Permanent Beet Storage Installation Cost Studies

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FOR SEVERAL YEARS we have been making experiments on the storage of sugar beets in regard to air capacity, friction loss, cooling efficiency, evaporative cooling, freezing temperatures, air washing and relative humidity. These problems all have to be approached from a scientific and experimental angle and their results are very much necessary before we can proceed in any kind of commercial storage installation. However, in the meantime, we can make tentative plans on paper for the purpose of estimating what our beet storage costs will be for any one of a number of varying conditions. The purpose of this paper is to estimate as nearly as possible the cost of storing sugar beets on a 10,000-ton scope with a permanent installation considering such variables as 1. open pile versus completely controlled closed piles; 2. 20 c.f.m. air requirement against 15 and 10 c.f.m. air requirement per ton; 3. washed air versus dry air; 4. a five months' storage versus 3 months' storage; 5. 18-foot pile height versus 14-foot pile height and 20-foot pile height; 6. a 90-foot width pile versus 75-foot width versus 60-foot width, in the closed storage set-up. In other words, what we are attempting to study is the design of a permanent installation for sugar beet storage taking into consideration technical background which we have learned about to the present date on a cost basis. Fundamental costs are shown in table 1.

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Table 1. Basis of cost estimates.

Description	Unit	Material	Labor	Total
Concrete and forms, reinforced	Cubic yard	$ 17.10	$ 13.40	$ 30.50
Concrete and forms, plain	Cubic yard	10.90	11.60	22.50
Excavation	Cubic yard	----	.70	.70
Gates and grates for air control	Pound	.30	Estimation	----
Hangers for conveyors	Ton	100.00	35.00	135.00
Insulation	Square feet	.06	.04	.10
Lumber	M.F.B.M.	70.00	90.00	160.00
Pipe, reinforced concrete (Varies according to diameter)	L.F.	1.00 to 6.50	.30 to .80	1.30 to 7.30
Pulleys, idler	Each	8.00	2.00	10.00
Pulleys, conveyor	Each	40.00	2.00	42.00
Purlins	Ton	100.00	35.00	135.00
Rails	Ton	70.00	35.00	105.00
Roofing	Square	10.00	3.00	13.00
Rubber belting	L.F.	2.25	----	2.25
Trusses	Ton	100.00	35.00	135.00

Assuming that beets lost 1 pound of sugar per ton per day of storage, and supposing that permanent beet storage installations which would save half of that amount could be designed, an expenditure of $1.00 per ton for storage equipment and its operation on a storage period of 25 days would not be out of line with sugar valued at $ .08 per pound. Considering a storage period of 50 days it would seem that something less than $2.00 per ton could be spent on controlled storage.

Two Different Plans Are Considered in This Cost Study

Plan A considers a pile of the open variety with all of the control operations carried on from the bottom of the pile. It consists of a system of underground tunnels at designated places throughout the piling area. Provision is made for varying the amounts of air to be introduced at various localities in the pile. Air washing possibilities are studied. The underground tunnel will be used for a drain as well as for a main conduit for the air. This plan is less complicated and less expensive from an installation viewpoint than is plan B.

Plan B.—This plan is the other extreme which goes all of the way towards complete control of the storage conditions. The pile is completely covered and a cross section of the building approximates a square set on a corner. Floors are of concrete. The roof is well insulated and covering is as air-tight as practically possible. Top vents may be used. Beets both enter and are discharged from the storage building by means of rubber belt conveyors. The loading and unloading station is at one point and the upper pile loading belts are just under the roof of the building. The lower belt for the pile discharge is underneath the building and just over the main air duct which will not be unlike the main duct for plan A. The blower house and air washer arrangement will also be somewhat similar to that of plan A. The Athey loader will not be required as the beets can be removed from the pile building by something similar to a fluming process, using the removal of grating at time intervals to affect the correct amount of discharge to the lower rubber belt conveyor. Regular tripping equipment may be used to discharge the upper pile loading conveyor.

Summary

If permanent storage is to be further considered, the following basic information should be obtained.

1. Definite information should be secured on how high beets can be piled without damage.

2. Definite information on how long beets can be kept under various heights determined in the previous experiment.

Table 2.

