Presented at the ASSBT meeting
in Anaheim, California, USA
Date: March 5, 1993

NEW MILK OF LIME STATIONS IN TWO WESTERN SUGAR FACTORIES

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CONTENT

INTRODUCTION

The subject of my presentation is an overview of milk of lime station design, engineering and its importance in the beet processing. My role as the designer and the Technical Director was to provide the basic plans based on my own experience, ideas and concepts. However, for the successful accomplishment of this projects I am indebted to the factory teams in both, the Billings and Fort Morgan plants. Without their sincere cooperation and hard work this projects could not be accomplished.

The Billings, Montana sugar plant was built in 1906 by Kilby Machine Company to process 1200 tons of beets per day. The Colorado plant in Fort Morgan was founded by The Riter Conley Machinery Company the same year for 600 tons of beet slicing capacity. Both factories were built with an intention of extracting the maximum yield of sucrose by application of Steffen process. As the years passed their capacities were gradually increased to an average of 4100 and 3600 tons of beets per day respectively. In an ever growing demand to increase slicing capacities while minimizing capital investments, the idea evolved to convert these last Steffen plants to a straight house operation. It was obvious that skilful conversion should result in simultaneous increased slicing capacities, less fuel and lime consumption and cost savings in processing and maintenance. The recognized drawback in such a project was the decrease in company's sugar yield due to the loss in unworked molasses. This last obstacle was overcome by the 1992/93 erection of a molasses desugarization plant in Scottsbluff, Nebraska. This enabled the company to realize a straight house conversion with no reduction in the volume of produced sugar.

An earlier experience in one of Western Sugar plants warned of serious negative consequences when a Steffen factory is converted into a Straight house without sufficient engineering and technological considerations. Consequently, careful planning and preparation was done in advance at both factories.

The basic idea was that a sugar plant cannot perform any better than the weakest link in the chain of the units comprising the technological process. It was obvious that in addition to a good training program for the management and station operators, it would be equally important to design a milk of lime station having sound technological justification, robust equipment and reliable automation.

During the 1992/93 campaign the Western Sugar reached most of the planned targets in both plants. This paper is a brief description of this projects.

CONCEPTS

The principles behind the Juice Purification system are the Lime - Carbon Dioxide - Non Sugar reactions. This principle has been recognized universally throughout the world known technologists. The entire system consists of a large number of reaction vessels, pumps, heaters, mixers, gas distributors and sludge separation equipment. During juice purification many physical and chemical reactions occur. Generally, the optimum purification results can be achieved only with precisely controlled chemical reactions. The key factors in each reaction are the pH, temperature and retention time. Closely associated with the mentioned factors are the densities and concentrations.

The conventional milk of lime preparation consists of mixing the burned lime with water, i.e. slaking, separation of foreign particles, i.e. screening and adjustment of milk of lime densities. Though in modern factories these are mostly automated, there are still places in which the operation is based on manual labor. The conventional milk of lime screening is associated with messy maintenance and dangerous cleaning procedures. On the other hand the manual density control is unreliable and it is a source of many irregularities during the juice purification.

The new concept in this project was to use very robust and reliable equipment, avoid screen cleaning of the milk of lime and apply remote control devices and consequently achieve a total automation of milk of lime station. The objective was targeted to preparation of pure, uniform density milk of lime with no labor involvement.
The milk of lime station operation is monitored from the factory's central control room. All waste material was to be conveyed and collected in an easy accessible storage area outside the building. Enough milk of lime storage capacity had to be built to store two hour of milk of lime reserve. This had to serve two purposes: Sufficient milk of lime in case of minor equipment break down and retention time for milk of lime ageing.

Some earlyer examples made us aware that introducing the new concepts and changes in conventional procedures may cause major confusions and operation problems. Consequently, an important part of the project was to train the technical management and station operators.

Both milk of lime stations, in Billings and Fort Morgan, were designed to apply identical process schemes. During the construction, due to on site specifics and available capital spending we had to make some minor technical changes. However, all changes were done with minimum alteration of the original basic concept. Provisions were made for easy completion of the original scheme, when the capital spending become available.

Also, in order to avoid technical errors and material or time loss, the project included close cooperation with the machine builder. A close communication with the equipment supplier was maintained from the beginning of the project.

PROCESS SCHEME

Please see the following scheme number 1 in the appendix section of this paper.

The burned lime is lifted by bucket elevator (1) to the third floor hopper (2) which is designed for two hours reserve capacity. Following the hopper is a reciprocating, variable speed, feeder that conveys burned lime to a "Silver - Toth modified" slaker (3). It is designed for fifteen minutes reaction time. Both slakers were built by the "Silver Engineering" at the Denver, Colorado manufacturing facility. The slaker's exit sides are supplied with two sections of reverse wedge screen, built as an integral part of the drum. The reverse wedged screens enable separation, washing and conveying the unburned lime cores. They are designed to perform continuous self cleaning action. The entire screen section is kept under moderate negative air pressure by a strong fan and water curtain dust catcher. The negative pressure serves two purposes: It keeps the vapor under control at the exit and also eliminates dust emission at the lime feeder side.

