AN OVERVIEW OF FIVE YEARS OF BALANCING AND EFFICIENCY IMPROVEMENT AT SANGHAR SUGAR MILLS

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SANGHAR SUGAR MILLS

INTRODUCTION

SSML was established in 1987 with a crushing capacity of 3000 tons cane per day (tcd). The plant follows defecation, remelt, carbonation process for production of white sugar of 99.8° polarization. The Karachi Shipyard and Engineering Works, Pakistan and FCB, France supplied equipment and machinery for the plant. The capacity of the plant was extended to 5000 tons cane per day in 1994.

From the very start and especially after the capacity extension, the SSML faced the problem of low capacity utilization, increased machinery breakdown, lower mills extraction, higher bagasse pol, higher steam consumption, higher bagasse/ fuel consumption, higher purity of final molasses, lower boiling house and overall efficiencies, higher color of sugar with much variation every season in sugar recovery and production.

Over the years various measures were taken to drive productivity but without much success. However, from 2007 onwards more serious efforts were made to identify those operations that merited attention. A team for the purpose was formed, with a general consensus from all parties, namely the management and the concerned technical staff in the team. This approach paid off as improvements began to be noticed from the very first season (2007-2008) of the exercise. What follows below is the section wise description of the plant, jobs carried out and comparative results obtained.

1. Cane Carrier and Mills:

- The cane carrier and milling tandem consisted of an auxiliary cane carrier with 02 cane feeding tables.
- One main cane carrier with 02 sets of cane knives, a heavy duty cane shredder and 05 FCB self setting 03 roller mills of 980 x 1820mm with a forced feeder.
- The previous 20 season's operation (1987-1988 to 2006-2007) revealed that crushing stoppages due to choking of cane knives were quite common with higher bagasse pol of +2.0° and mill extraction of 93-94%.
- The cane shredder was operated at a speed of 700 rpm and imbibition water at 230-270% fiber was applied at the mills.
- In addition, lot of mixed juice was passing over to the second mill along with Cush Cush from the DSM screens.

Considering all these points, following steps were taken:

- The under capacity 235 KW motor of first cane knives was replaced with a 600 KW electric motor drive to give 15-18 KW per ton fiber per hour.
- One additional set of cane knives with a 450 KW electric motor drive was provided at the auxiliary cane carrier.
- Gearbox of the cane shredder was repaired.
- An auto speed/ feed and imbibition control system was provided at the carrier and mills.
- One rotary screen (size 1800 x 3600mm) for mixed juice was provided in addition to the existing under capacity DSM screens.
- One small 3 roller mill (SSML machine shop fabricated) of 368 x 812mm with 18 KW electric motor, chain drive, 14 rpm for dewatering of Cush Cush was installed.
- Moreover, imbibition water at the mills increased to 302% on fiber.

The milling results obtained after all these jobs (2007-2011) and its comparison with the previous 20 seasons working given in Table-1.

Table - 1: SSML milling results 1987 - 88 to 2011-12

Description	Five seasons average results (per season)				
	1987-88 to 1991-92	1992-93 to 1996-97	1997-98 to 2001-02	2002-03 to 2006-07	2007-08 to 2011-12
Cane Crushing, days	171	164	121	130	131
Cane Crushed, tons (including stoppages)	443136	486520	406647	451435	581942
Cane Crushing/day, tons (including stoppages)	2591.43	2966.58	3360.71	3472.58	4442.30
Imbibition % fiber	164.24	179.22	228.05	270.11	302.60
Mill extraction % (plain)	91.19	93.01	92.90	94.37	95.21
Pol % bagasse	3.29	2.64	2.55	1.98	1.67
Moisture % bagasse	52.5	52.8	53.5	54.0	51.5
Steam consumption % cane	n/a	72	70	66	58
Surplus bagasse, tons	nil	Nil	nil	4100	15,000
Furnace oil consumption, tons	n/a	104	236	47	Nil
Boiler stack gasses temp. °C	205-210	205-210	205-210	205-210	180-185

- It is apparent from Table 1, that the daily cane crushing rate during 2007-12 as compared to previous 05 seasons (2002-03 to 2006-07) increased by 29%.
- The bagasse pol reduced by +0.31°.
- The mill extraction improved by 0.84°, and the choking of cane knives were eliminated.
- Because of regular and capacity crushing, the operation of boilers, turbo generators and boiling house became very smooth with reduction in consumption of steam.
- Substantial saving of bagasse and no extra consumption of furnace oil in boilers.

