

A HISTORY OF SUGAR PROCESSING

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Several months ago Mr. John Richmond invited me to say a few words at this Meeting. It was to be the Golden Anniversary of the ASSBT and there were to be three of us who would talk about different aspects of the beet sugar industry and the changes that had occurred during the past 50 years. We would each have about 30 minutes to bring everyone up to date! Do you realise what that means? For 30 minutes we have a compression ratio of 876,000 to 1 !!!! That's tight. My Macintosh's "stuffit" program can't do that and I don't think I can either, but I'll try to be interesting and talk about some of the things that have changed, and some of the things that haven't.

From a beet sugar factory operating point of view, the most outstanding achievements in the last 50 years have been the replacement of many batch processes with continuous ones and the introduction of process controls. Man minutes per ton of beet sliced or per cwt. of sugar produced, are currently less than 30% of what they were in 1947.

Fuel was never as cheap in Europe as it was in the United States so the priorities for improvements in Europe were different from those in this country, but the objective was the same; reduce labor, save fuel and become more efficient. I was lucky enough to have been involved with both programmes and enjoyed the challenge.

For those of you who don't know me, or who weren't listening when Pam Thomas introduced me, I'm Jeremiah Erastus Archimedes Rich, aka "Bob" and I retired from Holly Sugar six years ago after spending 41 years in the beet sugar industry; the first 13 with British Sugar and the last 28 with Holly. I enjoyed every one of them and met some wonderful people over the years, plus a handful I could never get along with!

When I first started working for British Sugar we worked five and a half day weeks in the off-season and a two shift system during campaign. None of the modern three or four shift systems with days off each week. For five plus months we worked twelve hours a day with an eighteen hour change-over every fortnight (two weeks). If you didn't like the hours there were always other people ready to take your place, so if you wanted to remain employed you kept your mouth shut and got on with the job. With only two shifts you always knew who had left everything in a mess; there was no "other" shift to blame. We used to work from 7 to 7 and when we changed shifts from days to nights we worked from 7am Saturday to 1am Sunday and didn't return again until 7pm that evening. Wow, 18 hours off! I wonder what the unions would say about that today? If you were on nights, you got off at 7am on Saturday, came back at 1am on Sunday, worked your 18 hours and went home at 7pm to return again at 7am on Monday!

The chemistry behind the extraction of sugar from beet hasn't really changed during the last 50 years, or 150 years for that matter, but the method of doing it, and the equipment that is used, certainly has. Fifty years ago the only parts of the process that were continuous were the beet washer, the evaporator station (with horizontal vessels), the pulp presses and the driers (if you had them), while everything else was "batch"! Batch or continuous, the only proper way to run any round-the-clock process is as steadily and smoothly as possible. That was true fifty years ago and it is still true today. Keep the house on an even keel!!

I was brought up on 19 division knives similar to those used by most US companies today, but even as recently as 30 years ago many US companies were still using 46 division "splitter" knives which produced cossettes that closely resembled snow-cone mush, particularly if the beets were frozen, and were incredibly difficult and time consuming to sharpen properly. I never could understand why we used those ridiculous knives as they wrecked just about every cell wall in each beet and tended to destroy the principles of diffusion. Fortunately beet purities were much higher then than they are today, so inspite of very poor cossettes we managed to produce an acceptable raw juice quality.

Before the advent of continuous diffusers, we all used Robert's batteries to extract raw juice from the cossettes and they came in a variety of shapes and sizes. The number of "cells" per battery varied from 10 to 14 and the physical layout varied from a straight line to a circle depending on the whim of the original designer and the shape of the space available to install it. Individual cells held from 3 to 6.5 tons of cossettes which could be varied by the method of packing. For those of you that were brought up to believe that pan boiling was an art rather than a science never had to rearrange the chains in battery cells! Chains were used to prevent the cossettes from packing too tightly inside individual cells and to allow for good juice circulation. Everybody had their own "pattern" that was better than anyone else's and thus produced a lower pulp loss. It was fun to listen to battery experts discussing chain arrangements! On a related subject, Holly had two factories with identical batteries except for a couple of seemingly inconsequential differences; one was in California and aligned North-South and the other was in Montana and aligned East-West. So what you say, how does that make them different? I used to be a fairly useful sailor and as such was interested in weather and tides. Tides are tied (no pun intended) to the phases of the moon which affect East-West waters more severely than North-South. As a result, the battery pit at Hardin was always more difficult to empty at a full moon than at a new moon. At a full moon, the pulp refused to flow towards the pump suction if you didn't help it with a fire hose. We never had that problem at Alvarado!

Another great thing about a Roberts battery was the method of calculating the daily slice. I only know of a few factories that weighed cossettes on their way to the battery and a few others that weighed whole beets on their way to the slicers, most weighed raw juice each time it was "drawn" from a battery cell. As most of you know, raw juice contains a large amount of air which makes it very "foamy". Fifty years ago we didn't have the foam breakers you have today so the area around the raw juice scales was invariably one of the less clean areas in a factory with foam waist deep. I remember one factory which sliced about 3000 tons per day and had three fourteen cell batteries with three separate raw juice scales. Each scale consisted of a large tank supported on a series of beams connected to a scale that had to be manually balanced each time a "draw" was

made. A person sat at each scale to balance the beam and manually record the weight. At the end of the day the scale tickets were totalled and with the aid of the lab folk, who had been analysing the raw juice on a regular basis, were able to calculate the tons of beet sliced and the sugar entering the house. As time went by, the scales were replaced by a manometric device that determined when a measuring tank had an exact predetermined weight of raw juice in it and then dumped the contents to a holding tank. It usually showed each dump on a chart and also kept a running total of dumps. This system eliminated the need for scale readers and the possibility of losing a scale ticket or recording an incorrect reading. It worked well, but it wasn't foolproof! Thirty odd years ago I was visiting a factory that had a Roberts battery and a Steffen's house. I happened to be in the Superintendent's office at 8 o'clock in the morning when the Chief Chemist came in and asked, "What do you want the slice to be for yesterday?" The reply was, "How much sugar did we make?" I've forgotten the actual numbers now but this turned out to be a daily ritual. Everything was worked backwards from the bags of sugar produced and the tons of molasses worked, what could be more simple? Later in the day I had a look at the raw juice manometer. It didn't appear to have been used for years!

