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SCREENING OF HOT RAW JUICE USING ROTARY JUICE SCREEN

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ABSTRACT

The article describes the details of hot juice rotary screen installed at few sugar mills along with data collected which shows hot juice quality improves by further screening of hot raw juice. Single stage screening which is universally carried out has the following limitations:

1. *Very fine cane preparation has increased fine particles of bagacillo in the juice which is not satisfactorily removed by 500 micron screen in Single stage.*
2. *These fine particles interfere with clarification process beside chocking juice pipes and pumps, plate heat exchange opening.*
3. *Particles have also been observed floating in clear juice.*

Hence it was thought to provide further screening of heated raw juice using a finer mesh at the rotary screen. The results were quite interesting and encouraging. The Sugar colour improved making sugar easily acceptable to the beverage industry..

Keywords: Unscreened mixed juice, screened mixed juice, rotary juice screen, fibre, ppm.

METHODS

Following internationally accepted ICUMSA methods are used for analysis of all intermediate products and final product, sugar.

a) Fibre content of juice - ICUMSA GS7-13 (1994)
b) Colour of juice - ICUMSA GS1/3-7

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c) Turbidity of juice - ICUMSA GS7-21 (1994)
d) Colour of white sugar - ICUMSA GS 2/3 – 9 and 10
e) Beverage floc test of sugar - ICUMSA GS 2/3 – 40
f) Conductivity ash of sugar - ICUMSA GS 2/3/9 – 17
g) Sediment content of sugar - ICUMSA GS 2/3/9 – 19
h) Sulphur Dioxide content of sugar - ICUMSA GS 2/1/7/9 – 33

*Global patent applied for 'equipment' and 'process'

INTRODUCTION:

To improve mill extraction we need to increase preparation index (PI) of prepared cane. At higher PI dust formation takes place resulting in very fine fibre particles which escape through opening of juice screening arrangement installed at milling tandem generally having a rotary juice screen of 500 micron opening.

Following data was collected during last 17 years

Period	**Fibre content in screened mixed juice**	
	Ppm	**gram / kg**
2000-2004	1350 – 1500	1.35 – 1.50
2005-2009	1500 – 1650	1.50 – 1.65
2010-2017	1800 – 2300	1.80 – 2.30

1,000 ppm = 1 g / kg = 0.1 % ≈ 1 g/ltr

Above results clearly indicates the trend of increase in fine fibre in screened juice.

To overcome the problem further screening of mixed (raw) juice was carried out.

A rotary juice screen installed to screen the mixed (raw) juice after first stage heating (primary heating) say upto 75 deg.C. Screening at this temperature helped to enhance screening efficiency and to reduce chocking problem. Much finer opening screen is used to achieve maximum possible fibre reduction from juice entering process house.

EQUIPMENT DETAILS

At milling tandem the rotary screen is open type of construction as the juice temperature is ambient. As hot raw juice screen is installed after first heating it is necessary to avoid temperature drop across the screen. Hence this screen is

of totally closed type of construction. Feed end, discharge end, juice collection trough and top of the screen are closed to avoid temperature drop.

The screen is made from working screen in stainless steel construction having much finer opening supported with backing screen also of stainless steel construction. Feed and discharge end drum and other juice contact parts like feed pipe, distributor, juice collection trough etc are also of stainless steel construction. Other non wetted parts are of mild steel construction. The screen drums along with drive and discharge end drums are supported on 4 nos. rollers which are mounted on heavy duty base frame. Power is transmitted through chain – sprocket arrangement. Spray nozzles are fitted on piped header located inside the screen drum to cover the entire length of screen. Screen washing is carried out automatically by a timer operated pump.

The Rotary Screen for hot raw juice screening is located near juice sulphiter. The hot raw juice from SO_2 absorption tower is delivered to juice inlet pipe of rotary screen and screened hot raw juice outlet of the screen is delivered to juice sulphiter by gravity. The bagasse discharged from the screen is delivered to a receiving tank by gravity and is pumped to mills/mud mixer of vacuum filter in a slurry form.

