or lose their viability altogether. Certain types of seeds will lose more than 60% of their germination power if exposed to high humidities even for just a few weeks. Conversely, some seeds can be preserved from season to season for periods of five years or more without appreciable loss of viability if stored at low controlled relative humidity conditions.

Since most deterioration of stored seed occurs at high humidity levels, and since too little humidity is rarely as much of a problem as too much, I will concern myself in this talk mainly with dehumidification and proper methods of removing moisture from the air rather than adding moisture to it. I will discuss the types of storage room construction, operating procedures, and equipment which have been found most suitable to prevent moisture infiltration and protect seed varieties against damage from excessive humidity.

In speaking of controlled low relative humidity, I will first define some of the words that the air conditioning engineer uses in describing the relationship of moisture and air. A brief review of a typical psychrometric chart will show you what we are talking about. You will note the relative humidity is the amount of moisture the air holds at a given temperature in comparison to the amount it could actually hold before saturation is reached. It can be increased or decreased by lowering or raising the temperature, i.e., by cooling or heating the air. However, this has no effect on the absolute humidity, that is the actual amount of moisture contained in a pound of air, or the dew point which is the temperature to which this air would have to be lowered to achieve 100% relative humidity or saturation. You can thus see that heating a typical storage space will not actually eliminate any moisture from the air, but that it can sometimes be effective in temporarily lowering the relative humidity when the weather outside

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is cool and humid. However, since most seed storage installations are not really designed for heating, it is not too practical to rely on this method for humidity control, and a positive way to remove moisture from the air must be found.

Basically then, when we speak of dehumidification, we are talking about the removal of moisture from the air, i.e., a reduction in the absolute humidity.

We should also distinguish here between product drying, which concerns itself mainly with removing moisture from the product itself; and dehumidifying, which is concerned mainly with the removal of moisture from the air. Dehumidified air will contribute appreciably to the drying rate since it increases the vapor pressure differential between the moisture in the product and the moisture in the air, but the techniques used for dehumidification do not necessarily lend themselves to product drying. Having discussed the need for achieving low controlled humidity, and some of the terms in common use within the industry, let us now look at the mechanical means of achieving and maintaining these ideal humidity conditions.

Generally speaking, there are two major categories of dehumidifiers -- refrigeration-type and chemical or "adsorption-type."

The former operates by drawing warm moist air over a metal coil through which is circulated a refrigerant, such as Freon. A part of the atmospheric moisture condenses on this cooling coil and is collected in a pan or bucket, or is drained off to waste. The cooled air coming off the coil, which now has a low temperature and a high relative humidity, is reheated by the condensor coil of the refrigeration system, thus raising the temperature and lowering the relative humidity.

The water removal capacity of this type of system is dependent on the difference in temperature between the entering air and the cooling coil. While these units are thus quite effective at high temperatures, they lose efficiency below 70°F and 50% RH and are thus best adapted for use in home basements and other closed spaces, but are not generally acceptable for industrial process drying or low-humidity storage where dew points below 50°F are required, as is desirable in seed preservation.

The same is true for refrigeration-type air conditioners, which can be used to "dehumidify," but operate in a manner similar to refrigerant dehumidifiers, except that they have larger cooling coil areas and provide air or water cooling of the condensing coils. Since their dehumidifying capacity is limited by the same factors as above, they have the same drawback -- inefficiency at lower temperatures and an inability to maintain very low humidities. In most storage applications, moreover, cooling for comfort is not necessary, and only a moderate amount of refrigeration is needed for temperature control at 70-75°F. The major portion of the "air conditioning" job, namely, removing sufficient water vapor from the air to maintain relative humidities in the 20 to 30% range, can be more economically accomplished by means of an adsorption-type dehumidifier.

As contrasted with refrigerant-type dehumidifiers, adsorption units do not use any compressors or coooling coils. They simply draw the moist air through a so-called "desiccant" -- a granular drying agent such as silica gel, activated alumina, or molecular sieve -- which has the ability to extract and retain moisture on its surface by a phenomenon known as "adsorption." The air is filtered and dried to a very low dew point in the process, and the desiccant is periodically regenerated by means of heated outside air which vaporizes the moisture and discards it back outside the space. Continuous operation of these machines is achieved by either using two desiccant beds which switch back and forth automatically or by using rotating beds of desiccant, a section of which is always dehumidifying the air, while another section is being regenerated. This new type of rotary machine is of particular interest to the seedsman since it is lighter and more compact than the dual-tower unit, has higher capacity, and delivers dry air at constant, non-cycling outlet temperatures and humidities.

Desiccant dehumidifiers provide maximum efficiency at lower temperatures, and are able to maintain constant relative humidities even below 10% over temperature ranges from minus 40°F to plus 120°F. They are thus ideal for all those applications where dew points less than 50° are required, i.e., where the temperature and humidity add up to less than 120; which is true for most seed storage applications.

In considering dehumidification of seed storage areas, then, we are discussing the removal of water vapor from the air surrounding the commodities. But of equal importance, even before dehumidification, is the <u>exclusion</u> of as much of this water vapor as possible from the space. This means simply that in order to have a dry storage room you must have a room which is capable of being dried. Moisture migrates instantly from areas of high to low humidity. A dehumidifier, which creates an area of low vapor pressure, will actually draw moisture from areas of high moisture content -- from insulation, walls, ceilings, floors or even from an adjacent room -- thus pulling moisture into the dehumidified space without materially reducing the humidity in the area. It is therefore vitally important to start the dehumidification operation with dry walls and an effective vapor barrier.

Time does not permit discussion in detail of the various possible construction methods used for widely different storage buildings and rooms in scattered parts of the country. However, here are a few points to remember:

1. Seal floors, ceilings and walls insofar as possible, using vapor-proof paint (such as aluminum paint), aluminum foil or foil-backed insulation, or polyethylene liner. Make sure that all joints and seams are tight, and use tape where necessary.

2. Instruct employees to open and close doors as infrequently as possible. Double doors may be desirable in openings carrying the heaviest traffic.

3. Dehumidify only that area where products are actually stored. If commodities are stored at one end of a large warehouse, seal off that end, and dehumidify only the smaller space.

4. Do not expect results overnight. The initial "pull-down" period may last several days or even weeks, until the moisture contained in the commodity and the room itself has reached equilibrium with the dehumidified atmosphere.

5. Take every possible precaution not to add moist products to the storage area once pull-down has been achieved.

Maintenance of adsorption dehumidification equipment is minimal. In most installations only an occasional replacement of the dust filter and oiling of blower motors is required. Cost of equipment may vary widely, depending upon conditions to be met and maintained, as well as the size of storage space, how well it is sealed, whether the commodity is in containers, and other factors. If cooling is required, this would, of course, be additional costs.

While I have touched only briefly on some of the aspects of dehumidified storage, I hope to leave you with an appreciation of the economic advantages of humidity control in this field, and an idea of the types of modern equipment and storage methods which are available today for the long-term preservation of seeds under favorable storage conditions.