Experience with Vincent Pulp Drier and Pneumatic Conveying of Dried Beet Pulp at Woodland

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The Woodland Factory of Spreckels Sugar Company initiated pulp drying operations during the 1952 fall campaign. Facilities installed for that initial campaign provided drying of pulp from approximately 1,800 tons of beets per day. Woodland factory daily slice exceeds 3,000 tons, therefore, the balance of the wet pulp is pumped to the existing wet pulp silo.

All wet pulp from the Oliver Morton continuous diffuser is conveyed by screw conveyors above three pairs of Zenith Model ZL pulp presses. Each press is supplied from a chute controlled by a rack and pinion slide gate. Only sufficient presses are operated, each at full capacity, to provide the drier feed. The remainder of the wet pulp continues along the screw conveyor to a chute feeding the wet pulp pumps. Some presses rotate at 3 rpm, and others at 4 rpm, which enables drier feed to be altered by selection of various speed presses.

The pressed pulp is belt conveyed to two 20-inch diameter stainless steel ribbon mixing screw conveyors in tandem about 45 feet total length where molasses is added under pressure through $^{3}/_{8}$ inch Marley spray nozzles. This molasses mixed pulp was initially fed into the driers through a rotating star type air lock feeder. However, this material built up in the sections of rotating air lock feeder, which hindered the drier feed rate. These airlock feeders have since been replaced by short tubular screw conveyor feeder sections, which *give* satisfactory results.

The two drier drums selected for Woodland were three-pass "Vincent 60B-180EH33 Vacuo Dehydrators" manufactured by the Dan B. Vincent Company of Tampa, Florida. Each unit was guaranteed to evaporate 22,500 pounds of water per hour from pressed pulp containing 83 percent moisture at a thermal efficiency of 1,500 Btu per pound of water evaporated. Actual operating data obtained over a 33-day campaign showed the drier efficiencies as listed in Table 1.

This style of drier has been used extensively on a commercial basis with citrus fruit wastes, alfalfa and fish meal.

The drier drum is horizontal and is somewhat unique in that the outside drum is stationary and only the two inner shells rotate. This feature enables the removal of pulp from the end of the second pass for recycling if necessary. The furnace is a cylindrical shaped steel-jacketed fire box with an annular air space around the periphery of the furnace shell. Air for the furnace is thus preheated as it is drawn through the annular space, which *in* turn provides a cooling of the furnace shell. Primary air necessary for proper combustion enters through a forced draft fan and secondary air enters through a refractory lining ring. Woodland furnaces are fired by either natural gas or fuel oil.

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Table 1.—Woodland Pulp Drier 1953 Spring **Campaign.**

1 Dried Pulp Produced—3708.6 Tons at 10.8% moisture
2 Molasses Added—947.1 Tons at 79.97 RDS
3 Pressed Pulp—81.94% Moisture
4 Molasses addition—25.54% on Dried Pulp
5 Gas Consumed—34,503.2 M. Cu. Ft. at 1026 Btu per Cu. Ft.
6 Time Duration—1492 Drum Hours
7 Oil Consumed—9.13 Bbl at 6,300 M. Btu per Bbl.
8 M. Btu per Bag Dried Pulp Produced—464.5 M. Btu. a
Loss assumed to be 10%, on Dried Pulp Produced
1. Water evaporated—17,167.34 lbs. per Hr. per Drum
2. Thermal efficiency—1 384.33 Btu per lb. H_3O Evap. b
No loss assumed
1. Water evaporated—15 211.10 lbs. per Hr. per Drum
2. Thermal Efficiency—1562.36 Btu per lb. H_>0 Evap.

Note: The fifth week of 1953 fall campaign showed the following efficiencies using 42-14% molasses addition:

a Loss assumed to be 10% on dried pulp produced
1. Water evaporated—16.128 lbs. per Hr. per Drum
2. Thermal Efficiency—1268.87 Btu per lb. H_2O Evap. b
No Loss assumed
1. Water Evaporated—13,929.05 lbs. per Hr. per Drum
2. Thermal efficiency—1469.22 Btu per lb. H_2O Evap.

