ASSBT CONTINUOUS PAN FORUM

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Richard Richter – MinnDak Farmers Cooperative
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Chair: Chris Rhoten – Monitor Sugar Company

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In the new reconstruction of the East German Factories only the BMA VKT (Vertical Krystallization Tower) pans were considered for installation. The main reasons were the small floor space required, simple installation and energy savings. Three units were used in the installations. One for 2nd grade white, one for high raw and one for low grade

The BMA VKT is constructed as four superimposed cylindrical chambers each fitted with a mechanical stirrer. All chambers are continuously fed. Seed magma is fed to the first (top) chamber in ratio to the total quantity of syrup fed to all chambers. Massecuite flows from one chamber to the next with no possibility for mixing between chambers. The ds content (indirectly the crystal content) is controlled in each chamber reaching a maximum of up to 55% crystal content in the final (bottom) chamber.

Modularization of chambers allows the bypassing and cleaning of individual chambers without complete shut down of the pan giving a high degree of availability throughout the campaign.

Mechanical stirring makes possible the highest possible crystal yields. Injection of steam cannot replace mechanical mixing. Mechanical stirring allows final crystal content up to 55% on massecuite. Such yields cannot be obtained without mechanical stirring. Reduced wash water and higher centrifugal yields can be obtained resulting in an overall reduction in massecuite production. With high crystal yields, white massecuite production may be lowered by 9%, high raw massecuite lowered by 12% and low raw massecuite lowered by 7.6%. Overall water evaporation is lowered by about 9%. Sugar Yield is increased by 1.2%.

VKT can be fed steam as low as 0.27 bar absolute. Typically, 0.5-0.8 bar absolute is used. VKT continuous pans should be considered as extensions of the evaporation system as additional evaporation effects.

Vic Curtis – Fletcher Smith
In order to obtain the best product quality there must be good seed quality and a high number of cells. Continuous pans with a greater number of cells will have lower CV than pans with fewer cells.

F/S (Fletcher/Smith) pans have 12 cells and no mechanical circulator. A long flow path for the massecuite and well-designed inlet/outlet points between cells prevents back mixing of massecuite between cells. A 50% crystal yield is possible with unstirred pans. High crystal yield gives good centrifugal performance with respect to washing efficiency and centrifugal yield.
The F/S pan has low total energy consumption when both steam and electricity are considered. Continuous pans usually have about twice the heating surface to volume ratio as batch pans and lower average hydrostatic head allowing the use lower supply steam pressures. Supply steam pressures in the 10-12 psia range are not uncommon. Steam supply can generally be moved from 3rd to 5th vapor. The patented F/S inverted heart shaped cell design gives excellent circulation and does not require stirrers for good circulation. Thus, there are no stirrers to maintain or fail.

Experience indicates nearly zero maintenance requirements for the F/S pans with welded stainless steel calandrias.

Stacked design allows on-line cleaning without the removal of the entire pan from service. The stacked design has been very popular in U.S. installations.

Backboiling for massecuite purity control can be accomplished by providing for the addition of lower purity feeds to the later cells of pan. Higher purity feeds are added in the upper cells.

Continuous pan operation requires a different mind set. Batch pan operation is reactive whereas continuous pan operation is more of a monitoring operation. The design of the control system is important. Many different modes of control are possible from completely manual to predictive, fully automatic systems. Pan measurements for primary boiling control may be refractometer, conductivity, R/F probe or nuclear density.

Advantages of F/S continuous pans include:
1. Increased extraction as a result of increased crystal growth.
2. Improved steam economy.
3. Use of low raw sugar as seed for the high raw continuous pan eliminates the affination system and equipment.
4. No mechanical stirrers required for high crystal yield.
5. Installation of a continuous pan allows rearrangement of the existing batch equipment for expansion of sugar end capacity.

Currently there are eleven continuous pan installations in the USA.
1 Langenay Pan
2 BMA VKT Pans
8 F/S Pans, 5 of which are “stacked” units.

Mark Suhr - Southern Minnesota Beet Sugar Cooperative
Langenay pan is circular in design with three sections labeled C1 comprised of six cells in an outer ring, C2 a ring of six cells inboard of the outer C1 ring and C3 a center conventional forced circulated calandria. Seed magma enters in the first of six cells comprising section C1. As magma volume increases as a result of feed and crystal growth, the magma moves to adjacent cells via ports in the bottom of the cells. At the end of the sixth cell in section C1, the massecuite enters section C2 through an overflow. The massecuite flows in the opposite direction around the cells in C2 exiting through a control valve into section C3. Sections C1 and C2 are feeding sections operated at higher temperature with C3 a final brixing chamber fitted with a mechanical circulator operated at a lower temperature.
The pan is fitted with multiple manually adjusted feed addition points allowing the use of high green, low green or water to each cell. Normally approximately 8 individual feed valves are opened. Pan capacity is 1400 cubic feet per hour in its intended high raw service but is being operated at approximately 500 cubic feet per hour in low raw service.

