DESIGN AND CONSTRUCTION OF A SMALL SCALE BREI SAMPLER

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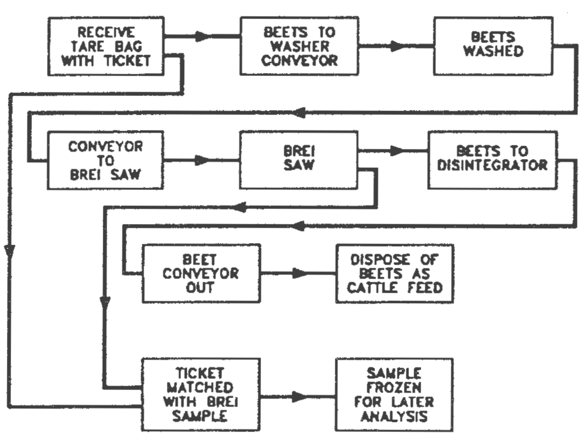
During the first year of operation, samples from the Idaho operation were processed through a contractual arrangement. After the first year it was decided that American Crystal Sugar would process their own samples. The design, construction, installation, and implementation of the brei sampler system was a project assigned to the Technical Services Mechanical Group of American Crystal Sugar.

Other tare labs were investigated for information and design concepts. These labs consisted of the following major components: a conveyor (beets to washer), a beet washer, conveyor (beets to brei saw), brei saw and conveyor (beet slabs out). As a result of checking these other systems, it was decided that a reduction in moving parts and use of standard components was necessary. Parts such as bearings and cyclic start-stop operation of electric motors would be avoided. Since a large quantity of the moving parts and bearings were located in the belt conveyors in the tare labs, a change in the conveyor systems was needed.

For economic reasons, it was decided that the lab at the Idaho location would be a partial system. The Idaho location performs the following operations:

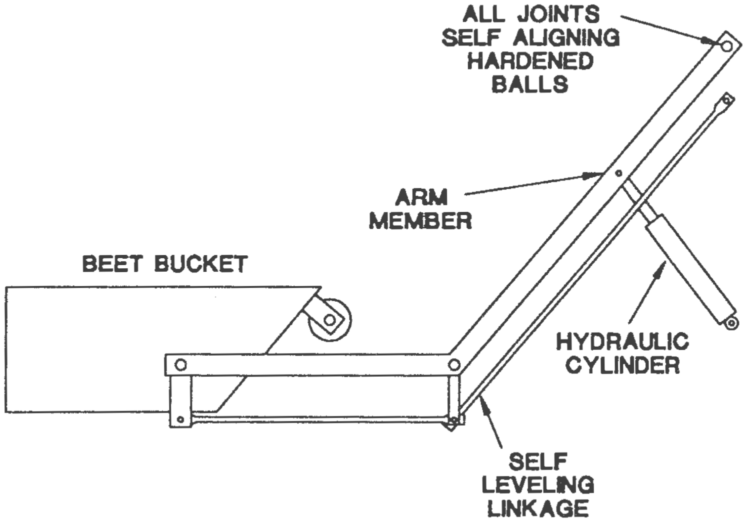
1. Receive tare bag with sample and ticket.
2. Empty tare bag into beet loading bucket and retrieve ticket.
3. Beet loading bucket loads beets into beet washer.
4. Wash beets.
5. Convey beets to brei saw.
6. Saw beets and retrieve brei sample.
7. Freeze brei sample with proper identification ticket.
8. Disintegrate remaining beet slabs.
9. Convey beet fragments to truck for disposal.
10. Clean brei saw for next sample.

The frozen samples were later processed at the Moorhead quality lab for analytical data. This was done in the off season. A description of each of the machine operations is detailed below.



