Commercial Ventilation of Beets In Storage

L. P. ORLEANS AND ROBERT H. COTTON[1]

A previous paper (3)[2] reviewed the early work on ventilation of sugar beets in storage. The purpose of this paper is to present the results obtained from ventilation performed at Sidney, Montana, in 1948; Carlton, California, in 1949, and Hardin, Montana, in 1949.

Experimental Method

Captive samples were used in all ventilation work to determine the savings obtained. These samples were made by matching triplets of beets from the same truckload for size and shape. The beets were cleaned by brushing off the adhering dirt, using care not to injure the beet, and from each triplet one beet was placed in a ventilated pile sample, one in a check pile sample, and one in a laboratory sample. Triplets were matched and cleaned for each set of samples until there were approximately forty pounds of beets in each sample. The laboratory sample was analyzed for purity and sugar content, and the other two samples were weighed and then placed in corresponding positions in their respective piles. The two piles were made simultaneously and side by side. Open mesh cabbage bags were used to hold the samples in the work at Sidney and Hardin, and bags made from one-inch mesh chicken netting were used for the work at Carlton. The captive samples remained in the piles until the beets were processed by the mill.

When the beets were removed for processing, the captive samples were again weighed and then analyzed in the laboratory for sugar and purity. Thus from the difference between the two samples we could calculate the actual savings obtained by ventilation. The results for each experiment were also analyzed statistically by analysis of variance to establish the significance of the differences between the ventilated and check treatments.

Sidney, Montana, Ventilation—1948

A 2,600-ton pile was ventilated using three 7.5 hp. axial flow fans having a capacity of 13,500 cubic feet per minute or an air supply of 15.5 CFM per ton of beets ventilated. Ducts to carry the air into the pile were constructed using 55-gallon oil drums as suggested by M. G. Frakes (2) of Michigan Sugar company. Our procedure differed from previous work in that two thermostats were used with each fan to operate the fans between the preset temperatures of the thermostats. Auomatic louvres were used to prevent escape of cool air from the piles through the ducts when fans were not in operation.

A brief summary of the results obtained at Sidney is given in Table 1. Temperatures of the piles were similar to those obtained by Doxtator and Downie (1), and more complete results of the work at Sidney have been

[1] Holly Sugar Corporation, Colorado Springs, Colorado.

[2] Numbers in parentheses refer to literature cited.

published elsewhere (3). Fifty captive samples were used in each pile and differences in purity and total sugar were between the 5% and 1% level of significance.

Table 1.—Results at Sidney, Montana—1948

	% Weight Loss	% Total Sugar Loss	Purity Drop	Tons Sugar Bagged per Pile	Tons Molasses Produced per Pile
Ventilated Pile	7.79	9.11	3.55	235.0	189.8
Check Pile	8.90	12.59	5.67	212.7	207.8
Difference	1.11	3.48	2.12	22.3	18.0

Economic analyses of the above data were so favorable that a commercial installation was installed in 1949 at Hardin, Montana.

Carlton, California, Ventilation—1949

Because of the extremely high temperatures encountered in the Imperial valley of California during the harvest period, the elapsed time between harvest of beets and the processing of them is held to a minimum. Although beets delivered directly to the Carlton plant are held in the storage bins only 12 to 48 hours, there is an important loss in sugar. Therefore, experiments were conducted using one 7.5 hp axial flow fan to ventilate 350 tons of beets in the storage bin. This was an air supply of 38.5 CFM per ton of beets. A duct was constructed of galvanized iron to carry the air through a spray chamber and into the bin through openings cut in the floor. A drop in air temperature of from 11 to 34° F. was obtained in the spray chamber during our tests when outside air temperatures ranged from 82° F. at night to 110° F. during the day. Two tests were used to evaluate our work with 19 sets of captive samples in one test and 20 sets in the other. Because of differences in length of time the beets were in the ventilated and check bins no statistical analysis was possible, but we were able to plot our results versus time in storage and the data shown in Table 2 are taken from these curves.

Table 2.—Results at Carlton—1949

			% Weight Retention		% Total Sugar Retention		% Purity Retention[1]		% Recoverable Sugar Retention	
	Average Temp.									
Hours in Bins	Vent.	Check	Vent.	Check	Vent.	Check	Vent.	Check	Vent.	Check
0	85.0	83/7	100	100	100	100	100	100	100	100
12	74.0	85.6	98.0	96.4	99.7	99.4	99.8	99.4	96.5	94.9
24	73.0	85.2	97.1	95.5	98.6	96.9	99.1	97.8	92.1	89.0
36			96.5	95.1	95.3	90.8	97.1	94.4	85.4	81.1

[1] % Purity retention = $\frac{\text{purity at given time}}{\text{initial purity}} \times 100$

Hardin, Montana, Ventilation—1949

Commercial ventilation of beets was practiced for the first time by Holly Sugar Corporation at Hardin in 1949. The method of ventilating beets at Hardin was the same as that at Sidney in 1948 with thermostats used to control the fans and automatic louvres to prevent escape of cool air from the pile through the ducts when the fans were not in operation. By using thermostats to control the fans we were able to utilize the maximum

possible time for ventilation. The thermostats were set to turn the fans as soon as the atmospheric temperature dropped low enough to cool the beets, and the fans remained on until the air again became too warm to cool the beets or so cold that it might freeze the beets. We also eliminated the necessity of having a man on duty 24 hours a day to turn the fans on and off as the weather dictated and thereby saved a great deal on labor costs.

Table 3.—Average Pile Temperature at Hardin, 1949

	Oct. 7	Oct. 14	Oct. 21	Oct. 28	Nov. 4	Nov.	Nov. 18	Nov. 25	Dec. 2	Dec. 9	Dec. 16
Vent. Pile	48.0	39.0	37.7	39.9	39.6	38.1	36.9	35.6	36.8	34.0	34.9
Check Pile	49.5	45.8	39.7	44.9	48.9	47.4	45.3	44.6	43.4	35.4	34.1
Difference	1.5	6.8	2.0	5.0	9.3	9.3	8.4	9.0	6.6	1.4	0.8

The automatic louvres, which remained closed while the fans were not in operation, prevented the cool air from leaking out of the pile through the ducts. This did not prevent cool air seepage through the sides of the pile, but without louvres a strong outward current of cool air passed through the ducts, which offered the path of least resistance to the flow of air. Eight fans were used to ventilate 7,500 tons of beets, with an air supply of 14.4 CFM per ton of beets. Sixty-seven captive samples were placed in each pile. The results, when analyzed statistically by analysis of variance, were significant beyond the 1% level for both total sugar retention and purity change. Weekly temperatures for the ventilated and check piles are shown in Table 3. A summary of the results of the ventilation work is shown in Table 4.

Table 4.—Results at Hardin—1949

	% Weight Loss	% Total Sugar Loss	Purity Drop	Tons Sugar Bagged	Tons Molasses Produced
Ventilated Pile	6.02	4.61	.04	983.6	243.7
Check Pile	6.05	8.29	1.61	927.1	264.5
Difference	.03	3.68	1.57	56.5	20.8

After the cost of ventilation (5% repair and maintenance, power and labor) was subtracted from the gross saving, a gross profit from ventilation of $.808 per ton of beets ventilated was realized. It appears that such an installation will pay for itself in terms of net profit in three to four years of operation.

Literature Cited

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