MULTIPLE ADVANTAGES OF "HOT RAW JUICE SCREENING:

1. Reduction of Clear Juice colour by 1500 – 2000 IU.
2. Reduction of Clear Juice turbidity and improvement in transmittance.
3. Additional separation of 0.15 to 0.165% cane of dry fibre for extra power generation
4. Lowest ever fibre in screened hot raw juice 200 – 300 ppm (Aprox. 0.2 to 0.3 g/l)
5. The white sugar produced has always tested 'negative' to the beverage floc test using ICUMSA GS2/3-40 method.
6. The Sedimentation test for white sugar using ICUMSA GS2/3/3-19 has shown average value of 30 mg/kg; much below to the desired norm prescribed by beverage industry. As such all the pre-requisites prescribed by bulk consumers by beverage indusry.
7. Reduced solid and colour loading on subsequent process of juice, syrup and melt clarification.
8. No fibre contamination of sugar crystal.
9. Other mechanical advantages like chocking at PHE is eleiminated

10. Increase in capacity of existing clarifier and vacuum filter/Decanter capacity due to reduced solid loading.
11. Most importantly, improvement in sugar colour by 10 - 15 IU in normal condition and 15-20 IU in favourable situation.

CONCLUSION:

Total Fibre separation from unscreened mixed juice to screened hot raw juice is achieved to the extent of 95 %. The fibre reduction helped to reduce suspended solid loading of clarification house and improve overall performance and to improve the keeping quality of sugar.

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Data collection at various installations:

TABLE 1

Name of the Sugar Factory:- M/s. Krantiagrani Dr. G.D. Bapu Lad SSK Ltd.,
(Standard double sulphitation process adopted without syrup clarification system)

Sr.	Particulars		Weekly average of data collected			
			I	II	III	IV
Mill house Rotary Juice Screen Analysis – before and after screening						
1	Fibre - Inlet of RJS	ppm	6570	8920	7130	7248
2	Fibre - outlet of RJS	ppm	1910	1850	2290	2196
3	Moisture of discharged bagasse	%	79	82	78	81
4	Colour of un-screened mixed juice	IU	13271	15822	15875	14574
5	Colour of screened mixed juice	IU	13917	15577	14674	14143
Hot Raw Juice Screening System Before screening						
6	Colour - Inlet of RJS (IU)	IU	9593	15237	14403	13771
7	Temperature - Inlet of RJS	°C	77	78	72	78
Hot Raw Juice Screening System After screening						
8	Fibre - Outlet of RJS	ppm	120	190	228	198
9	Colour - Outlet of RJS	IU	7185	13895	12865	12001
10	Temperature - Outlet of RJS	°C	76	77	71	77
11	Moisture of discharged bagasse	%	82	84	83	85
Clear juice from clarifier						
12	Clear Juice – Colour	IU	8255	7174	7618	7382
13	Clear Juice – Transmittance	IU	45.1	50.5	53.3	56.9
14	Clear Juice – Turbidity	IU	9.4	5.8	4.1	3.6
S-30 grade sugar sampling and analysis done by – Maarc Labs Pvt Ltd.						
15	Sugar Colour by GS 2/3 - 9	IU	91			
16	Sugar Colour by GS 2/3 - 10	IU	68			
17	Beverage Floc		Negative			
18	Conductivity Ash	%	0.038			
19	Sediment	mg/kg	23			
20	Sulphur Dioxide	mg/kg	16.73			

Average reduction of fibre in juice going to sulphiter (No. 2 – No. 8) : 1877 ppm
Average reduction of colour in juice going to sulphiter (No. 5 – No. 9) : 3091 IU

Note: Hot raw juice rotary screen yet to be insulated.

TABLE 2

Name of the Sugar Factory:- M/s Shree Chhatrapati Shahu SSK Ltd.
(Standard double sulphitation process adopted with syrup clarification system)

