SCREENING OF HOT RAW JUICE TO REMOVE FINER FIBROUS PARTICLE AT SONHIRA S.S.K. LTD MOHANRAOKADAMNAGAR

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INTRODUCTION

In order to facilitate easy extraction of juice by milling tandem, modern cane preparation devices like fibrizer, heavy duty shredder are installed in sugar factories. The fineness of prepared cane has been increased, the preparation index goes up to +85, and this leads higher quantity of bagacillo in juice. Higher quantity of bagacillo increase the color of clear juice as tea brewing effects, increase the mud volume and suffered filtration station. It also blocks juice heater tubes and passes to clear juice and further find its way in sugar. The sugar quality becomes dull. Thus removal of bagacillo is must. Various static equipments were used in sugar factories like

- Stationary parabolic screen (DSM) with 1.00 mm aperture.
- Double stationary parabolic screen (DSM) with 1.00 mm &0.7 mm aperture.
- Hydro cyclone with DSM screen of 0.7 mm aperture.

But efficiency of all above units are not more than 60% & there is recirculation of juice which is rich in purity. It is also observed that lot of fine fiber particles are escape through wide gap of wedge bar opening, even though these fine particle cannot be trapped by using screen of 0.50 mm opening and lesser opening screens are chocked frequently. **This chocking is due to inadequate percentage opening of screen. In view of above consideration & to avail more screening area "ROTARY SCREEN" of various designs is installed in sugar industries for separation of bagacillo from juice.**

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ROTARY SCREEN

We at Sonhira S. S. K. Ltd. installed two rotary screen having opening 0.45 mm & 0.35 mm for removal of bagacillo with one as stand by. This is advance unit in sugar industry. As the name implies it is continuous juice strainer. The juice screening is affected on welded wedge bar screen. The screen is fitted on a cylindrical drum mounted in horizontal position with appropriate slope to non drive end. The entire screening area provided in rotary screen is fully utilized and hence maximum efficiency is achieved. The dynamic movement of screen allows utilization of smaller size wedge bar opening (0.45mm/0.35 mm) for removal of smallest bagacillo particle from juice. The diameter, length & linear speed (less than 1 m/second) of rotating screen are such designed that the projectile formed by solid remain on the screen and facilitates complete drainage of juice. The direction of rotation of screen is such that maximum juice is removed in the first 30% section of screen and balance in the remaining 70% of screening area. As standard accessory, cleaning arrangement by automatic application of hot water through flat cone nozzles is provided to wash entire screening area.

The feed juice containing suspended solids particles of fine fiber enter continuously from drive end of the drum through distributor. The screened juice is collected in the slopping half cylindrical trough from trough it quickly removes to strained juice receiving tank. The solid mass keeps on rolling on wedge bar screen and removed towards non drive end from this it transfer to cane carrier /rake carrier. There is no recirculation of juice along with solid mass. In order ensure clean wedge bar opening it is washed by using hot water or caustic soda solution or whenever time permits. Such units are now installed in most of sugar factory during last 15 year using 0.50 mm opening. **Each sugar factory claim that efficiency of the unit is more than + 90% and moisture is about 75%. The analytical report is shown in table no 01 which is self explainer.**

However efficiency determined as percent removal of bagacillo by screening is inadequate and in admissible in view of process technology. Efficiency determined as above increase as feed quantity increase and vice versa, against discharge quantity of bagacillo remain the same on specific screen. Normally in sugar factory rotary screen of 0.5mm aperture is used through which discharge fibrous quantity is about 2-3gram/lit of juice i.e about 0.2-0.3%. This range may be safe for chocking and settling but gives problem in color formation. **These fibrous materials are insoluble in water and mainly consist of cellulose, semi-cellulose lignin which forms the color after heating. Hence as process parameter there should be zero fibrous material in juice to avoid color formation. Even though efficiency of unit is +90. Secondary screening is must to remove finer fibrous particle.**

