A Comparison of the Dirt Screen Efficiency of Beet Receiving Equipment in Use in the Alberta, Canada, Area Served by Canadian Sugar Factories Limited

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Area Data

The region served by Canadian Sugar Factories Limited lies between 49° and 50° North Latitude and 112 and 113 Meridian West Longitude and centers on the city of Lethbridge in the Province of Alberta, Canada. The first factory was erected at Raymond in 1925 and has operated continuously since. Factories were subsequently erected at Picture Butte in 1936 and Taber in 1950. These three plants now have a combined daily slicing capacity of 6000 tons of beets.

The ten-year average yield from the 38,500 acres of beets harvested annually is 12 tons per acre. Beets in Alberta are normally planted April 20 to May 20 and harvested in October. The average number of frost free days is 140.

Purpose

Preliminary tests were made during the fall of 1955 to study the respective efficiency of dirt screens utilized by company beet-receiving equipment comprising 27 units in all, located at its three factory and thirteen tributary railway points.

Equipment and Screens

All dirt screens in the area were originally of the rotating squirrel-cage design. Subsequent changes introduced the potato chain in 1930 and 1946; steel Rienks-type screens in 1934; the first rubber Rienks-type screens going into service in 1951.

The equipment used in this study was located at the three factory and four of the country points and consisted of twelve 36-inch Silver Engineering Works pilers—half with rubber and half with steel Rienks screens operated at various speeds; two Ogden Iron Works stations with rubber Rienks screens; one loading station with potato chain-type screen; one station with squirrel-cage rotating-type screen. Specification details and operating data covering the equipment tested are shown in column A Table 1.

All 36-inch Silver piler Rienks screen, both rubber and steel elements, are 12 inches in outside diameter and have clearances of 1⅝-inch and 1⅜-inch respectively between kickers. However, due to greater hub and element widths on the rubber screens there is less space to permit dirt, clods, and trash to fall through onto the dirt belt. This was calculated by Johnson (1)[2] to be 20 percent less on rubber screens having 60-inch by 8-inch roll specifications. The Ogden Iron Works screens utilize 14-inch O.D. kickers

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[1]General Agricultural Superintendent, Raymond, Alberta, Canada, and Factory Agricultural Superintendent, Picture Butte, Alberta, Canada, respectively, Canadian Sugar Factories Limited.

[2] Numbers in parentheses refer to literature cited.

Table 1.—Comparison of Results Grouped According to Type and Speed Dirt Screen.

*Screen Type Size and Speed	Net Tons Beets	Percent Tare	Ave. Wt. Beets	Lbs. Tare Ret'd P/Ton Beets	Lbs. Beets Ret'd P/Ton Beets	Dirt Removal Efficiency Rating	Beet Loss Efficiency Rating
(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
Steel Rienks (Silver)							
537 FPM x 8R x 60" x 1-3/8" x 12"	839	4.2	1.50	171	.18	85	3
427 FPM x 8R x 60" x 1-3/8" x 12"	303	4.1	1.55	197	.10	100	2
Rubber Rienks (Silver)							
537 FPM x 8R x 60" x 1-5/8" x 12"	654	4.0	1.72	137	.33	71	4
427 FPM x 8R x 60" x 1-5/8" x 12"	504	4.2	1.47	184	.56	91	5
361 FPM x 10R x 71" x 1-5/8" x 12"	390	9.1	1.26	315	nil	72	1
Rubber Rienks (Ogden)							
452 FPM x 11R x 55" x 2" x 14"	533	4.3	1.42	191	1.19	92	7
452 FPM x 14R x 72" x 2" x 14"	353	4.9	1.49	245	3.27	104	8
Potato Chain							
198 FPM x 140" x 38" x 1-3/8"	262	5.4	1.42	184	.85	71	6
Squirrel Cage							
348 FPM x 110" x 42" x 1¼	149	7.1	1.51	190	nil	56	1

* Screen specifications—537 FPM x 8R x 60" x 1-3/8" x 12" refers to screen with peripheral or surface speed of 537 feet per minute x 8 screen rolls 60 inches in length having kicker wheels 1-3/8" apart at outer circumference and having outside diameter of 12 inches.

and 2-inch element interspaces. The squirrel cage bars have 1¼-inch spacing while the potato chain screen under study has inter-bar space of 1⅜-inches.

