Table II. Effectiveness of Scrubbing Solutions in Removing Scald-Producing Compounds from Moving Air Stream Containing Apple Storage Volatiles

Scrubbing Solution	Time (Hours) and Degree of Damage								
	8	12	24	30	36	96	120	144	168
	Room Temperature (26° to 28° C.)								
(*a*) Distilled H_2O	++	+++							
(*b*) 1% KOH	−	−	+	+++					
(*c*) 10% KOH	−	−	−	+	+++				
(*d*) $KMnO_4$[a] + (*c*)	−	−	−	−	−	+	+++		
(*e*) $KMnO_4$[b] + (*c*)	−	−	−	−	−	−	−	+	+++
(*f*) $KMnO_4$[b]	++	+++							
(*g*) 10% H_2SO_4 + (*f*)	+	++	+++						
(*h*) 10% NaOCl + (*c*)	−	−	−	+	+++				
(*i*) 5% Alc. soln. chlorophyll	−	+	+++						
(*j*) 5% aq. soln. chlorophyll	−	+	+++						
	Cold Storage (0° to 2° C.)								
(*k*) Distilled H_2O	−	−	−	−	−	+	++	+++	
(*l*) 10% KOH or NaOH + (*f*)	−	−	−	−	−	−	−	−	−[c]

[a] 5 grams of $KMnO_4$ per 100 ml. of solution.
[b] 10 grams of $KMnO_4$ per 100 ml. of solution.
[c] Slight damage after 21 days, severe after 30 days.
− No damage.
+ Slight damage.
++ Medium damage.
+++ Severe damage.

Acknowledgment

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APPLE SCALD

Use of Alkaline Permanganate for Control in Refrigerated Storage

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Preliminary studies on the use of alkaline permanganate air scrubbing for control of apple scald in refrigerated storage rooms showed considerable promise. An experimental air-scrubbing apparatus is described and the approximate cost of operation is given.

Removal from the air of certain volatile compounds produced by apples in storage is highly desirable, as it would help delay ripening, prevent storage scald, and retain apple quality. A brief review of the chemical composition of apple volatiles and the characteristics of apple storage scald has been given (*1*).

Kuc *et al.* (*1*) showed that esters, which constitute the major fraction of apple storage volatiles, were the most active scald-producing agents under laboratory conditions. Air scrubbing with an alkaline permanganate solution was effective in trapping esters and other volatiles and suggested a possible control measure for scald in commercial apple storages. Smock (*2*) reported in a series of trials with 2-bushel lots of McIntosh apples in controlled storage that alkaline perman-

Table I. Comparison of Air-Purification Methods in Reducing Incidence and Severity of Scald on Grimes Apples in Storage

Days in Storage	Treatment	Per Cent Scald: No Aeration after Storage: Slight	Medium	Severe	Total	Aeration after Storage: Slight	Medium	Severe	Total
52[a]	Alkaline permanganate	0.0	0.0	0.0	0.0	...	...	...	...
	Carbon	2.1	0.0	0.0	2.1	...	...	...	...
	Control	21.7	0.0	0.0	21.7	...	...	...	...
62	Alkaline permanganate	23.9	0.0	0.0	23.9	...	...	...	...
	Carbon	48.7	0.0	0.0	48.7	...	...	...	...
	Control	58.3	0.0	0.0	58.3	...	...	...	...
70[b]	Alkaline permanganate	17.0	61.7	0.0	78.7	12.3	22.0	0.0	34.3
	Carbon	...	...	...	...	...	...	...	...
	Control	8.1	88.7	0.0	96.8	20.0	71.7	0.0	91.7
76	Alkaline permanganate	23.2	38.8	14.8	76.8	20.6	28.8	2.0	51.4
	Carbon	35.8	35.8	9.4	81.0	7.2	28.8	58.5	94.5
	Control	9.5	41.5	46.2	97.2	7.7	37.4	51.5	96.6
83	Alkaline permanganate	30.0	0.0	17.0	47.0	14.4	13.4	15.2	43.0
	Carbon	6.2	0.0	91.1	97.3	6.7	0.0	89.5	96.2
	Control	0.0	0.0	100.0	100.0	7.5	0.0	92.5	100.0
90	Alkaline permanganate	40.4	0.0	11.1	51.5	22.9	0.0	24.8	47.7
	Carbon	14.9	0.0	79.2	94.1	14.1	0.0	82.6	96.7
	Control	2.3	0.0	93.9	96.2	17.2	0.0	77.7	94.9
95[c]	Alkaline permanganate	27.1	0.0	32.2	59.3	26.8	0.0	22.5	49.3
	Carbon	16.2	0.0	70.9	87.1	15.4	0.0	78.0	93.4
	Control	17.6	0.0	70.9	88.5	9.8	0.0	86.6	96.4

[a] Results for 52- and 62-day storage periods based on 2-bushel samples per room per treatment.
[b] Results for 70-, 76-, 83-, and 90-day storage periods based on 1-bushel samples per room per treatment.
[c] Final scald count based on 10-bushel samples per room per treatment.

ganate in the concentrations used did not give control but that activated charcoal on which bromine had been adsorbed gave effective control of scald. Alkaline permanganate has been compared with activated carbon for the removal of volatiles in a pilot size apple storage and the results are presented in this preliminary report.