The screened milk of lime separated from spalls were gravity conveyed to "Door - rake" type classifier (4). This equipment is designed by Western Sugar engineering and built by "Empire Steel" at Billings, Montana manufacturing facility. By the author's earlyer experience in Europe (1950's) and later in Michigan Sugar (1970's) the Door - rake classifier is not only able to replace milk of lime fine screening but in addition; it is a very reliable and low maintenance equipment. In Door classifier the grit and most of the sand were separated by gravity. The milk of lime over-flowed to high density tank (5) while at the same time the grit and

sand were intended to move to washing in an other classifier (10). Due to both, time and capital spending limitations it was decided not to build the classifier "10" but to apply spray washing at the classifier "4" exit side.
The high density milk of lime was pumped to the hydro cyclone separation (6). This separation is able to eliminate all remaining sand from the milk of lime. Considering the important requests for good performance on hydro separation, special design measures were taken to assure constant flow and pressure at hydro cyclones.

The purified milk of lime density from hydro separation was adjusted and stored in the "low density" tank (7). Besides density adjustments the tank "5" and "7" had two additional purposes: (1) To assure appropriate retention time for preparation of high quality milk of lime and (2) supply volume for 1.5 to 2.0 hours lime reserve.

The waste materials from "3", "4", "6" and "10" were collected and conveyed by scroll (11) to the waste storage, located outside of building.

The wash waters from "3" and "10" were intended to collect in the tank (13) and recirculated into the system. The tank was supplied with automatic level and temperature controllers in order to assure steady provision of hot water to the milk of lime station.

AUTOMATION AND INSTRUMENTATION

The level of milk of lime tank (7) sets the speed of slaking. A signal from the level sensor is sent to LC/7. The output ratio from the instrument to lime feeder and water valve are set manually. This controller calculates and sets an approximate milk of lime density in the slaker to the range of 32 to 37 Brix. Fast level drop in tank "7" will send higher output signals triggering an increase in the slaking speed and vice verse.

The level controller LC/5 controls the level in the tank 5 assuring constant flow and pressure for hydro cyclones. When the tank level becomes critically low it triggers an output signal to reverse acting valves sending the flow to tank 5 while closing it to tank 7.

The nuclear density controller (DC) does a fine tuning in the density of lime to process. It controls water addition to tank 7 trimming the high density lime to the requested value of 30 Brix.

The level controller LC/13 controls the valve on house hot water to tank 13 assuring a safe water level.

The following instruments, micro-processors and sensors were used in the project:

1. Moore single loop digital controllers - 352 (6 pcs).
2. Moore logic and sequence controller - 382 (1 pcs).
3. Moore satellite for controller interface - 321 (1 pcs).
4. Moore area console - 39M16 (1 pcs).
5. Opto relay stations for I/O interface (2 pcs).
6. Moore I/P transducers (7 pcs).
7. RTD with two wire Wilkerson transmitters (3 pcs).
8. Two "Texas Nuclear" density controllers (2 pcs).
9. "Sparling" flow meters (2 pcs).
10. "Rosemont" D/P level transmitters (3 pcs).
11. Bindicators for hopper level control (2 pcs).
12. "Allen Bradley" variable frequency drive (1 pcs).

Valves:

1. "Fisher" V- ball (1 pcs).
2. "Keystone" butterfly valves (9 pcs).

Pumps:

1. "Goulds"; model JC; 2 pcs; size; 3 x 4 x 14; Hp 25;
   Motor speed 1750 RPM; Pump speed 1450 RPM.
   Design conditions: Milk of lime before sand removal;
   Temperature 95 C.; Viscoss. 100 SSU;
   Sp.G. 1.2; 210 GPM; Head 155'H2O.

2. "Goulds"; model 3196; 2 pcs; size 2 x 3 -13 MTX; Hp 20;
   Motor speed 1750 RPM; Pump speed 1750 RPM.
   Design conditions: Milk of lime to process; Temperature
   95 C.; Viscoss. 100 SSU; Sp.G. 1.2;
   Head 135' H2O.

RESULTS

During campaign 1992/93, due to permanent mechanical and technological problems in the lime production, the "factory F" in the Western Sugar company had to be run on a very low lime consumption. This situation created an excellent opportunity to compare the results achieved in Billings and Fort Morgan to "factory F".

