HortScience 15(6):759–760. 1980.

An Inexpensive Chemical Scrubber for Oxidizing Volatile Organic Contaminants in Gases and Storage Room Atmospheres[1]

Mikal E. Saltveit, Jr.
Department of Horticultural Science, North Carolina State University, Raleigh, NC 27650

Additional index words. ethylene, potassium permanganate, Perlite, Purafil, air pollution, postharvest

Abstract. **A simple, inexpensive method is presented to prepare an effective chemical scrubber which oxidizes volatile organic contaminants in gases. The scrubber is made by mixing 100 ml of 1 M $KMnO_4$ per liter of dust-free Perlite in a large clear plastic bag.**

It is often necessary to remove volatile organic contaminants from streams of compressed gases and from closed storage rooms. Ethylene, a plant hormone produced by ripening and diseased fruits and vegetables, and an environmental pollutant, is difficult to detect at the very low concentrations at which it is physiologically effective (1). Adverse effects on stored crops can be minimized by using purified gases, by separating the ethylene-producing and -susceptible crops into individual rooms, or by venting the room with clean outside air (12). However, these may not be economical solutions, and venting the room cannot be done in CA storages. Scrubbing compressed air streams and recycled storage room air to remove volatile organic contaminants may be the best solution if economical and effective.

Ethylene and other volatile contaminants have been removed from air samples and from storage room atmospheres by either reacting them with chemicals, or by absorbing or adsorbing them with inert material. Dostal and Hoff (3) suggested using paraffin oil to remove volatiles from storage atmospheres. Brominated charcoal has been found effective in reducing apple scald (11), but its effectiveness in removing ethylene from air samples in lab tests has been both positive (11) and negative (5). Of the reactive chemicals, the noncorrosive chemical potassium permanganate ($KMnO_4$) is generally regarded as the most effective scrubber (1, 3, 5, 10). It also has the desired quality of reacting with other pollutants as well as ethylene (3, 7, 8). Kuc et al. (6) built a unit in which a fine spray of an aqueous alkaline solution of $KMnO_4$ came in contact with storage room air. They did not measure ethylene levels, but reported less scald on apples in the room with the unit. However, such units are not very efficient since ppm concentrations of ethylene in air react slowly with aqueous permanganate solutions (3, 8). To overcome this, $KMnO_4$ has been applied to support material to make an easily handled solid scrubber, and to increase the effective surface area. Celite (4, 5), silica gel (2), and vermiculite (10) have been used as support material. Self-indicating soda-lime, that contains manganate, has been reported to remove ethylene from air (9). A comercially available material, Purafil (H.E. Burrough and Assoc., 3550 Broad St., Chamblee, GA 30341) is compounded with alumina and is more effective but more expensive than the other scrubber formulations previously listed.

An inexpensive scurbber can be made by mixing aqueous $KMnO_4$ with commercial horticultural Perlite. The Perlite must first be cleaned of dust and particles smaller than a mm in diameter by sieving or winnowing. A 1.0 M solution of $KMnO_4$ is then made by dissolving 15.8 g of $KMnO_4$ in 100 ml of 50°C water. One hundred ml of the hot $KMnO_4$ solution is added per liter (110 g) of sized Perlite in a large clear double-layered plastic bag. The contents are gently shaken until the purple colored solution is uniformly distributed.

One kg of $KMnO_4$, which costs from \$21.00 to \$1.70 depending on the purity and quantity purchased, makes about 63 liters (2.2 cu ft), or 8 kg (17 lb.) of this air scrubber. With a 50% efficiency, this amount of scrubber could oxidize about 78 liters of pure ethylene to ethylene glycol. This is equivalent to scrubbing a 35 × 35 × 6.4 m storage room (e.g., a 100,000 bu apple storage) of 10 ppm ethylene, or removing 10 ppm ethylene from an air stream at 1 liter/min for 15 years! However, the oxidation of other volatile compounds in the air would almost certainly drastically reduce the effective life of any scrubber.

The scrubber material can either be enclosed in a glass jar or tube to remove volatile organic contaminants from streams of compressed gases, or it can be enclosed in porous containers of various configurations to scrub contaminated storage room air. A cylindrical, porous container can easily be made from a meter square piece of either PVC coated fiberglass, or galvanized metal window screen. The cut ends of the PVC coated fiberglass can be welded together with a hot glass rod. The cut ends of the metal and fiberglass screen can also be sewn together with fine wire to form a cylinder. One end of the cylinder can then be sealed shut, and the scrubber poured in the other end, which can then be sealed. If the Perlite has been properly sized to remove small particles there should be no problem with dust if the units are handled gently. The high relative humidity typically found in most storage rooms enhanced the activity of the scrubber. Periodic examination will indicate when to replace the scrubber material in either application, since it changes color from a deep purple to a rusty red and finally an ashy gray as the MnO_4^- is reduced to MnO_2.