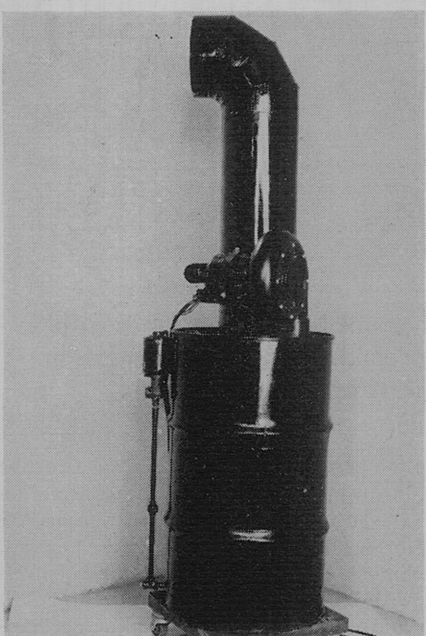


Figure 1. Air scrubber used for alkaline permanganate treatment of storage air

Methods and Materials

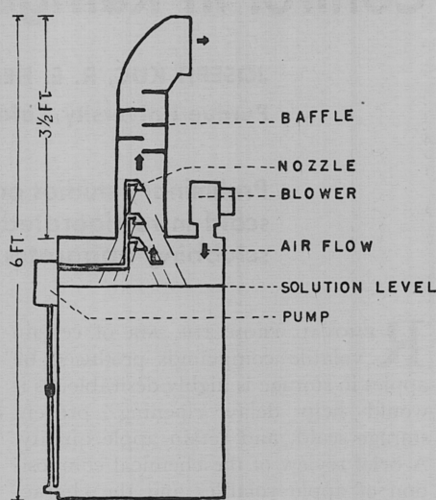
Eighty bushels of Grimes and 10 bushels of McIntosh apples were stored for 95 days in each of three experimental refrigerated storage rooms of 150- to 180-bushel capacity cooled by overhead plate coils. One room was equipped with a commercial activated-carbon air-purifying unit consisting of a blower and two canisters of activated coconut shell carbon. The second room served as the control and had similar air circulation without activated carbon. The third room was equipped with an alkaline permanganate air scrubber. The temperature in all rooms was maintained at 30° to 34° F., and the relative humidity varied between 85 and 95%. The concentration of sodium hydroxide and potassium permanganate in the alkaline permanganate scrubbing solution was such as to maintain the above relative humidity with no difficulty.

Grimes apples were placed in storage September 9, 1952, at a distinctly preclimacteric stage (average pressure test, 24 pounds; soluble solids, 12.4%). They were stored in wooden boxes, stacked five high, and a 2-inch space was allowed for the circulation of air around each stack. Postclimacteric McIntosh apples were placed in storage September 18, 1952. They were stored merely to increase the volatile level in the storage rooms, and scald counts and pressure tests were run only with Grimes.

The alkaline permanganate air-scrubbing apparatus was constructed from a 30-gallon oil drum, a large air blower (ILG Type P volume air blower, size 7$^1/_2$ P, 3400 r.p.m., 80 cubic feet per minute at 3-inch static water pressure.) small liquid-circulating pump, assorted spray nozzles, and several lengths of $^1/_4$ inch pipe and 9-inch furnace duct (Figures 1 and 2). Eighteen pounds of technical grade sodium hydroxide and 7 pounds of C. P. potassium permanganate were dissolved in 25 gallons of water in the drum. This solution, circulated at 1.0 to 1.5 gallons per minute by the small pump located at the side of the tank, was sprayed through a series of five nozzles to wash the rising air. Five semicircular baffle plates in the 9-inch duct above the nozzles prevented spray from being carried out into the storage room. The concentration of sodium hydroxide and potassium permanganate in the scrubbing solution varied during the storage season, between 5.0 and 7.9% and 1.9 and 2.9%, respectively. The solution was replaced twice during the storage season. The blower circulated the air at approximately 100 cubic feet per minute.