Conveyor to Washer

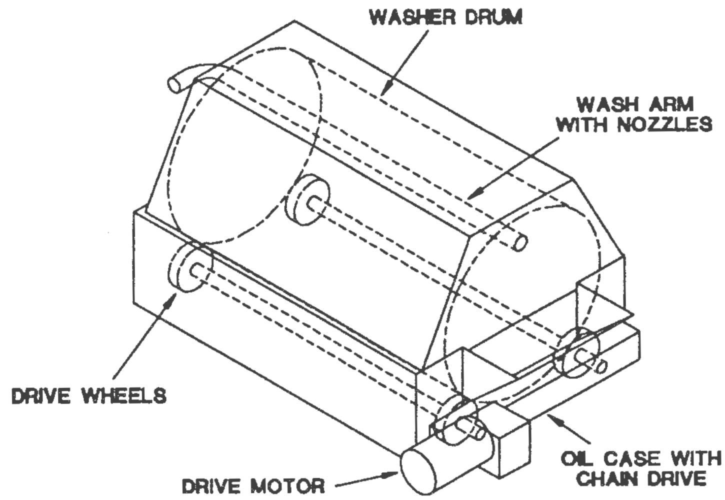
The moving of the beets from the sample bag to the washer was the first conveyor to be considered in the elimination of belt conveyors. Two concepts were considered -- a wheel on a horizontal axis and a moving arm. Since elimination of bearings was a consideration, the moving arm was chosen. Self-aligning ball joints were chosen for the joints in the moving arm. The ball joint consisted of a hardened steel ball with a hole through the center of it for the pivot bolt. The ball was retained in an unhardened weldable steel cage. The cage was welded to one of the parts in the pivot joint and bolted to the other. The type of ball joint selected has been used extensively in the loader and hydraulic cylinder industry and proven reliable. The lift arm was comprised of a beet bucket, self leveling linkage, and arm member actuated by a hydraulic cylinder. During operation the beet bucket remains level until the arm reaches the top of its stroke. At this time a wheel on the bucket strikes the washer hopper and causes the beet bucket to dump into the washer.



Beet Washer

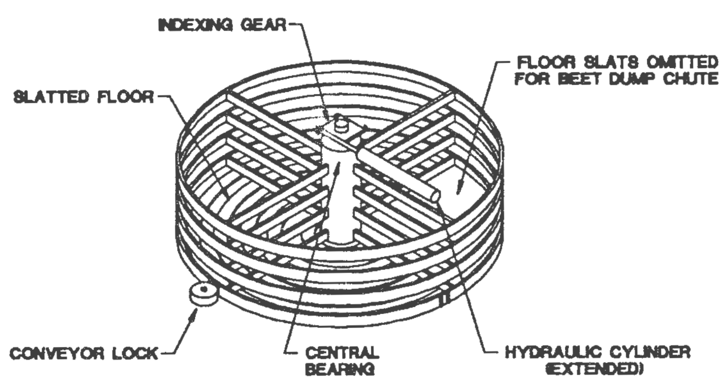
The washer is a single batch type with rotating drum and spray nozzles. Power to the washer drum is provided by a 1 hp electric motor through a 60 to 1 ratio worm gear box drive. Power from the worm gear box is supplied to the contact drive rollers which drive the washer drum. As a result of prior maintenance experience on other washers, the drive line, materials of construction, and washer nozzles were areas changed to increase life and reliability. Bearings in the drive line were moved to reduce contact with the wash water. Chains were put in oil filled chain cases to increase chain life. Drive rollers were selected with rubber drive surfaces (70 durometer shore A) to improve traction between drive rollers and washer drum. Materials of construction were changed to 304 SS where possible to eliminate failure due to rust out and the need for painting.

The nozzles were selected for quick removal to facilitate easier cleaning when necessary. The nozzles which seal against a compression gasket require a quarter turn for removal. Nozzle size and number dictate the maximum orifice diameter (.040") in the nozzle. This allows larger particulate to pass through the nozzle; therefore the time to clean nozzles is reduced. Water to the washer is pumped by a 15 hp centrifugal pump. Pump size was 2x1x10 with a trimmed impeller (9.50"). With the final nozzle size selected, the pump delivered about 35 gpm at 150 psi.