Open Pile 18 Feet High Closed Pile 90 Feet Wide	Material costs	Labor costs	Installation costs	Interest and maintenance	Operational costs	Cost per ton year 10-year basis	Cost per ton year 20-year basis		
Open pile air at 20 CFM/T	$25,654.00	$ 9,373.00	$ 35,027.00	$ 2,102.00	$ 1,472.00	$ .71	$ .53	Air alone	5 months storage
Closed pile air at 20 CFM/T	55,501.00	22,432.00	77,933.00	4,676.00	1,472.00	1.05	.73		
Open pile air at 15 CFM/T	16,974.00	7,357.00	24,331.00	1,460.00	1,069.00	.50	.37		
Closed pile air at 15 CFM/T	52,276.00	21,896.00	74,172.00	4,450.00	1,069.00	.95	.65		
Open pile air at 10 CFM/T	13,347.00	6,857.00	20,204.00	1,212,00	780.00	.40	.30		
Closed pile air at 10 CFM/T	50,059.00	21,550.00	71,609.00	4,297.00	780.00	.88	.60		
Open pile air at 20 CFM/T	35,733.00	12,008.00	47,741.00	2,864.00	2,278.00	.99	.75	Washed air	
Closed pile air at 20 CFM/T	66,652.00	24,239.00	90,891.00	5,453.00	2,278.00	1.34	.96		
Open pile air at 15 CFM/T	26,788.00	10,028.00	36,816.00	2,209.00	1,496.00	.74	.55		
Closed pile air at 15 CFM/T	63,597.00	24,665.00	88,262.00	5,296.00	1,496.00	1.22	.85		
Open pile air at 10 CFM/T	19,628.00	8,489.00	28,117.00	1,687.00	1,050.00	.56	.41		
Closed pile air at 10 CFM/T	56,515.00	2 ,107.00	79,622.00	4,777.00	1,050.00	1.04	.71		
Open pile air at 20 CFM/T	25,654.00	9,373.00	35,027.00	2,102.00	2,454.00	.81	.63	Air alone	3 months storage
Closed pile air at 20 CFM/T	55,501.00	22,432.00	77,933.00	4,676.00	2,454.00	1.15	.83		
Open pile air at 15 CFM/T	16,974.00	7,357.00	24,331.00	1,460.00	1,781.00	.57	.45		
Closed pile air at 15 CFM/T	52,276.00	21,896.00	74,172.00	4,450.00	1,781.00	1.02	.72		
Open pile air at 10 CFM/T	13,347.00	6,857.00	20,204.00	1,212.00	1,300.00	.45	.35		
Closed pile air at 10 CFM/T	50,059.00	21,550.00	71,609.00	4,297.00	1,300.00	.94	.65		
Open pile air at 20 CFM/T	35,733.00	12,008.00	47,741.00	2,864.00	3,796.00	1.14	.90	Washed air	
Closed pile air at 20 CFM/T	66,652.00	24,239.00	90,891.00	5,453.00	3,796.00	1.49	1.11		
Open pile air at 15 CFM/T	26,788.00	10,028.00	36,816.00	2,209.00	2,493.00	.84	.65		
Closed pile air at 15 CFM/T	63,597.00	24,665.00	88,262.00	5,296.00	2,493.00	1.32	.95		
Open pile air at 10 CFM/T	19,628.00	8,489.00	28,117.00	1,687.00	1,750.00	.62	.48		
Closed pile air at 10 CFM/T	56,515.00	23,107.00	79,622.00	4,777.00	1,750.00	1.11	.78		
Separate comparison—3 months air supply 20/CFM/T									
Open pile height 14 feet	27,535.00	11,392.00	38,929.00	2,336.00	1,472.00	.77	.58	Air alone	
Open pile height 20 feet	23,082.00	8,705.00	31,787.00	1,907.00	1,472.00	.66	.50		
Closed pile 60 feet wide	71,632.00	24,330.00	95,962.00	5,758.00	1,472.00	1.34	.93		
Closed pile 90 feet wide 20,000 tons of beets (3 months 20 CFM/T)	89,736.00	35,833.00	125,569.00	7,534.00	2,994.00	.94	.65		
Open pile height 18 feet Air velocity main duct 5,000 FPM (3 months 20 CFM/T)	23,277.00	7,771.00	31,048.00	1,863.00	1,755.00	.67	.52		

Building fan shed above ground lowers cost per ton per year $.0103 on 10 year basis and $.0071 on 20 year basis.

Allowing for .3-inch increase in friction loss through washers the cost of washing air is $.02 higher on 10-year basis and $.01 higher on 20-year basis than shown.

Cost per ton per year of operating Athey loader and Silver piler on a 10,000 pile is $.34 for 10-year life and $.27 for 20-year life.

Costs per ton per year on closed pile figures are above the cost of operating Athey loader and Silver piler.

Arguments for Plan A:

1. Less costly installation.
2. Less maintenance.
3. Air washing possibilities available.

Arguments for Plan B:

1. Better control of temperatures.
2. Better control of humidity.
3. Should keep beets longer due to less freezing and heat damage.
4. Adapts itself to areas distant from factory location.
5. Can be designed to do work of piler and Athey loader.
6. Air washing possibilities available.