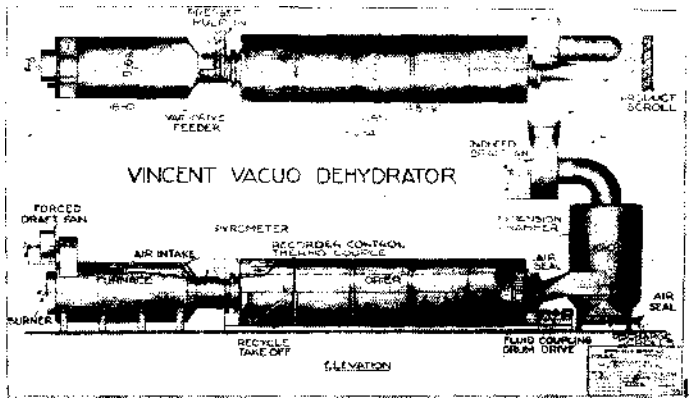

Figure 1.—General Arrangement of Drier.

Drier controls consist of a potentiometer-type pneumatic recorder controller which senses the temperature in the third pass and resets the index on furnace throat pyrometer temperature recorder controller to adjust for any load change. The pyrometer controller in turn pneumatically adjusts the forced draft damper and fuel supply control valves.

Each drum is equipped with a "fail safe" electrical control system which is approved by the Factory Insurance Association. If a fire develops in

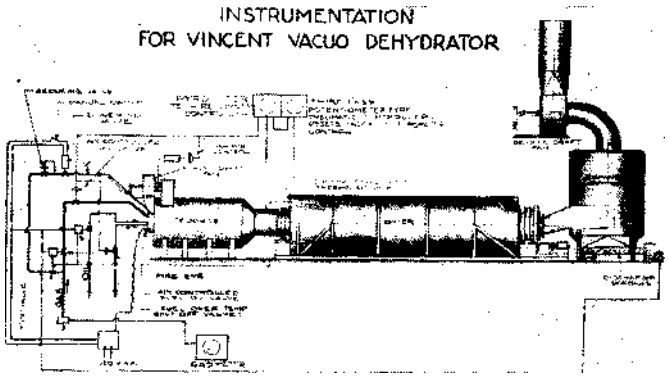

Figure 2.—**Instrumentation** Diagram.

either drum, a thermocouple in the third pass detects the resulting increased temperature. When third pass temperature exceeds maximum set point of 450° F., the over temperature circuit shuts off the induced and forced draft fans, fuel safety shut off valve, and the product collecting screw conveyor. A selector switch in forced draft fan circulit can then be set to remove troubled drum from "fail safe" circuit, and the product collecting screw conveyor started manually to continue with one-drum operation.

To resume drier operations after difficulty has been corrected, the product collecting screw conveyor is set to the "fail safe" circuit for both driers and restarted, followed by the induced draft fan, and the forced draft fan. By starting the forced draft fan, a time delay relay is energized preventing the main fuel valve from being opened, thus providing adequate time for furnace and drum purge. Should the poilot light be extinguished, the complete purge sequence would be repeated. When the first time delay relay was energized, this would energize a second time delay relay on the pilot circuit. At expiration of purge period, the induced and forced draft fans would be shut down. This second time delay relay on pilot system would allow time for operator to manually energize pilot valve to open and light pilot light by hand. As soon as the pilot light is lit the "Fire-eye" takes over and permits energizing circuit to main fuel valve. Normal sequence of bringing the drier on the line can then be followed. An annunciator alarm panel is incorporated as an aid to the operator so that he can instantly locate point of any drier system irregularity or failure.