For the first and second scald counts made after 52 and 62 days of storage, two bushel boxes of Grimes apples were removed from each of the storage rooms, wrapped with brown paper, and allowed to stand at room temperature for 3 days before being counted. For the third scald count made after 70 days of storage and for subsequent counts, one of the two boxes was wrapped with paper to restrict aeration, while the other box was opened and the apples

Figure 2. Diagram of air scrubber



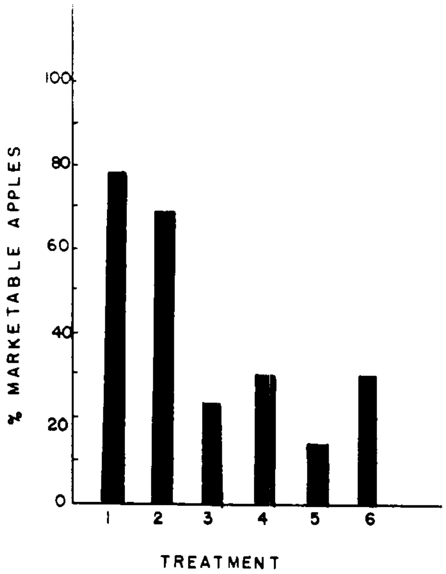


Figure 3. Comparison of alkaline permanganate and activated carbon in maintaining marketability of Grimes apples during 95 days' storage

1. Alkaline permanganate plus poststorage aeration
2. Alkaline permanganote
3. Activated carbon plus poststorage a eration
4. Activated carbon
5. Control plus poststorage aeration
6. Control

were spread out on a table to provide aeration during the 3 days prior to counting.

The final scald count was conducted 95 days after storage with 20 bushels of Grimes apples from each of the test rooms. Ten bushels from each room were wrapped with paper and stacked; the apples from the remaining 10 bushels were spread out singly in a large vacant room. The apples were kept at room temperature for 4 days, and then inspected for the incidence and severity of scald. Slight scald was judged as that injury which would not appreciably detract from the market value of the fruit, medium scald that injury which would definitely result in a drop in market value, and severe scald as that which would render the fruit essentially unsalable.

Results and Discussion

Pressure tests with the Magness and Taylor pressure tester showed no consistent differences in softness between apples in the control room and those in the permanganate room; however, they did show a slightly softer fruit in the activated carbon room. The air temperature in the carbon room rose to 42° F. during a 5-hour period on the 17th day of storage because of necessary repairs on the cooling system. This temperature rise may account in part for the slightly increased comparative softness of the fruit in this storage room.

The incidence and severity of scald on apples stored in the permanganate room were substantially lower than those on apples in the other two rooms (Table I). The percentage of marketable apples was, therefore, much greater in the permanganate room (Figure 3). Most of the scald in this room was slight and would result in little reduction of the market value of the apples. On the other hand, apples in the control and carbon rooms had a considerably lower percentage of marketability (Figure 3).

Aerating after removal from cold storage generally proved beneficial in reducing scald on apples from the permanganate room but not on apples from the other rooms.

Although perfect control of apple scald was not attained in this experiment, the method shows considerable promise. Since the apples were stored in tight wooden boxes, lack of proper aeration during storage was undoubtedly an important limiting factor. Apples in the center of the box consistently exhibited more scald injury than those on top or around the sides. Slatted field crates would undoubtedly allow greater aeration, and with respect to scald control, would be more suitable. It is probable that most orchardists would pick apples at a more advanced stage of maturity and therefore less susceptible to scald than those used in this experiment. The conditions imposed by this experiment have provided a severe trial for the prevention of scald.

Certain improvements can be made in the air-scrubbing apparatus. The apparatus was out of operation for short periods because of mechanical failure. During the last 10 days of the experiment the circulating pump ceased to operate and only the blower was functioning. Three shutdowns of approximately 4 hours each were experienced while the solution was being changed. Minor changes in mechanical design and the use of a continuous-action circulating pump of larger capacity should correct these defects.

The total cost of operating the air scrubber for 95 days was $31.00, $10.00 of which was for chemicals and $21.00 for electrical power to operate the pump and blower. This work is preliminary in nature. Further experiments using an improved air scrubber and other varieties of apples are planned.

Summary

At the end of a 95-day storage test with Grimes apples 68% of the apples were marketable when stored in a room equipped with an alkaline permanganate air-scrubbing unit, as compared with 29% in a room equipped with an activated carbon unit, and 29% in a room without air treatment. When apples were aerated after removal from storage, the percentages of marketability were 78, 22, and 14%, respectively.

Experimental equipment using an alkaline permanganate solution for the removal of apple storage volatiles is described.

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FOOD ANALYSIS

Identification of Enzyme-Desugarized Egg Solids

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A NEW METHOD FOR REMOVING GLUCOSE FROM EGG ALBUMEN and whole egg prior to drying has been adopted by producers of egg solids in the past year (*1, 2, 4*). The glucose is converted to gluconic acid through the use of glucose oxidase and catalase with the concomitant addition of hydrogen peroxide as a source of oxygen. When properly prepared, their blandness and freedom from odor distinguish these products from egg solids prepared by other com-