Also, back in those days the tare house at several factories was just that, a tare house. Many factories in the Rocky Mountains did not measure their growers' individual sugar contents until the late 1960's. Loads of beet were sampled for tare only and every grower was paid according to the "belt sugar", or the sugar in the cossettes headed for the battery or diffuser. Every grower was paid for the same average sugar content and I'm not sure if they realized it at the time but it certainly didn't pay a farmer to grow beet with a higher sugar content than his neighbor.

The first sugar factory I worked in still had batch carbonatation and it wasn't until 1953 that it was replaced by the continuous process. The savings in labor were amazing as we replaced 16 large plate and frame filters with four rotary vacuum fliters on 1st. carb' and 6 more plate and frames on 2nd. carb' with three pressure filters. It was quite a learning process for all of us as we now had to handle raw juice continuously instead of a tankful at a time and carbonate it properly with very little chance of making a correction if you messed up! Of course everybody has the continuous process today but back then it was new and exciting. Our factory still had a raw juice tank which was the heart of the beet-end. The flow out of it effectively controlled the through-put of the whole factory, and its level, how we were doing before and after it. As instrumentation was being used more and more I remember some great discussions on the need to control the level in the raw juice tank. Personally I always believed that if you maintained a constant level, you didn't need the tank, but if you let the level float between high and low limits you could maintain a steady flow forward to the rest of the house. Very few factories use plate and frame filters today as they are labor intensive and difficult to automate. Some of us missed them for a very different reason. The juice trough on the side of the filter press was a great place to heat up your can of soup or beans before lunch.

Most of the early factories had horizontal tube evaporators as opposed to the vertical tube ones that nearly everybody uses today. In boiler language, horizontal evaporators are like fire-tube boilers whereas vertical ones are akin to water-tube boilers. In a horizontal evaporator the juice is on the outside of the tubes and the steam flows through them, while in a vertical one steam is on the outside of the tubes and the juice flows through them. Even with portholes in the shell of a horizontal body it is extremely difficult to see how well the tubes are cleaned when the vessel is

boiled out, so at the end of each campaign the steam jacket covers were removed to gain access to the tubes. The tubes were taken out and then "rumbled" in a device like a miniature pulp drier with a mixture of sand and coke to remove the scale. This was a time consuming job and hard on tubes which were usually brass or occasionally stainless steel. Many had to be replaced each year as rumbuling made holes in them and caused them to break. Vertical vessels are easier to inspect and seem to be easier to acid boil to keep clean. Horizontal vessels were replaced by verticals when higher steam pressures were used. The large flat surfaces of the horizontals could not stand up to the higher pressures.

Fifty years ago, and at some places much more recently, there were very few individual electric motors driving separate pieces of machinery in a beet sugar factory. Up until the day it stopped processing beet, Holly's factory at Santa Anna, California, had a single steam engine that drove everything in the pulp drier building via line-shafts and flat belts. The driers, the presses, the fans, the elevators and the conveyors were all driven from a single engine. I'm not suggesting that you should revert to that system of power or to the rope drives that were used in the Steffen House at Salinas for many years but just to remember that it used to be done that way. It is much more efficient to generate electricity with high pressure steam and send that power around the factory than it is to have numerous small steam engines driving pumps and piping systems gathering up all the somewhat dirty condensate.

The Yellowtail Dam was built on the Bighorn River a little more than 30 years ago and one of its objectives was to provide irrigation water to the Hardin Bench and other land in the immediate area via a series of canals and ditches. Holly of course was very interested in this project as it could provide many more acres of beet within a reasonable distance of the Hardin factory. The land closest to the new reservoir was all owned by the Crow Indians and the Bureau of Indian Affairs had decreed that every indian whose land would be crossed by a canal or a ditch had to give his approval before any work could begin. Trying to get approval was even more difficult than pulling hen's teeth. It was at this time that I learned a new philosophy, "If its good for the white man then it must be bad for the indian", and you start your negotiations from there. We were making very little progress so Holly decided to mount an intensive PR program to convince the indians that the irrigation water would be a major asset to the whole tribe and had buttons made up that said "Water Now". I don't know how many buttons were handed out but it seemed that everybody had one. Then somebody said, "Why don't we have 'Water Now' translated into Crow" and we can have indians wear the buttons too? Good idea, so the Indian Languages Department at Montana State University, Bozeman was contacted and the resident guru said, after a little thought, "Belay-a-hook". More buttons were made up and distributed, but the indians refused to wear them. They pointed fingers and laughed at those of us who did. Obviously something was wrong so we contacted another wizard, this time at Eastern Montana State in Billings. When advised of the problem he paused and then said, "Of course they laugh, 'Belay-a-hook' means 'My bladder is full'."

In closing, I would like to thank you for having me and to wish you all a successful meeting and Golden Anniversary. May the next 50 years show as many improvements and advances as the last 50.