Woodland Factory Pneumatic Dried Pulp Conveying

Located at discharge of drier product screw conveyors is a product collecting screw conveyor, elevator, and a Merchen continuous scale which discharges into a rotary air lock feeder. This feeder drops the product

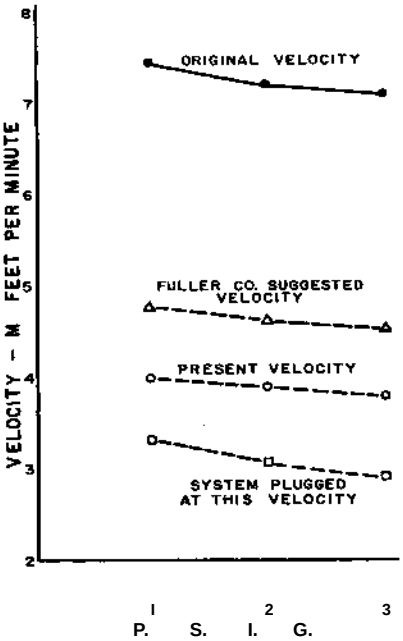

Figure 3. — Air Velocities Tried in the Woodland Pneumatic Conveying System.

into a Fuller Company airveyor system. The airveyor system is made up of a No. 1626 Sutorbilt Blower (driven by a 150 h.p., 900 rpm, T.E.F.C. motor) , a 14 inch blower discharge pipe to a venturi-type product inlet beneath air lock feeder, and 10 inch delivery pipe to warehouse. The product travels approximately 710 feet to the warehouse, where it has free discharge 100 feet to floor of warehouse. All bends in the 10 inch conveyor pipe are made on an 8 foot radius except final 90° cornucopia type outlet in center of warehouse.

The Fuller Company supplied this pneumatic system as a package unit. Original design deliberately provided for future conveying of 3.3 times the present capacity, accounting for the apparent excessive size of equipment. At original design capacity, this system was set up to operate at a pressure of 7 PSIG (considered a high pressure system) as indicated between blower and feeder. Actual operations showed this pressure to be between 2 and 3 PSIG (classified as a low pressure system) .

Figure 3 shows the various air velocities tried in the Woodland pneumatic conveying system. (Material travels at approximately 80 percent of air velocity in pneumatic conveyor, as per "Conveyors and Related Equipment" by H. G. Hudson) .

The original air velocity of 7,250 FPM at 2 PSIG in this pneumatic conveyor most certainly delivered dried pulp to the warehouse. However, soon the local pulp trade expressed some dissatisfaction with the lack of bulkiness of the Woodland pulp; that is, there were too many fines.

Our interest in possible improvements of the product, as delivered to the warehouse, led to review of airveyor conditions. First hand investigation of other pneumatic conveyors conveying dried pulp revealed they were operating with an air velocity considerably below the Woodland airveyor system velocity. Further discussion with the Fuller Company produced their recommendation of 4,500 FPM at 3 PSIG. Subsequent tests showed an improvement in product bulkiness at this reduced speed. Still further velocity reductions were attempted. Finally, with air velocity of 3,250 FPM at 1 PSIG, the 10 inch delivery pipe plugged at the base of a relatively steep incline.

Having established a known "break point," the blower speed was revised upward to supply air at 3,975 FPM at 1 PSIG. This air velocity was used during most of the 1953 fall campaign.

The following are comparative typical screen analysis of random samples of pulp obtained:

1. After air conveying at original velocity, warehousing, recovery, and packing during 33 day, 1953 spring campaign.

2. After air conveying at revised velocity, warehousing, recovery, and packing from one month during 1953 fall campaign.

Table 2.—Dried Pulp Screen Analysis.

	7,250 F.P.M. Velocity—1953 Spring		3,975 F.P.M. Velocity—1953 Fall	
Screen Size	**Product at Drier—%**	**Product in Sacks—%**	**Product at Drier—%**	**Product in Sacks—%**
+ 3	0.41	0.06		
+ 6	7.40	1.94	9.2	2.90
+ 10	58.87	**32.41**	55.76	44.29
+ 20	29.37	46.36	30.26	43.05
+ 28	2.54	7.40	2.94	5.04
+ 35	0.83	3.65	1.06	2.12
—35	0.58	8.50	0.76	1.73
—20 **Total**	3.95	19.28	4.76	8.89

The western dairy trade desires a pulp that contains a total —20 fraction of no more than 11 percent, and prefers this fraction below 8 percent. Tests have shown that our present recovery system may account for approximately 43 percent of the breakage between drier and sacked product. One particularly desirable feature of the pneumatic conveyor results from cooling and vapor removal of the pulp enroute to the warehouse. The airveyor, as operated in present condition, appears as a reasonably satisfactory dried pulp conveyor.