Tons of beets passsing over the screens under maximum load conditions were determined to be 3.68 tons per minute at 415 FPM increasing to 4.66 tons per minute or 26 percent greater at 530 FPM where the entire piler had been speeded up to increase receiving capacity, by enlarging the size of the motor drive pulley from 7-inch to 9-inch O.D. Load tests, unfortunately, were not made on pilers having been speeded up through increase of motor drive while the screen speed had been correspondingly slowed with compensating screen-drive sprocket changes. The potato chain was found to be passing 1.75 tons per minute, about one-half the volume of the lower speed Rienks screen.

For the purpose of discussion and analysis Rienks-type screen speed ranges have been grouped at four speeds:

[3]169 RPM to 173 RPM = Ave. 171 RPM = peripheral speed 537 FPM
[3]132 RPM to 140 RPM = Ave. 136 RPM = peripheral speed 427 FPM
[4]123 RPM = peripheral speed 452 FPM
[3]115 RPM = peripheral speed 361 FPM

Method

A total of 26 growers delivering approximately 5,000 tons of beets during the test period co-operated in the project. Five growers, selected

[3] 12 inches O.D. Rienks kicker wheels.
[4] 14 inches O.D. Rienks kicker wheels.

at each factory point, were instructed to distribute their daily deliveries to all the receiving units in service at their respective stations for the 6-day period, October 13 to 20, 1955, making sure some beets were delivered to each. A minimum of two to three growers at each country point were similarly selected and, where practical, made deliveries to a station other than their own each day.

Each load as delivered was weighed in and out including tare dirt and empty truck over company receiving scales. Return dirt was removed from the truck and the truck re-weighed to obtain accurate weight of dirt returned through dirt screen. Weight of all beets having a diameter of two inches or greater returned with dirt from the piler was determined at the time the dirt was unloaded. All loads were tared for dirt and top growth at the respective piler or station when they were received. The data obtained were analyzed by grower and grouped according to unit over which the beets were received. This information subsequently summarized appears in Table 1 and Table 2.

Beets received during the test period were considered in excellent condition for storage and processing, being generally crisp and moist following light rains the first 10 days of October. No further moisture fell while the tests were being conducted. Average dirt tare over the three factory area was 5.25 percent for the test period.

Discussion

The efficiency measure of any screening equipment is the actual dirt and trash removed from delivered beets in relation to total amount in the loads, while at the same time conserving the maximum quantity of processable beets.

Using these two factors, dirt removed and high beet retention as yardsticks, the conclusions suggested are set out in columns G and H Table 1, where results are analyzed according to type and speed of screen.

It was felt that the results for all screens where dirt tares fell into the 4 percent to 5 percent tare range were directly comparable on the basis of pounds of dirt returned to truck per ton of clean beets received. At the higher tare levels of 9.1 percent and 7.1 percent obtaining over the 361 FPM rubber Rienks screen and the squirrel cage respectively, it was assumed they should have returned dirt to the truck in direct proportion to the higher tare secured.

The standard 60 inch by 8 inch roll screen returning the greatest quantity of dirt to truck per ton of beets (column E) in relation to percent tare was the steel screen operating at a speed of 427 FPM which actually removed 70.6 percent of total dirt. For convenience in comparison this screen was given an efficiency rating of 100. The other screens were then rated accordingly on the assumption that they should remove dirt in proportion to percent tare or amount of dirt going over the screen and into storage piles. The results are shown in Table 1.

Note that the greatest combined efficiency was secured on 60 inch by 8 inch roll steel Rienks screen at 427 FPM but ranked second in dirt removal and second in beet conservation. While the 72 inch by 14 inch roll rubber-Rienks screen removed 4 percent more dirt, not surprising in view of its much greater area, it was considerably more wasteful in terms of beets returned—3.27 pounds per ton of beets delivered. The 60 inch by 8 inch roll Rienks-type steel screen eliminated more dirt at 537 FPM when compared to the larger 72 inch by 10 inch roll rubber screen operating at a lower speed of 361 FPM in spite of the larger area of the latter. The rubber Rienks-type screen at 427 FPM showed superiority over the rotating squirrel cage where the 7.1 percent dirt tare suggests that a relatively large amount of dirt is passing over the screen to storage.

The high loss of beet tissue through the two inch spacing on two of the rubber screens suggests that this opening should be reduced in size. It will be noted in two instances that fewer beets are removed with the dirt at the lower speeds for equivalent wheel spacings. If it is accepted that the majority of these are removed by the reverse rolls, then probably some study should be made on the effect of slowing the reverse rolls down in relation to the forward rolls.