Sr.	Particulars		Weekly average of data collected			
			I	II	III	IV
Mill house Rotary Juice Screen Analysis – before and after screening						
1	Fibre - Inlet of RJS	ppm	11145	8269	10480	12000
2	Fibre - outlet of RJS	ppm	2145	1852	2078	2292
3	Moisture of discharged bagasse	%	76	81	78	80
4	Colour of un-screened mixed juice	IU	16727	18509	15633	15327
5	Colour of screened mixed juice	IU	16224	18553	14308	14881
Hot Raw Juice Screening System Before screening						
6	Colour - Inlet of RJS (IU)	IU	16133	14691	15083	14826
7	Temperature - Inlet of RJS	°C	78	79	78	79
Hot Raw Juice Screening System After screening						
8	Fibre - Outlet of RJS	ppm	224	232	187	197
9	Colour - Outlet of RJS	IU	14845	13654	13048	13690
10	Temperature - Outlet of RJS	°C	77	79	77	78
11	Moisture of discharged bagasse	%	81	82	80	81
Clear juice from clarifier						
12	Clear Juice – Colour	IU	9101	9090	9278	11940
13	Clear Juice – Transmittance	IU	44.8	48.5	45.2	38.6
14	Clear Juice – Turbidity	IU	5.3	2.5	7.1	10.1
S-30 grade sugar sampling and analysis done by – Maarc Labs Pvt Ltd.						
15	Sugar Colour by GS 2/3 - 9	IU	89			
16	Sugar Colour by GS 2/3 - 10	IU	63			
17	Beverage Floc		Negative			
18	Conductivity Ash	%	0.022			
19	Sediment	mg/kg	25			
20	Sulphur Dioxide	mg/kg	11.89			

Average reduction of fibre in juice going to sulphiter (No. 2 – No. 8) : 1881 ppm
Average reduction of colour in juice going to sulphiter (No. 5 – No. 9) : 2182 IU

Note: Hot raw juice rotary screen yet to be insulated.

TABLE 3

Name of the Sugar Factory:- M/s. The Sanjivani (Takli) S.S.K. Ltd.
(Standard double sulphitation process adopted without syrup clarification system)

Sr.	Particulars		Weekly average of data collected			
			I	II	III	IV
Mill house Rotary Juice Screen Analysis – before and after screening						
1	Fibre - Inlet of RJS	ppm	6954	8236	9024	8194
2	Fibre - outlet of RJS	ppm	1647	1942	1868	2250
3	Moisture of discharged bagasse	%	78	80	79	81
4	Colour of un-screened mixed juice	IU	25290	22559	25895	18353
5	Colour of screened mixed juice	IU	25793	22272	24701	20089
Hot Raw Juice Screening System Before screening						
6	Colour - Inlet of RJS (IU)	IU	21520	19296	22443	16357
7	Temperature - Inlet of RJS	°C	67	73	70	71
Hot Raw Juice Screening System After screening						
8	Fibre - Outlet of RJS	ppm	208	218	193	226
9	Colour - Outlet of RJS	IU	20784	17044	18110	15065
10	Temperature - Outlet of RJS	°C	67	72	69	70
11	Moisture of discharged bagasse	%	80	72	74	74
Clear juice from clarifier						
12	Clear Juice – Colour	IU	12382	13401	13734	13340
13	Clear Juice – Transmittance	IU	38.6	36.7	37.8	30.4
14	Clear Juice – Turbidity	IU	9.2	9.8	8.7	11.7
M-30 and S-30 grade sugar sampling and analysis done by factory						
15	Sugar Colour by GS 2/3 - 9	IU	M-30	140	174	120
16	Sugar Colour by GS 2/3 - 9	IU	S-30	120	154	95

Average reduction of fibre in juice going to sulphiter (No. 2 – No. 8) : 1715 ppm
Average reduction of colour in juice going to sulphiter (No. 5 – No. 9) : 5463 IU

Note: Hot raw juice rotary screen yet to be insulated.

Cost economics by selling more bagasse saved by using Totally Closed Rotary Juice Screen having much finer opening for hot raw juice:

Base		
1.	Total Annual cane crushing	10 Lac tons
2.	Bagasse sell rate	Rs. 2500/- per ton
As per actual data collected at one of the installations		
1.	Residual fibre content in screened mixed juice at 1st stage Rotary Juice Screen having 500 micron opening.	0.2% (~ 2 g/l) screened mixed juice on oven dry basis
2.	Residual fibre content in screened hot raw juice at Rotary juice Screen having much finer opening.	0.035 % (~ 0.35 g/l) screened mixed juice on oven dry basis
3.	The reduction in residual fibre content in screened mixed juice	0.165 % screened mixed juice on oven dry basis
4.	For the sake of simplicity of calculations let us consider screened mixed Juice % cane	100
5.	Hence the reduction in fibre content in screened mixed juice % cane	0.165% cane on oven dry basis
6.	Let us consider fibre % mill bagasse	50%
7.	Therefore additional mill bagasse % cane	0.33 % cane
8.	Quantity of additional mill bagasse	= 0.33 x 10,00,000 / 100 = 3300 Ton
9.	Additional revenue by selling saved bagasse	= 3300 x 2500 = Rs. 82,40,000
FOREVER NET FINANCIAL GAIN PER SEASON		**Rs. 82.50 Lacs**
FINANCIAL GAIN PER TON CANE CRUSHED		**Rs. 8.25**