Certain precautions are necessary when making the scrubber. Potassium permanganate is a poisonous and highly reactive chemical which should only be handled by competent personnel wearing proper protective clothing, gloves, and safety glasses. Proper disposal may present a problem since manganese is a potentially toxic heavy metal pollutant.

The efficiency of the scrubber was compared to that of 3 mm diameter pellets of Purafil in a number of tests. The oxidizing capacities of the scrubbers were compared by titration with oxalic acid. One to 3 g of each scrubber was ground to a fine dust with a glass rod, mixed with 200 ml of boiling water, and titrated with boiling 0.1 M oxalic acid until the solution became colorless. Our scrubber contained significantly more $KMnO_4$ than did Purafil. Each g of Purafil oxidized 12.8 ± 0.6 mM of oxalic acid, while the Perlite scrubber oxidized 17.3 ± 1.4 mM of oxalic acid.

In another test, glass tubes, 2.3 cm diameter by 110 cm, were filled with about 440 ml of scrubber; this corresponds to about 125 g of the Perlite scrubber and about 330 g of Purafil. Since we observed that the efficiencies of the scrubbers were related to moisture content, humidified ethylene-free air was passed through the tubes for a week to equilibrate their moisture contents. Humidified air containing 10 ppm ethylene was then passed through the tubes. Detectable amounts of ethylene were measured in the effluent from each

[1]Received for publication March 27, 1980. Paper No. 6339 of the Journal Series of the North Carolina Agricultural Research Service, Raleigh, NC. The use of trade names in this publication does not imply endorsement by the North Carolina Agricultural Research Service of products named, nor criticism of similar ones not mentioned.

The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper must therefore be hereby marked *advertisement* solely to indicate this fact.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-08-31 via Open Access. This is an open access article distributed under the CC BY-NC-ND license (https://creativecommons.org/licenses/by-nc-nd/4.0/). https://creativecommons.org/licenses/by-nc-nd/4.0/

of 3 tubes containing the Perlite scrubber at flow rates above 190 ml/min, while flow rates had to exceed 500 ml/min for ethylene to be detectable in the effluent from tubes containing Purafil. Although Purafil was more effective on a volume basis, the Perlite scrubber was just as effective as Purafil on a weight basis in this test.

The flow of 10 ppm ethylene in air was continued at a reduced rate of 100ml/min. After 1 week, about 2 cm of Purafil near the inlet was discolored, while about 8 cm of the other scrubber was discolored. We assumed that discoloration took place in both scrubbers when equal amounts of ethylene had been oxidized. Purafil was 4 times as effective on a volume basis, but only 50% more effective on a weight basis.

In another test, the efficiency of Purafil was compared with that of scrubbers having Perlite or vermiculite as the solid substrate, and containing equal amounts of $KMnO_4$. After the moisture contents of the scrubbers were equilibrated, 20 g of each scrubber was put into each of 3 one-liter glass jars. One ml of pure ethylene was injected into the jars, and its rate of loss monitored by taking periodic 1-ml gas samples. The half-time for ethylene loss was 1.9 ± 0.5 min for Purafil, 4.8 ± 0.2 min for the scrubber made with Perlite, and 7.7 ± 0.4 min for the scrubber made with vermiculite. In this final test, Purafil was about 2.5 times more effective than the Perlite scrubber, and about 4 times more effective than the vermiculite scrubber. In this comparison, the Perlite scurbber was 60% more efficient than the vermiculite scrubber.

Although the Perlite scrubber is generally not as effective as Purafil on a weight or volume basis, its relative cost makes it an attractive alternative to commercial methods of removing volatile organic contaminants from gases. At current prices, a kg of Purafil costs about \$7.20, while a kg of the Perlite scrubber can be made for only \$2.25.