Conveyor to Saw

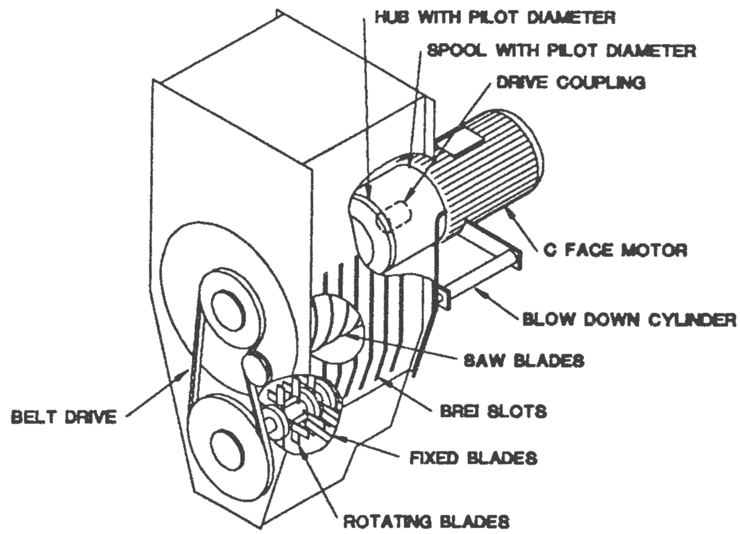
The conveyor, which moves the beets from the washer to the saw, is designed to prevent the mixing of the samples and to allow the samples to drip dry. In some tare labs, a bucket and chain conveyor or various types of belt conveyors have been used. In an effort to eliminate bearings, a circular conveyor was chosen with one main bearing. The bearing system used came from the trailer industry. Economics provided the incentive for this choice. The conveyor was designed with spoked compartments and slatted floors. These allowed for drip drying of the sample. Power for the conveyor is provided by a hydraulic cylinder which engages in a four tooth indexing gear. With each full stroke of the cylinder the conveyor is advanced one compartment. The cylinder provides high starting torque with adjustable speed, eliminating start-stop operation of an electric motor. The common hydraulic power source was shared by the bucket cylinder, washer dump cylinder, and brei blow down cylinder.



Brei Saw

The 25 hp brei saw was designed similar to other saws at American Crystal Sugar. The saw uses six (20 inch, 400 tooth) blades which rotate at a motor speed of 1750 rpm. A wheel hub and bearings were used on the main saw shaft. In addition to economics, a secondary advantage of the hub was the pilot diameters which allow for the use of a c-face motor. Therefore, no motor coupling alignment or shims are required.

Due to problems of disposing the beets after sampling, the saw is equipped with a disintegrator, to reduce the size of the slabs. The disintegrator is belt driven from the main saw shaft with two b-section belts. The disintegrator is of the hammer mill type, comprised of fixed and swinging blades. Due to hammer wear, revisions are planned for next season. The end product from the hammer mill is a feedable product disposed of as a livestock feed. At the end of each sawing cycle the brei receiving area is cleaned. This is accomplished by an air blow down nozzle arm. The arm is hydraulically actuated each cycle.



Conveyor Beets Out

The out conveyor is a conventional belt conveyor with a Z-shaped path configuration. The beets are moved from the disintegrator to the truck for disposal. The conveyor belt is 18" wide with 9" x 1 1/4" cleats at 8 1/2" spacings. The margin or space outside the cleats is used for topside rollers and return rollers. The belt is powered by a 1 hp electric motor through a gearbox and final chain drive. This drive system provides a conveyor belt speed of 90 feet per minute.

Hydraulic System

For simplicity and commonality of parts, all cylinders have a 2 inch bore with a tie rod design. Cylinder speed is controlled by adjustable orifices where necessary. Overall system speed is controlled by an adjustable flow divider, located at the valve manifold. The valve manifold is populated with four closed center valves and a valve to pressurize the valve manifold. The pressure valve diverts oil flow to the manifold each time a hydraulic function occurs. This arrangement allows the system to unload between hydraulic functions. It also permits the use of a low cost gear pump rather than a pressure compensated pump or accumulator system. To reduce hydraulic noise, a 1200 rpm motor is used to drive the pump which provides 6 gpm. Cooling for the system is provided by an air to oil cooler. Air flow for cooling is provided by the saw motor because of the large fan size.

Control System

A programmable controller was chosen to allow for ease in program changes. Due to cost and the harsh environment, the program is set up with input for the start function and emergency stop only. Microswitches, magnetic reed switches, and optical devices were avoided as position indicators for the various functions. The program is entirely based on timers. The use of timers is a simple operation and requires 16 of the 80 possible timers in the programmable controller. As the operators became familiar with the process, the cycle time was shortened. The washing cycle became the limiting factor for each cycle. A cycle time of 40 seconds was reached, with a daily average of 80 samples per hour. Programming changes were made in the lab with a small hand held programmer while program development was aided with a software package, running on a PC, provided by the manufacturer.

A special note of thanks to the following people:

Stuart Shulstad for dedication and some great ideas.
Clyde Trupp for sticking it out through start up.
Dick Watkins for allowing ideas to flow.

Material Source List

Item	Supplier
hydraulic pump	Grainger
hydraulic filter	Grainger
motor starters	General Electric
programmable controller	IDEC Corporation
electric hydraulic solenoid valve	Vickers Incorporated
hydraulic flow control valve	Graingers
oil cooler	Blissfield
motors	Baldor
saw blades	California Saw & Knife
self aligning ball joints	Danuser Machine Co.
bearings	Timken
washer pump	Worthington