Table 2.—Comparison of Rubber vs. Steel Rienks Dirt Screens at Four Alberta Locations—All Speeds and All Deliveries Grouped.

	RUBBER SCREEN					STEEL SCREEN					
Location	Net Tons Beets	Percent Tare	Ave. Wt. Beets	Lbs. Tare Ret'd P/T.B.	Lbs. Beets Ret'd P/T.B.	Net Tons Beets	Percent Tare	Ave. Wt. Beets	Lbs. Tare Ret'd P/T.B.	Lbs. Beets Ret'd P/T.B.	Rubber Effic. Steel Based @ 100
Raymond	335	4.5	1.40	206	.62	690	4.1	1.45	188	.10	equal
Coaldale	140	6.6	1.63	223	.70	200	6.6	1.65	269	.40	83
Picture Butte	390	9.0	1.27	315	nil	198	8.3	1.36	320	nil	91
Taber	823	4.0	1.68	142	.36	557	4.0	1.65	156	.24	91
Av. mean	422	6.0	1.49	221	.42	411	5.7	1.53	233	.19	

Table 2 summarizes rubber vs. Steel Rienks-type screens at locations where both were in use. The results lead to the general observation that, at three of the four locations, the steel screens provided greater efficiency in the removal and return of dirt to the grower, while at the same time provided a maximum saving of beet tissue.

Several observations based on operating experience with the various types of screens would appear pertinent to this study.

Soil Type and Moisture Content at Delivery Time

Experience in Alberta has brought about the virtual abandonment of the squirrel cage type screen because of its tendency to clog solidly with mud and leaves on the outer circumference when beets are delivered in a reasonably moist condition. As a result, excessive quantities of dirt pass with the beets into factory flumes and wet hoppers resulting in high receiving and freight costs and factory processing delays.

Although the potato chain does not plug up and slow deliveries, it likewise has a tendency to pass excessive dirt over with beets.

The Rienks type screens have become standard in this area because of their higher capacity and greater efficiency under extreme conditions of load and stress.

Effect of Soil Types on Rienks Type Screen Wear and Replacement Costs

Under Alberta conditions, the steel Rienks kickers have an average life expectancy of approximately 200,000 tons of beets before some replacement becomes necessary. There is little difference for the various soil types.

This is in sharp contrast to experience with rubber. For example, at the Picture Butte factory where fine silt and clay loam soils predominate, replacement of some rubber kickers (particularly where the beets are discharged onto the screen) will be necessary after handling 150,000 tons; while at the Taber factory (where sharp and highly abrasive sandy soil types predominate), replacement of some screen sections have been necessary at the 50,000 to 75,000 ton level.

Rocks and Excess Mud

Rubber screens have proven to be superior to steel, particularly from the standpoint of reducing receiving time delays because of screen stoppage due to rocks in areas where rocks are a factor. At the same or higher speed, rubber screens are considered to require less cleaning and result in less delay under muddy conditions. However, while rubber may continue to rotate at the higher speeds under conditions of extreme mud, the importance of keeping hubs clean to prevent excessive kicker wear must be strongly emphasized.

Summary of Conclusions

The results of this study and Alberta operating experience seem to warrant the following conclusions.

1. Steel Rienks-type screens were more efficient both as to dirt removed and beet tissue conserved than rubber Rienks-type screens of the same size and rotation speed for all locations included in the tests.

2. Speed of screen rotation and travel appear to have a direct bearing on the efficiency of both rubber and steel type screens. The most efficient speed would appear to lie in the 420 to 440 FPM range for 12 inch O.D. screen elements. The volume of beets and quantity of dirt they carry has a bearing on this and perhaps justifies further study.

3. The Rienks-type screens, both steel and rubber, provided greater efficiency than the potato chain and rotating bar types.

Under Alberta conditions and at average crop yields of 12 tons per acre, the 1⅝ inch provided between individual kicker elements on rubber screens would appear to be optimum if maximum beet tissue is to be salvaged, this perhaps suggests the need for intensified engineering studies to more closely approximate the steel screen relations in this respect, as well as increasing screening area as suggested by Johnson (1).

5. Rubber screens cause less receiving delays and interruptions compared to steel, under conditions of rocks and extreme mud.

6. Wear and maintenance of rubber Rienks-type screens are increased over steel in receiving beets from moist abrasive-type soils.

References

(1) Johnson, Charles R. 1954. Comparative efficiency of rubber and steel Rienks screens. Proc. Amer. Soc. Sugar Beet Tech. 8(1):330-332.