Pan was originally installed as a high raw pan and for operation on "A" sugar as part of a 4-boiling system for the processing of high color extract produced from molasses desugarization. Problems with severe encrustation prevented its use as intended for high purity syrups. The pan required cleaning as often as weekly in the intended service. Such cleaning required the pan to be completely removed from service causing significant and unacceptable interruption to process operations. In low raw service, the pan can be operated about 30 days between cleaning cycles.

Cleaning timing is determined by observing the pan calandria steam pressure required to maintain capacity operation. At 2.0 psig C1 and C2 calandria pressure the pan is cleaned. Pressure is used since it is not possible to visually observe encrustation in the pan while in service except in the C3 section. Normal steam supply pressure when the pan is clean is 0.0 psig.

Operation is by fixed seed magma flow. Syrup flow is set for approximately 90% of feed to section C1, 10% to section C3 and 0% to section C3. Final brix from pan is approximately 92% ds. Seed magma is generally 15-25% crystals with final magma from low raw crystallizers in the range of 38% crystals.

Original installation in high raw service was considered a failure due to excessive encrustation and short service life. The pan operates reasonably well in low raw service.

Richard Richter – MinnDak Farmers Cooperative

MinnDak Farmers Cooperative installed a F/S continuous pan for high raw service and converted one of the two old batch high raw pans to white service and the second to low raw service. The F/S pan installed was a 3-stacked design having four cells in each section for a total of twelve cells. The pan has a capacity of approximately 5300 cubic feet operating on third vapors. The purpose of the installation was to increase the sugar end capacity.

Seed for the pan is a mixture of 100% of the low raw sugar mixed with "B-green" to a density of 92.5 RDS. "A-green" is fed to the first six cells (all cells in the top section and first two cells of the second section) of the continuous pan. "B-green" is "back-boiled" into the last two cells of the second section and all cells in the bottom section for purity control of the high raw massecuite. Final massecuite from the pan is 93-94% RDS.

Initially encrustation problems were encountered causing flow blockage between cells in the pan. The installation of 11 additional water sprays in each section helped to alleviate the problem. When encrustation becomes evident through observation, water sprays are activated for one minute every other hour as needed. Three high level probes were also installed to detect plugging between cells caused by encrustation deposits breaking off and plugging passages between cells.
Pan is completely cleaned every 24-25 days. One section is cleaned every 8 days. The section to be cleaned is drained to the next section and "water boiled" to remove encrusted sugar. Chemical cleaning can be done if necessary. High level probes are cleaned as required.

All R/F probes are cleaned every 16 hours. One shift cleans the odd cell probes and the following shift cleans the even cell probes in an ongoing schedule from shift to shift.

Pan was constructed at Dakota Machine in Fargo, North Dakota. Excellent workmanship was evident in all aspects of construction.

The factory is very pleased with the pan and its performance.

Vic Jaro – The Amalgamated Sugar Company, LLC
The Twin Falls continuous high raw pan system installed in 1995 consists of three F/S pans stacked vertically above one another. The pans are referred to as "A", "B" and "C". The "A" and "B" pans have a capacity of 1766 cubic feet each and the "C" pan has a capacity of 2119 cubic feet. Heating surface area is $11\, \text{m}^2$ per $\text{m}^3$ massecuite in the "A" and "B" pans and $10\, \text{m}^2$ per $\text{m}^3$ massecuite in the "C" pan. All three pans are operated as a single unit on either 2nd or 3rd vapor. Batch pans formerly in this service were operated on either 1st or 2nd vapors. Continuous pans are generally operated on 3rd vapor.

A seed magma system produces seed magma for the low raw pans and for the initial charging of the continuous pan. Unwashed low raw sugar is "magmatized" for use as seed for the continuous high raw pan. The quality of the seed is extremely important for the good operation of the continuous pan. Seed magma for the continuous pan is generally 87-89% purity at 93-94 RDS. Lumpy, poor quality seed gives problems at the centrifugal station and is very hard on centrifugal screens.

Feed line plugging can be a problem if feed is not continuously flowing to the pan at all times. If the pan feed is interrupted for any length of time, grain will settle into the feed ports and plug them requiring considerable time and effort to unplug. Flushing feed lines with condensate and then isolating the lines during an outage until restart of the pan makes for much smoother restarts after any downtime.

Latter cells of the pan are fitted with low green feed for backboiling and massecuite purity control.

An additional spray bar has been added to each pan section and to the outlet overflow weirs for each pan. Careful attention is taken to assure that the spray nozzles are properly positioned for optimum washing. The spray system is automatically controlled to function without operator attention on a routine schedule.

