BUILDING DIGEST

CENTRAL BUILDING RESEARCH INSTITUTE, INDIA

# THERMAL DESIGN OF POTATO COLD STORAGE

## Introduction

A Cold Storage, as the name implies, is a place for storing commodities at the required low temperature. Such a storage is of great importance in increasing the life of perishable foods, dairy products and medicines. A proper lay out and thermal design of cold storage spaces is important both for efficiency and economy in construction. This digest aims to provide a few suggestions for storage space, building, insulation and refrigeration plant which shall be helpful in the design of a potato cold storage.

## Space Requirement

The cold storage capacity is normally specified in terms of the volume of the storage space. It does not include loading and drying platforms, machine and office rooms, precooling chamber and any other space outside the room. The size of the chamber depends upon the total quantity of the product to be stored, the method of packing and the clear space provided for movement. It is found that a storage space of 3.4 cubic meter/ton of potato is most suitable for proper stacking and circulation of cold air. The height of the chamber varies from 5 to 10 meters for equal distribution and proper circulation of cold air. For ease of loading and unloading operations the following steps are suggested.

(1) The passage between the rows of the racks should not be less than 75 cm.

(2) The racks should be kept away at least 20 to 25 cm from the walls.

(3) A gap of at least 30 cm should be provided between the ceiling and the product loaded in the top most shelve of each rack.

For potato cold storage, the floor area for different heights of the room is given in Table 1. From this table floor area for a particular height

**Table 1**

**Capacity of the Cold Storage for Different Height of the Potato Cold Storage**

| Floor Area ($m^2$) | Quantity of product to be stored (tons) | | | |
|---|---|---|---|---|
| | Height of the room (meters) | | | |
| | 4 | 6 | 8 | 10 |
| 50 | 64 | 96 | 128 | 160 |
| 100 | 128 | 192 | 256 | 320 |
| 150 | 192 | 288 | 384 | 480 |
| 200 | 256 | 384 | 512 | 640 |
| 250 | 320 | 480 | 640 | 800 |
| 300 | 384 | 576 | 768 | 960 |
| 350 | 448 | 672 | 896 | 1120 |
| 400 | 512 | 768 | 1014 | 1280 |
| 450 | 576 | 864 | 1142 | 1440 |
| 500 | 640 | 960 | 1270 | 1600 |

## Building Design

The building may be constructed of bricks, stone or reinforced concrete as per prevalent practice in the locality. The thickness of the wall and roof is mainly decided from structural load requirement. A wall thickness of more than 45 cm is generally not necessary. The roof may be either flat or sloping with A. C. sheets.

The asbestos cement roof is provided with a false ceiling horizontally. The exposed long walls of the chamber should, as far as possible, be oriented towards south to minimise solar heat gain.

## Thermal Insulation

The cold storages have to be properly insulated. For this purpose there are various materials available in the market such as, expanded polyestrene, resin bonded fibre glass, mineral wool, foam concrete, saw dust and rice husk. The insulation thickness is determined by balancing the cost of insulation against the over all economics of the refrigeration plant and its operating expenses. In addition, the insulation thickness chosen should be sufficient to prevent condensa-

dew-point. The minimum economical thickness for walls, roof and floor for potato cold storage is given in table 2. It would be seen that greater thickness of insulation is required for roof, and walls exposed to solar radiation and lesser thickness for floors. The thickness of insulation used for partition walls should not be less than half that used for the exposed walls and the insulation should be applied on each sides. The success of an insulation system depends upon the correct application of vapour barrier. The correct practice is to make outer skin as impervious as possible. The inner should be of more permeable type so that no condensation takes place within the insulation. The trouble connected with the condensation and frequent freezing of water in the insulation can be minimised if the following precautions are taken.

**Table 2**

**Recommended Minimum Thickness of Insulation for Potato Cold Store Building Section.**

| Sr No. | Insulating material. | Density ($Kg/m^3$) | Thickness (cm) | | |
|---|---|---|---|---|---|
| | | | Roof | Wall | Floor |
| 1. | Cork | 164.0 | 8.0 | 7.0 | 5.0 |
| 2. | Fibre glass | 26.5 | 7.5 | 7.0 | 5.0 |
| 3. | Expanded polyestrene | 18.4 | 7.0 | 7.0 | 5.0 |
| 4. | Mineral wool | 72.5 | 7.5 | 7.0 | 5.0 |
| 5. | Foam concrete | 320.0 | 18.0 | 15.0 | 10.0 |
| 6. | Saw Dust and Rice Husk | 150.0 | 25.0 | 20·0 | 15.0 |

(1) Apply the materials such as bitumen based composition, aluminum foil and polyethylene paper as water vapour barrier on the warm side of the insulation, as this is the zone of higher vapour pressure potential.

(2) Take adequate care to seal the joints of vapour barrier materials properly.

(3) Do not place a vapour barrier on the cold side of the insulation. This will ruin the insulation, since it would trap the moisture that might have leaked within the insulation due to several reasons.

**Selection of the Refrigeration Plant Capacity and Machinery**

The compressor being the heart of the refrigeration system it must be selected very carefully. A slow speed compressor is better suited to our climatic conditions. The floor area, number and height of the chamber, and estimated refrigeration plant capacity for cold stores of capacity 500, 1000 and 2000 tons of potato are given in table 3. It is advisable to distribute the total refrigeration load over two compressors each with slightly more than half the estimated capacity.

**Table 3**

**Design Specification for Cold Storages of Different Capacity.**

| Quantity of potato to be stored (tons) | Height of the chamber (meter) | Floor area ($m^2$) | No. of Rooms | Estimated Refrigeration capacity (tons) |
|---|---|---|---|---|
| 1. 500 | 6 | 283 | 1 | 13.5 |
| | 10 | 170 | 1 | 12.5 |
| 2. 1000 | 6 | 566 | 2 | 25 0 |
| | 10 | 340 | 1 | 23.0 |
| 3. 2000 | 6 | 1132 | 4 | 48.0 |
| | 10 | 680 | 2 | 45.0 |

The condenser must be selected to match the heat rejection of the compressor taking into account the available temperature of water. An atmospheric type of condenser is better suited to potato cold store, since it is easy to maintain. The refrigerants that are normally used are ammonia, freon-12 and freon-22. Freon is non toxic and leakage will not harm the product. Freon refrigerants however require very carefully designed piping due to their oil carrying property. From the initial cost point of view there is not much difference in ammonia or freon plants. The consumption of electricity per ton of refrigeration is also almost the same in both the plants. But the price of ammonia is about one fourth that of freon and therefore running expenses are much lower in case of ammonia plants.