Breather Bag for CA Fruit-Vegetable Storages

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In the CA (controlled-atmosphere) type fruit and vegetable storage described by Smock (4) the temperature is regulated and the level of oxygen and carbon dioxide is controlled. The equilibrium oxygen level must be equal to or below the desired control point if the oxygen level is to be controlled. The equilibrium oxygen level is determined by the rate at which the fruit consumes oxygen and the rate at which oxygen leaks into the storage room with the outside air. The rate of utilization or respiration is more or less fixed by the fruit variety and the storage temperature; therefore, the suitability of a room for CA storage is determined by leakage rate. Since leakage is a function of pressure differentials arising from several sources, (Pflug and Dewey, 2) any mechanism that reduces pressure differentials will have a substantial effect on the equilibrium oxygen level.

The possible use of an expansion device or breather bag to reduce leakage in CA storages was proposed by Pflug and Southwick (3). They found that pressure differentials and accompanying leakage due to temperature cycling of the refrigerating cooling device could be reduced through the use of a suitable breather device. Continued study of leakage characteristics of refrigerated CA storages indicates that the volume change is proportional to absolute temperature changes and that the temperature cycle is of the general shape illustrated in Fig. 1. The frequency of the temperature cycle is a function of the temperature differential of the off-on thermostat and the heat gain on the refrigerating device; however, total leakage is related to the heat gain of the storage rather than the differential of the thermostat.

The author discusses selection and operation of a breather bag for the controlled-atmosphere type of fruit and vegetable storage, and shows how it acts to reduce air leakage and as a safety device.

The breather bag serves as a reservoir for the confined storage room and functions by giving up air to the room during the cooling part of the temperature cycle. It operates in parallel with the leaks in the storage room; therefore, to be effective it must supply and recover air with very small pressure differentials. As the bag is made more efficient, the amount of air entering the room through the leaks will be reduced; however, some air will always enter and leave the storage room through the leaks.

In making recommendations for a breather bag, the space requirement and cost must be balanced with desired efficiency. The breather bag should be large enough to supply the room with the required air with a differential pressure of 0.005 in. of water. The shape of the breather bag is very important, since it must supply and then recover air from the storage. The breather bag is located outside of the storage room and in order to function must contain a large volume of air at equilibrium (The pressure inside the bag is equal to atmospheric pressure). To accomplish this the bag is supported by a rectangular frame (Fig. 2) that permits the lower portion of the bag to assume the shape of a catenary (at equilibrium). The pressure-volume characteristics of a bag that contains air at equilibrium are related...
to the length and width of the supported top, the depth, and
the weight of the material from which the bag is fabricated.
Increasing either the length, width, or depth increases the
quantity of air that can be removed from the bag for a given
pressure differential. Increasing the weight of material from
which the bag is fabricated reduces this quantity.

Two sizes of breather bags have been designed specifically
for CA rooms and have been tested to determine their
pressure-volume characteristics. One of these breather bags
is illustrated in Fig. 2. The large bag has a 3 x 10-ft top
and a depth of 7 ft at equilibrium; the smaller bag has a
3 x 5-ft top and a 7-ft depth. Both bags were fabricated
from 12 mil (0.012 in) vinyl sheeting. The pressure-vol­
ume characteristics of these bags are illustrated in Fig. 3.

The size of breather bag required for a given CA storage
will depend on the air exchanged per temperature cycle.
This is a function of the size of the room, the temperature
differential of the thermostat and the refrigeration capacity
in relation to the storage size. In making a design for gen­
eral application the following average conditions will be
used: thermostat differential, 2°F; cubic feet of atmosphere
per cubic foot of storage volume, 0.65. The resulting volume
change per 1000 cu ft of storage is 2.6 cu ft per 2°F tem­
perature change. Referring to Fig. 3 it is found that the
large bag (Curve A) will give up about 60 cu ft under the
design conditions and is sufficient to take care of a 23,000-
cu ft room and the small bag (Curve B) is adequate for a
9200-cu ft storage.

A breather bag will not be of value in reducing room
leakage if the connecting tubing and fittings require large
pressure differentials to move the air from the bag to the
room. The effect of an undersized connecting tube was
pointed out by Pfug and Southwick (3). It is recom­
nended that a 3-in I.D. duct be used to connect the breather
bag to the storage room. This duct should be as short as pos­
sible with minimum number of bends or elbows. If the con­
ditions of the installation call for a long duct or several
elbows, the duct should be sized for the particular installa ­
tion using a design pressure drop of 0.005 in of water and
duct friction data contained in the ASHVE Guide (1).

The breather bag should be connected to the room at a
point where it will not be subjected to negative or positive
pressures created by the evaporator fans. Some type of rigid
perforated duct should be used in the bag to prevent the
collapsing bag from sealing the outlet when the CA storage
room rapidly withdraws air from the bag.

Summary

The selection of the proper size of breather bag and con­
cnecting duct for a CA fruit or vegetable storage has been
outlined and the operation of the bag explained. The
breather bag acts to reduce air leakage due to temperature
cycling and at the same time acts as a safety device for the
room. In general, a properly sized and installed breather
bag may reduce the leakage from temperature cycles by 50
percent; however, the breather bag will not reduce leakage
from pressure differentials induced by evaporator fans, wind
or changing barometric pressures.

References

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3 Pfug, I. J. and Southwick, F. W. Air leakage in controlled­
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