DOUBLE ROTARY SCREEN

For further removal of fibrous material its particle size and distribution is more important for selecting the screen opening. Analytical work for determination of particle size and its distribution has been carried in Australian sugar factories and it is reported that fiber percent in discharge juice from 0.5 mm screen was less than 500 micron in size, with 80% being smaller size than 260 micron. Hence trial has been conducted in various sugar factories for double screening of juice in series by using second rotary screen of opening 0.20 mm. (In Warana piggy-back Rotary screen having wedge bar opening 0.5mm in inner stage and woven wire mesh screen of 0.2mm opening outer stage was installed during season 1999-2000, latter on woven wire mesh removed due to chocking) But trials were not satisfactory due to chocking of screen. **This chocking may be due to fineness of bagacillo particle, wax in juice or micro-organizing contaminations. It is further advocated for screening of clear juice. The screening of clear juice is benefited for further downstream process like crystallization and curing, but cannot avoid the color formation during settling after heating. Hence removal of finer fibrous particles before entering clarifier is required to avoid color formation i.e. screening of hot raw juice, after raw juice heater and before sulphitor.**

SCREENING OF HOT RAW JUICE

Normally on mill when hot water (70-80^{0}c) is used for imbibitions then bagasse is swelling and last mill get chocked. This concept is considered and fibrous material before and after heating (70-80^{0}c) is analyzed for swelling. **The report is given in table no 02**. The report indicates that swelling is about **47 %**. Hence the partial trial for second screening of hot raw juice was taken at Sonhira S. S. K. Ltd during seasons 2014-2015 by using 0.12mm opening. The results obtained are encoring with respective further reduction in bagacillo removal and improvement in color of clear juice. There was no chocking of screen due to wax which may be melting at this temperature or bacterial contamination. Temperature (70-80^{0}c) helps for swelling bagacillo and thus screening.

During season 2015-16 Rotary screen of size 1.8 x 4.8 (dia x lenght) meter with 0.12 mm (120 micron) opening is installed for screening hot raw juice. **This may be 1st installation in sugar industries**. The hot raw juice after heating up to 70 to 80 ^{0} C at raw juice heater & passing to tower is fed to Rotary Screen by gravity. In a normal cold juice Rotary screen assembly is of "total open". However in this case considering the temperature of hot juice at 70-80^{0}c, the Rotary Screen assembly is provided with "totally closed" to avoid heat losses and to prevent subsequent reduction in temperature of screened juice. In addition to totally closed arrangement lagging with aluminum cladding needs to be provided to avoid radiation heat loss. Screened raw juice from rotary screen is collected at bottom trough and transferred directly to juice reaction tank (sulphitor) by gravity. The fibrous matter separated at hot juice rotary screen is discharged into the mud tank by gravity or collected in slurry preparation tank to pump to mill station. The gravity flow arrangement is shown in Fig. 2. **The analytical data before and after screening is reported in table no 03. It indicates that removal of fibrous material is about 89% and discharge quantity of fibrous material is about 0.126gram/lit i.e about 0.0126%**

Apart from finer bagacillo removal, it observed that there is reduction in color of juice across the rotary screen. This may be mechanical removal of color like affination process in refinery. **Same is reported in Table no 04 and Fig. 1. Average color removal is about 16 to 17 %**. It is also observed that mud volume is reduced which decrease the load on vacuum filter and recycling of filtrate,

ADVANTAGES

1) **Overall screening efficiency**

   Screening efficiency during cold and hot screening using 0.45/0.35mm and 0.12mm opening is about **98%** with discharge quantity of fibrous material 0.0126%. That is practically NIL hence no color formation due to tea brewing effects.

2) **Mechanical removal of color.**

   Like affination process in refinery where high color raw sugar is mingled and purged to remove 50% color without any purification process. In this case juice is heated to swell up fibrous material and screened to remove color. The color removal is about 16 to 17 % across hot juice screening.

3) **Reduced load on vacuum filter**

   There is reduction in mud volume which reduces the load on vacuum filter and quantity of filtrate to recycle.

4) **Improvement in sugar quality**

   Analytical report indicates that there is color reduction by mechanical process during cold juice screening about 3.50% and hot juice screening is about 15-16 % and by clarification process 25-26 % hence quality of sugar improves.

PROBLEM FACED.

1) **Material of construction to withstand the temperature and juice properties of Hot raw juice.**

   Suppliers may study the required material of construction which will withstand to this temperature of hot raw juice for longer service life of the equipment.