TABLE 1; BEET SLICE; BILLINGS - "FACTORY F":

	BILLINGS		"FACTORY F"	
Week	Avg.Slice (Tons/day)	% of nominal capacity	Avg.Slice (Tons/day)	% of nominal capacity
1	3142	76.6	-	-
2	4115	100.4	-	-
3	4362	106.4	2470	68.6
4	4129	100.7	2844	79.0
5	4391	107.1	3061	85.0
6	4680	114.5	3823	106.2
7	4498	109.7	3800	105.6
8	4885	119.0	3853	107.0
9	5056	123.3	3331	92.5
10	4243	103.5	3963	110.1
11	4849	119.3	3731	103.6
12	4784	116.7	3994	110.9
13	4851	118.3	3953	109.8
14	4956	120.9	4013	111.5
15	4306	105.0	3700	102.8
16	4414	107.7	3925	109.0
17	2942	-	3409	94.7
18	4436	108.2	3487	96.9
19	4621	112.7	3781	105.0
20	4464	108.9	3454	95.9
AVERAGE	4457	109.4	3554	98.7

Slice difference in % of nominal capacity= 109.4 - 98.7= 10.7

TABLE 2; BEET SLICE; FORT MORGAN - "FACTORY F":

	FORT MORGAN		"FACTORY F"	
Week	Avg.Slice (Tons/day)	% of nominal capacity	Avg.Slice (Tons/day)	% of nominal capacity
1	3429	97.1	-	-
2	3993	113.0	-	-
3	3971	112.5	2470	68.6
4	3965	112.3	2844	79.0
5	4026	114.0	3061	85.0
6	4018	113.8	3823	106.2
7	4125	116.9	3800	105.6
8	4170	118.2	3853	107.0
9	4323	122.5	3331	92.5
10	4221	119.6	3963	110.1
11	4124	116.8	3731	103.6
12	4113	116.5	3994	110.9
13	4018	113.8	3953	109.8
14	4298	121.8	4013	111.5
15	4138	117.2	3700	102.8
16	4179	118.4	3925	109.0
17	3792	107.4	3409	94.7
18	4155	117.7	3487	96.9
19	4140	117.3	3781	105.0
20	4028	114.1	3454	95.9
AVERAGE	4061	115.1	3554	98.7

Slice difference in % of nominal capacity= 115.1 - 98.7= 16.4

TABLE 3; EXTRACTION; ON % SUGAR IN BEETS:

Week	BILLINGS	FT. MORGAN	"FACTORY F"
1	-	82.8	-
2	-	84.0	-
3	85.7	85.6	77.5
4	86.6	84.1	80.3
5	84.1	87.0	82.8
6	82.6	85.8	83.8
7	84.7	85.3	84.0
8	83.3	84.6	80.8
9	84.5	85.3	79.7
10	84.6	85.8	80.8
11	83.4	83.4	83.2
12	85.4	81.7	81.5
13	85.5	82.5	85.4
14	85.9	84.0	82.6
15	84.3	84.0	80.7
16	91.5	79.8	81.2
17	75.7	80.2	79.3
18	87.3	80.5	80.7
19	87.0	80.6	77.5
20	83.7	81.01	71.6
AVERAGE	84.8	83.4	80.8

Extraction differences; % sugar in beets:

(1) Billings - "Factory F" = 84.8 - 80.8 = 4.0 %

(2) Ft.Morgan - "Factory F" = 83.4 - 80.8 = 2.6 %

CONCLUSION

1. Both new Milk of Lime stations implemented in Billings, Montana and Fort Morgan, Colorado sugar plants performed satisfactorily supporting the main line of process.
2. The new equipment proved to be very reliable with no major mechanical or technological problems throughout the entire campaign.
3. The advance training of the factory teams resulted in a good start-up at the beginning of 1992/93 campaign, steady processing and excellent results.
4. The Tables 1 and 2 lists results that justify the importance of a steady supply of high quality milk of lime into the beet sugar processing operation.
   We underline: Failure to provide a steady supply of Milk of Lime causes downfall in beet slicing as high as 10.7% to 16.6% from the achievable capacity.
5. Data presented in Table 3 proved the damage caused by a shortage of Milk of Lime in processing. The consequence of Milk of Lime shortage results in sever sugar losses of 2.6% to 4.0% on sugar in beets.
6. The new Milk of Lime Station project completed in these factories; Billings, Montana and Fort Morgan, Colorado proved the benefit of automation when sound technological principles are applied.

ACKNOWLEDGMENTS

The following members of the engineering and factory team were credited for their successful contribution to the Milk of Lime station project:

Billings
1. Vernon L. Vickery, Factory Manager
2. Nick Shyne, Master Mechanic
3. Karl Saas, Process Engineer
4. Joe Moore, Engineering
5. Tom Shellooe, Chief Chemist

Fort Morgan
1. Richard Kraus, Factory Manager
2. Don Hill, Engineering and Maintenance Manager
3. Darol Hall, Master Mechanic
4. Steve Schmidt, Engineering
5. Mark Bright, Engineering