2. Steam Boilers and Electrical Power House:

- A total of 03 nos. bagasse fired boilers with a working pressure of 25 Kg/cm² and provision of furnace oil fuel are installed in the SSML.
- Two boilers are identical to FCB, France design, each of 45t and 01 boiler of HMC, Pakistan of 80t steam generation per hour.
- The working of boilers during 1987-88 to 2006-07 remained erratic with frequent pressure and load fluctuations.
- Higher temperature (+215 °C) of stack gasses.
- Higher consumption of bagasse, Higher moisture (53-54%) in bagasse.
- Additional consumption of furnace oil.
- Lower temperature (94-96°C) of feed water, etc.
- In addition, the 80 t/hr boiler was not able to operate above 70 t/hr.
- All these factors contributed to reducing cane crushing, fostering increased consumption of bagasse and reducing boiler efficiency.

Therefore, following steps were taken to drive efficiency:

- All the steam carrying vessels and pipes in the boiler house and the entire factory were properly insulated.
- Missing and defective steam traps were replaced.
- Bagasse drying arrangement with boiler stack gasses was made.
- Under capacity, ID fan of 80 t/hr boiler was replaced with a bigger capacity fan.
- Heating surfaces of economizer and air-heaters were increased by 40% each, etc.
- In addition, a turbo generator set to produce 6MW electric power was installed to make 03 turbo generators of 6, 5 and 2MW.

Following the implementation of the above mentioned measures, decisive improvements were observed in terms of boiler efficiency as well as overall working results of the factory.

- The moisture in bagasse, fed to the boilers reduced by 2.5°.
- The 80 t/hr boiler operated at the designed capacity.
- Boiler feed water temperature increased by 6°C.
- Boiler stack gasses temperature reduced by 20°C.
- Consumption of furnace oil was eliminated.
- There was saving of bagasse.
- Regular and capacity operation of the mill was ensured (Table 1).

3. Boiling House:

With the study of the available equipments and the working results obtained during (1987-2007), it was noticed that:-

- Pol in filter cake was high i.e. above 2.5°.
- Temperature of juice heater for the limed juice before the clarifier was not maintained regularly at +102°C.

- Syrup Brix from last evaporator (Quadruple effect) was not regular and extremely low i.e. 52-60°.
- High temperature (+65°C) and lower vacuum (-530mm) were noted at the last evaporator and 3 nos. continuous pans for A, B and C-massecuites.
- Temperature of injection/ spray water was also high and there was higher purity of final molasses i.e. +36°.
- Further, there was much variation in quality of white sugar i.e. 99.4 - 99.7O polarization and 50 - 120 ICUMSA color of R1, R2 and R3 sugar containing iron rust particles which were quite visible.
- Additionally, the boiling house was not capable of accommodating higher crushing and higher imbibition water at the mills.

Considering all these issues, measures to address them are briefly described below.