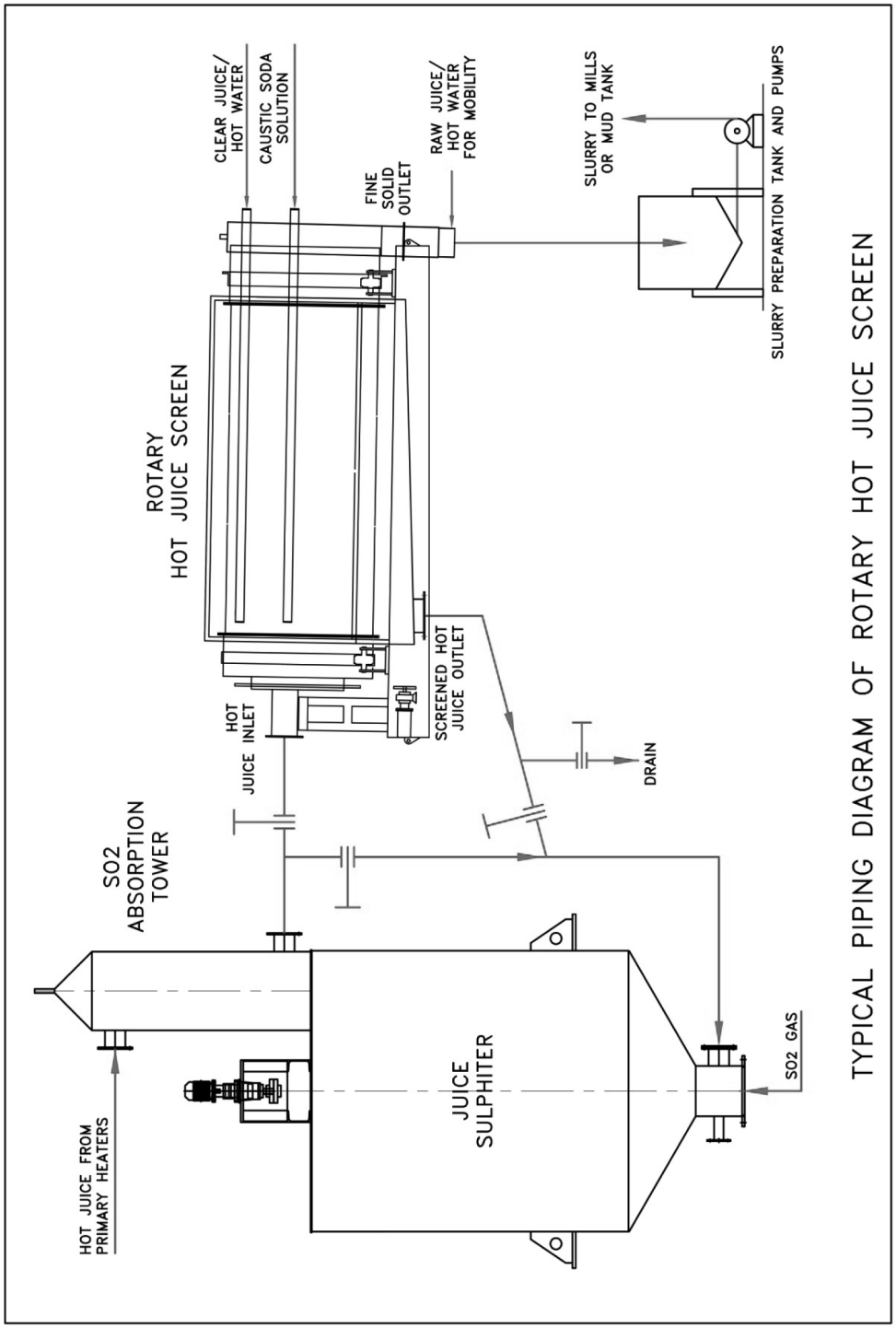

FIGURE 1 – PROCESS FLOW DIAGRAM

FIGURE 2 – INSTALLATION OF TOTALLY CLOSED ROTARY SCREEN FOR HOT RAW JUICE SCREENING