Conditioned Seed Storage - Justification, Design and Operation

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Work has shown that the methods used to prepare seeds and to store them prior to use can be a limiting factor in performance and yield. Grabe (1) has reported yield decreases for seeds stored in warehouses under ambient conditions. Delouche (2) has discussed storage conditions which will delay the rate of deterioration of seeds and has related yield decreases to time and condition of storage. Gill (3) has summarized the several methods of measuring vigor and deterioration and has related yield to storage conditions.

An important conclusion in this work is that the decreased yields were not due to decreased stands but to less efficient setting of seed.

All of this work presents a real challenge to engineers in the seed industry to design, justify, and build facilities and equipment that are beneficial and economical.

Also, the research work has been extremely helpful in design and justification of facilities.

The now classic curve on deterioration and germinability presented by Delouche (2) has been helpful in organizing our thoughts on seed quality. It demonstrates that deterioration has already started before germination begins to drop off.

To quantify this phenomenon, our research has developed the data of Figure 1 which shows the relative drop with time in ambient storage of cold test, glutamic acid decarboxylase activity (GADA), and yield while the germination remained high. All values were high, however, when the seed was stored in controlled atmosphere (CA) storage ($50^\circ F$, $50\%$ RH).

The results of research on storage of seeds have been the basis for design and justification of controlled atmosphere warehouses for foundation seed and commercial seed. Also, seed breeding work has been helped for some years by the ability to use seeds for comparison and evaluation work which have been stored under controlled atmospheres.

In the case of foundation seed, the economic justification for controlled atmosphere storage (for a seed company which has its own foundation seed department) lies in the increased yields obtained in the production fields for commercial seed. The investment cost for insulation, cooling equipment, and dehumidification equipment would be justified by the savings caused by a yield in-

\[1/\] Manager of Physical Facilities for Funk Bros. Seed Co., Bloomington, Illinois.
Figure 1. Results of tests showing how controlled atmosphere storage maintains seed quality.
crease in the commercial production fields (assuming contract growing).

In the case of commercial seed, the economic justification for controlled atmosphere storage lies in the value of a unit of inventory, the previous history of discard due to poor vigor quality, the amount of carryover, and the seed company's return on investment criteria (4). The economics depend primarily upon the discard and inventory policy of the company. Studies show that a higher return may be obtained for investment in controlled atmosphere storage for the carryover portion only than for the remaining portion of the storage. However, the studies also show that favorable returns may be obtained in both cases. In the case of a new warehouse of Funk Bros. Seed Co., in Bloomington, the decision was to invest in controlled atmosphere for the entire storage including bulk storage and for 12 months per year.

Another beneficiary of the practice of controlled atmosphere storage of seed by seedsmen will be the farmer. The increased income from an added yield of 5 or 10 bushels per acre is not difficult to calculate. But in some cases it can make a difference in the profit from the farm operation.

Once the seed company has decided to use controlled atmosphere storage, the selection must be made of equipment for temperature and humidity control and of building insulation for reducing heat and water vapor transmission. Beck has outlined the many alternates available (5).

Table I gives design data for a typical controlled atmosphere storage plant for seed. Electric battery powered Fork lift trucks are used to prevent fumes in the warehouse. Electric motor-operated doors are used to keep "door-open" time at a minimum. Also, an order-make-up or staging area is used between the cool room and the outside loading docks.

Operation of the system is relatively trouble free. Temperature-humidity recorders are used and charts from these recorders are inspected periodically. Routine maintenance on the compressors and fans generally is all that is required. It is important that personnel responsible for the operation be trained in the principles of temperature and humidity control. With this training, adjustments in controls can be made readily for satisfactory operation.
Table 1 - Design Data for Controlled Atmosphere Seed Storage Plant
(50°F, 45% R.H. Year around)

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume of room</td>
<td>2,100,000 Cu. ft.</td>
</tr>
<tr>
<td>Heat flow resistance, walls</td>
<td>0.1 BTU/hr/ft²/°F diff.</td>
</tr>
<tr>
<td>Heat flow resistance, roof</td>
<td>0.05 BTU/hr/ft²/°F diff.</td>
</tr>
<tr>
<td>Vapor flow resistance, walls &amp; roof</td>
<td>0.1 grain water vapor per hr/ft²/in. Hg diff. in vapor pressure.</td>
</tr>
<tr>
<td>Cooling capacity</td>
<td>900,000 BTU/hr (2 units 450,000 BTU/hr each)</td>
</tr>
<tr>
<td>Heating capacity</td>
<td>150 kw duct heaters</td>
</tr>
<tr>
<td>Air flow</td>
<td>30,000 cfm (2 units 15,000 cfm each)</td>
</tr>
<tr>
<td>Humidifier</td>
<td>15 kw elec. boiler</td>
</tr>
<tr>
<td>Fresh air make up</td>
<td>1,000 cfm</td>
</tr>
<tr>
<td>Humidity control</td>
<td>Hot gas defrost on cooling units; 22°F coil temp; 30°F air temp. off coils.</td>
</tr>
</tbody>
</table>
References