Literature Cited

1. Abeles, F.B. 1973. Ethylene in plant biology. Academic Press, N.Y. p 16, 24-25, 153-196.
2. ________, L.E. Forrence, and G.R. Leather. 1971. Ethylene air pollution. Effects of ambient levels of ethylene on the glucanase content of bean leaves. *Plant Physiol.* 48:504-505.
3. Dostal, H.C. and J.E. Hoff. 1968. Feasibility of use of paraffin oil for purification of storage atmosphere. *HortScience* 3:46-48.
4. Forsyth, F.R., C.A. Eaves, and H.J. Lightfoot. 1969. Storage quality of McIntosh apples as affected by removal of ethylene from the storage atmosphere. *Can. J. Plant Sci.* 49:567-572.
5. ________, ________, and C.L. Lockhart. 1967. Controlling ethylene levels in the storage atmosphere of small containers of apples. *Can. J. Plant Sci.* 47:717-718.
6. Kuc, J., R.E. Henze, C.E. Baker, and F.W. Quackenbush. 1953. Apple scald: use of alkaline permanganate for control in refrigerated storages. *J. Agr. Food Chem.* 1:1107-1109.
7. Nelson, R.C. 1937. The quantity of ethylene present in apples. *Plant Physiol.* 12:1004-1005.
8. ________. 1939. Studies on production of ethylene in the ripening process in apple and banana. *Food Res.* 4:173-190.
9. Nichols, R. and A. Topping. 1966. Absorption of ethylene by self-indicating soda-lime. *Nature* 211:217.
10. Scott, K.J., W.B. McGlasson, and E.A. Roberts. 1970. Potassium permanganate as an ethylene absorbent in polyethylene bags to delay ripening of bananas during storage. *Austral. J. Expt. Agr. Anim. Husb.* 10:237-240.
11. Southwick, F.W. and R.M. Smock. 1943. Lengthening the storage life of apples by removal of volatile materials from the storage atmosphere. *Plant Physiol.* 18:716.
12. Staby, G.L. and J.F. Thompson. 1978. An alternative method to reduce ethylene levels in coolers. *Flor. Rev.* 163:31, 71.

HortScience 15(6):760–762. 1980.

Influence of Ground Bed Heating and Cultivar on Tomato Fruit Cracking[1]

T.J. Koske[2]

Louisiana Cooperative Extension Service, Louisiana State University, Baton Rouge, LA 70803

J.E. Pallas, Jr.[3]

Southern Piedmont Conservation Research Center, P.O. Box 555, Watkinsville, GA 30677

J.B. Jones, Jr.[4,5]

Department of Horticulture, University of Georgia, Athens, GA 30602

Additional index words. Lycopersicon esculentum, soil temperature

Abstract. **Increased temperature of the growing bed had no effect on fruit yield, fruit cracking, skin strength, or plant growth of tomato (*Lycopersicon esculentum* mill.). Yield losses from cracking were 2, 16 and 35% in the fall, spring and summer crops, respectively. The pink-fruited 'Ohio-Indiana Hybrid O' and 'Missouri Hybrid 756' had greater fruit losses due to cracking than the red-fruited 'Floradel' and 'Rapids'. Large fruit were more susceptible to cracking. Fruit cracking in the fall crop was predominantly concentric in nature whereas cracked fruit in the summer was predominantly radial. Skin puncture resistance was inversely related to fruit cracking.**

Fruit cracking is one of the most serious fruit disorders of greenhouse tomatoes. A 3-crop greenhouse tomato study was made to determine the nature and extent of fruit cracking among 4 cultivars in an artificial rooting medium with continual subirrigation and elevated temperatures of the growing beds. Temperature treatments served to partially evaluate an alternate method of adding heat to a greenhouse tomato crop.

Four cultivars of greenhouse tomato, 'Floradel' and 'Rapids' (red-fruited) and 'Ohio-Indiana Hybrid O' and 'Missouri Hybrid 756' (pink-fruited), were selected based on preliminary studies.

The study was conducted during the 1975-76 season in a glasscovered house located near Watkinsville, Ga. (83° 25' W, 33° 52' N). The climatic conditions existent in the greenhouse and the cultural practices, water regulation, trough structure, and fortified pine bark-vermiculite medium have been previously described (3, 8). A 300-watt electric heating mat was positioned between the gravel and the medium. The root-zone temperature was controlled by a thermostat (5°C differential) whose sensor was positioned 12 cm above the mat.

An unheated control and minimum media temperatures were maintained at 20, 24, 28°C for the fall and winter crops. During the summer of 1976, a 32°C minimum temperature treatment was substituted fo the 20°C treatment. The water table level was maintained 3 cm above the mat. Greenhouse air temperature was maintained at a minimum of 18°C. From April 14, 1976 until Ocotber 23 "Lumite"[6] shade

[1]Received for publication May 31, 1980. Partial fulfillment of requirement for the Ph.D. degree.

The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper must therefore be hereby marked *advertisement* solely to indicate this fact.

[2]Extension Horticulturist.

[3]Plant Physiologist, U.S. Department of Agriculture.

[4]Professor of Plant Science.

[5]The authors gratefully acknowledge the assistance of Mrs. Edith Jones and Mr. Donald Maxey. Seed for these studies was provided by W.L. George, Jr., University of Illinois, Urbana, and V.N. Lambeth, University of Missouri, Columbia.

[6]Trade names and company are given for the benefit of the reader and do not imply preferential endorsement by U.S. Department of Agriculture over similar products of firms.

Downloaded from https://prime-pdf-watermark.prime-prod.pubfactory.com/ at 2025-08-31 via Open Access. This is an open access article distributed under the CC BY-NC-ND license (https://creativecommons.org/licenses/by-nc-nd/4.0/). https://creativecommons.org/licenses/by-nc-nd/4.0/