- A vacuum filter of drum size 3m x 6m similar to the 02 already operating was installed.
- Vapour bleeding arrangement from third evaporator vessel for primary heating of mixed juice was provided.
- One rotary screen (size 1800 x 3600mm) for clarified juice was installed.
- Bigger diameter vapour pipes to condenser and domes at the last evaporator and 03 nos. horizontal tube type continuous pans were provided. One evaporator body of 3500 Square meter heating surface was installed.
- All the corroded condensers of mild steel for evaporator and pan were replaced with S.S. condensers and S.S. tail pipes.
- One vertical tube type continuous pan of 102 cum capacity as per FS design was installed for boiling low-grade c-massecuite.
- Entrainment catchers were provided in the last evaporator and all the pans.
- Phosphate floatation process for color removal and refining of raw-melt was provided in place of the existing flue-gas carbonation system.
- A bigger capacity (30 tons/hr) pressure-reducing valve was provided for supply of live steam.
- One continuous centrifugal for c-massecuite of 10 t/hr and one batch type centrifugal of 1300 kg/charge for white sugar was installed.
- One additional set of sugar elevator, dryer and grader similar to the existing one was installed.
- Proper sealing arrangement to avoid re-mixing of molasses with cured sugar in all the A, B and C-massecuite continuous centrifugals was provided.
- A set of magnetic iron separator was installed after sugar grader and before sugar bin to remove iron rust particles from sugar.
- Capacity of spray pond was increased by 40% by reducing various bends and increasing the diameter of pipes and no. of spray nozzles.
- In addition, scrapping, beating, rust removal and oiling of all the vessels including clarifier, evaporators, pans, crystallizers, storage tanks, etc was made a routine in every off-season.
- The replacement and upgrading was managed so as not to disturb the original layout of the plant and machinery.
- To ensure continuing easy access for operation and maintenance. Productivity improvements following these upgrades noted during 2007-08 to 2011-12 and its comparison with outputs during 1987/2006 are given in Table 2.

Table - 2: SSML production season results 1987-88 to 2011-12.

Description	Five seasons average results (per season)				
	1987-88 to 1991-92	1992-93 to 1996-97	1997-98 to 2001-02	2002-03 to 2006-07	2007-08 to 2011-12
Milling time efficiency %	83.93	84.63	81.41	83.70	90.61
Sugar recovery % cane	8.99	9.17	8.92	9.00	9.57
Cane sugar production, tons	39510	41559	34771	40552	55694
Purity final molasses	36.35	36.14	36.61	36.16	32.99
Boiling house efficiency %	81.66	82.54	83.21	84.00	85.45
Overall efficiency %	74.50	76.78	77.31	79.27	81.37
White sugar pol	99.4-99.7	99.4-99.7	99.4-99.7	99.4-99.7	99.8
White sugar color, ICUMSA	50-120	50-120	50-120	50-120	30-70
Temp. in last evap. & Pans ^{o}C	64-68	64-68	64-68	64-68	58-61
Vacuum in last evap. & Pans, mm	-520-540	-520-540	-520-540	-520-540	-640-670
Brix^{o} of Syrup	53	55	56	57	61
Pol % filter cake	2.9	2.8	2.6	2.6	1.6

As a result of implementing variety of measure spread over a period of 4 to 5 years to drive operational efficiency, it is apparent from Table 1 and 2, that the:-

- Average milling time efficiency of cane crushing during 2007-08 to 2011-12 increased to +90% compared with 83% prior to upgrades during 1987-2006.
- The boiling house was able to accommodate higher imbibition water (302% on fiber) and higher cane crushing by 29%. The pol % filters cake was reduced by +1.0^{o}.
- The final molasses purity reduced by 3.17^{o}.
- The boiling house efficiency increased by1.45^{o}.
- The overall efficiency increased by 2.1^{o}. The white sugar quality i.e. polarization increased by 0.1^{o}.
- The color of sugar decreased by 40% and became free from iron rust and any foreign particles.
- In addition, the sugar production increased by 37%.

Ongoing and future initiatives:

Following plans are being considered and some of it is already in various stages of implementation:

a. Improve / increase the Brix of cane syrup to +65 ^{o}.
b. Carry out expansion of SSML to 7000 tons cane per day in the first phase and to 10000 tons cane per day later on.
c. Reduce the steam consumption by 6-8%.
d. Carry out automation of various sections of the plant.
e. Sale of surplus electric power of + 5000 KW to the national grid.
f. Convert filter cake and boiler ash into bio-fertilizer for use as soil conditioner and fertilizer in sugar cane fields.
g. Establish an alcohol distillery and a fiberboard plant for utilization of molasses and surplus bagasse respectively.
h. Bring down the final molasses purity to 30° and below i.e. by 2-3°.