The pan was originally installed with R/F (radio frequency) probes normally supplied with the pan. Such probes require frequent cleaning to maintain good measurements and feed control. Twin Falls had problems with R/F probe sensitivity during juice and extract processing when low conductivity syrups are encountered. Pan feed control has been changed to "in situ" refractometers. The refractometers were installed in 13 of the former 20 R/F probe locations. Where a measurement is missing, the feed is averaged.
between two cells sharing a common measurement. Each probe is fitted with an automatic purge system for cleaning thus eliminating any need for operator or technician time for this purpose. This arrangement has worked out very well.

Temperature indication is provided at each refractometer probe location. If temperature indication begins to fall below a certain value, it is indicative of encrustation around the refractometer probe that can result in measurement errors.

Good circulation is essential to good pan performance. To augment circulation in the pan, the "jigger" steam addition has been automated. Not only does the addition of steam improve circulation; it also reduces encrustation in the bottom of the pan. The automation provides the addition of "jigger" steam in a timed sequence through the pan. The "jigger" steam system may also be activated when a temperature drop is noted in any individual cell to improve cell circulation and restore accurate refractometric measurement.

Pan performance is currently running 61.37% crystallization on sucrose producing high raw sugar with 97.6% purity with 1300 ICUMSA color. Grain size of high raw sugar is in the 225-250 MA range. Little or no water is used on the high raw centrifugals. A purity drop across the pan and centrifugals of 13-14 purity units is normal and may be as high as 15 units. High green feed to the pan is generally 85.0-87.5 while producing a low green purity in the range of 71.0-73.0.

Chris Rhoten –Monitor Sugar Company

The evolution of the "continuous recovery system at Monitor Sugar Company began in 1993 with the installation of a BMA VKT in low raw service. This installation was followed in 1995 with the installation of a second VKT on high raw service. Subsequent upgrades to the system were installed in 1997 including a backboiling system on the high raw VKT for high raw massecuite purity control and a process data management system for the management of massecuite density and purity. The data management system was very important and helpful to the system operators to aid in their adjustment to the new mindset of continuous as opposed to the former batch operation of the sugar recovery system.

Seed for the entire system is boiled in a batch pan at 77-79 purity to 100-150 MA. This seed is boiled on demand to the needs of the low raw VKT. The quality of this seed is extremely important to the overall efficiency of the recovery system. Unwashed low raw sugar is mingled with low green syrup to produce 92 RDS seed magma for the high raw VKT. 100% of the low raw sugar is fed to the high raw pan as seed. Thus, only high raw sugar is melted in the thick juice. Typically, low raw sugar is 300 MA and high raw sugar is 500 MA. Very little water is required for high raw sugar washing. High raw sugar is in the range of 98-99% purity and low raw sugar is in the range of 93-94% purity.

The low raw pan is controlled by the temperature of the massecuite that is relative to the density of the massecuite at a constant absolute pressure. The calandria pressure controls the speed of boiling in turn controlling the feed rate to each chamber to maintain the set point temperature (density). Seed flow to the pan is a ratio set on the totalized syrup feed flow to the pan. The high raw pan is controlled in the same way with the exception that the individual cell massecuite density is measured by nuclear
The operator only has to manage the speed of the pan as all other functions of pan control are cascaded from the "speed control".

The factory experienced a steady decline in pan massecuite density and an increase in massecuite purity as the sugar recovery equipment was changed from batch to continuous systems. This was in spite of the fact that crystal yields from the continuous pans were as high or higher than with the batch equipment. To counter this decline in performance, "pseudo" run charts were devised based on averaged laboratory analysis for chamber brix and massecuite purity. These "run charts", while not statistically "correct", gave the operator a clearer view of the process trends over the most recent three-week period. This information allowed him to make minor adjustments to the various set points of the pan density and purity control (backboiling) to maintain a proper density and purity profile in the recovery system. The results were dramatic and immediate giving better performance with the continuous systems than has been obtained with the former batch systems.

The importance of setting up a proper system of data feedback will eliminate or reduce the problems of over or under control. In some cases the operators were making adjustments to the process that were unnecessary. In other instances the operators were making no adjustments when needed because they didn't trust the laboratory data. By averaging the data on the basis of a running average, the "errors" in the process and the data were cancelled out. The operator could see and react to true trends in the process that had not been evident to him except with the presentation of the data in the averaged, trending format. Each laboratory data point entered into the database results in the automatic updating of the trend chart to give the operator as close to a real time view of the process as possible. By virtue of this system, the continuous pan operator now has complete control of sugar end recovery efficiency.

Viewing of the trend charts along with knowledge of the "speed control" settings gives an excellent indication of the pan cleaning requirements. Typically, the high raw pan, operated at 85-87% purity and 93-94 RDS, is cleaned on a 30-40 day cycle. The low raw pan is operated at 74-76% purity and 94-95 RDS and cleaned on a 70-75 day cycle. Monitor experiences virtually no problems associated with encrustation with these pans with the exception of a decline in capacity.