2) **Moisture in finer bagacillo**

   Finer bagacillo containing with some juice is having higher moisture, at that time mud become thin and create problem in filtration station in case of transferring this discharged bagacillo to mud tank. There may be some arrangement to squeeze finer bagacillo to remove moisture and then mixed with mud and to transfer the same to mills.

3) **Pumping to mill station.**

   If slurry of finer bagacillo is prepared and pumps to mill then there is recirculation of juice which may reduce the crush rate to minor extent.

ANALYTICAL PROCEDURE.

1) ICUMSA Method No. GS7-13 (1994) – For the Determination of Sugarcane Fiber in Juice.

2) ICUMSA Method No. GS 1/3- 7 (1994) – For the Determination of Sugarcane Color of factory intermediate.

3) ICUMSA Method No. GS 2/3- 10 – For the Determination of Color of white sugar solution.

CONCULSION

- Rotary. Screen having 0.45mm/0.35mm opening is ideal for cold juice screening with discharge fibrous quantity 1.5 to 2.0 grams /lit of juice i.e 0.15-0.20%. This range may be safe for chocking and settling but gives problem in color formation.

- Second Rotary screening of hot raw juice having 0.12mm opening is ideal screening for further removal of finer fibrous particle, with discharge fibrous quantity 0.126 gram/lit of juice i.e.0.0126. In this there is mechanical removal of color by 15%.

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References :

1) "How Raw Juice Screening System" by gravity flow – Subodh V. Joshi, Sugar Technologist, Suviron Equipments Pvt.Ltd., during STAI-DSTA joint convention 2015 held at Goa.
2) Separation of Bagacillo from raw juice by V.R. Kaledhonkar, Chief Chemist, Shree Tatyasaheb Kore Warana SSK Ltd., Waranangar on 25th April, 1990 at Manjara SSK Ltd.
3) Rotary Screen separation Pioneer Mills Ltd. By R.E. Bickle and M.W. Webster.
4) Juice screening by G.A. Brotherton – proceeding of Australian Society of Sugarcane Technologists - 1981.

Table no 01

Efficiency of rotary screen having 0.35mm opening (cold juice)

Sr. no.	Quantity of bagacillo before screening gram/lit of juice	Quantity of bagacillo after screening grams/lit of juice	% Efficiency
1	12.725	2.082	83.63
2	11.401	2.290	79.91
3	12.310	2.084	83.07
4	11.767	2.220	81.13
5	12.573	1.120	91.09
6	11.221	1.055	90.59
7	11.528	1.359	88.21
Average	**11.932**	**1.744**	**85.38**

Remark: first four reading are on 0.45 mm opening and last three are on 0.35 mm opening

Table no 02

Swelling of bagacillo after heating up 70-75^{0}c measured by volume
After 30 minutes

Sr.no	Volume of sedimentation Before heating ml/lit of juice	Volume of sedimentation After heating ml/lit of juice.	Swelling%
1	85	125	47
2	80	120	50
3	105	120	14
4	80	120	50
5	70	110	57
6	75	110	46
7	60	100	66
Average	**80**	**115**	**47**

Table no 03-

Efficiency of rotary screen having 0.12 mm opening (hot juice)

Sr. no.	Quantity of bagacillo before screening gram/lit of juice	Quantity of bagacillo after screening grams/lit of juice	Efficiency%
1	0.809	0.086	89.37
2	0.988	0.092	90.69
3	0.992	0.048	95.16
4	1.162	0.076	93.45
5	0.909	0.160	82.40
6	1.298	0.165	87.29
7	1.324	0.154	88.37
8	1.224	0.166	86.44
9	1.198	0.161	86.56
10	1.108	0.148	86.64
Average	**1.101**	**0.126**	**88.56**

Table no 04

Color removal across the hot juice screen with 0.12mm opening

Sr. no.	Color before screening	Color after screening	**%**removal	Color clear juice	%removal
1	13362	10768	19.41	7067	34.37
2	13413	11772	12.24	10410	11.57
3	13584	12041	11.36	8344	30.70
4	13327	11196	15.99	8156	27.15
5	10570	8164	22.76	8024	--
6	11968	9327	22.06	8045	13.71
7	13253	11513	13.12	7703	33.09
Average	**12782**	**10683**	**16.70**	**8251**	**25.09**

Figure 1

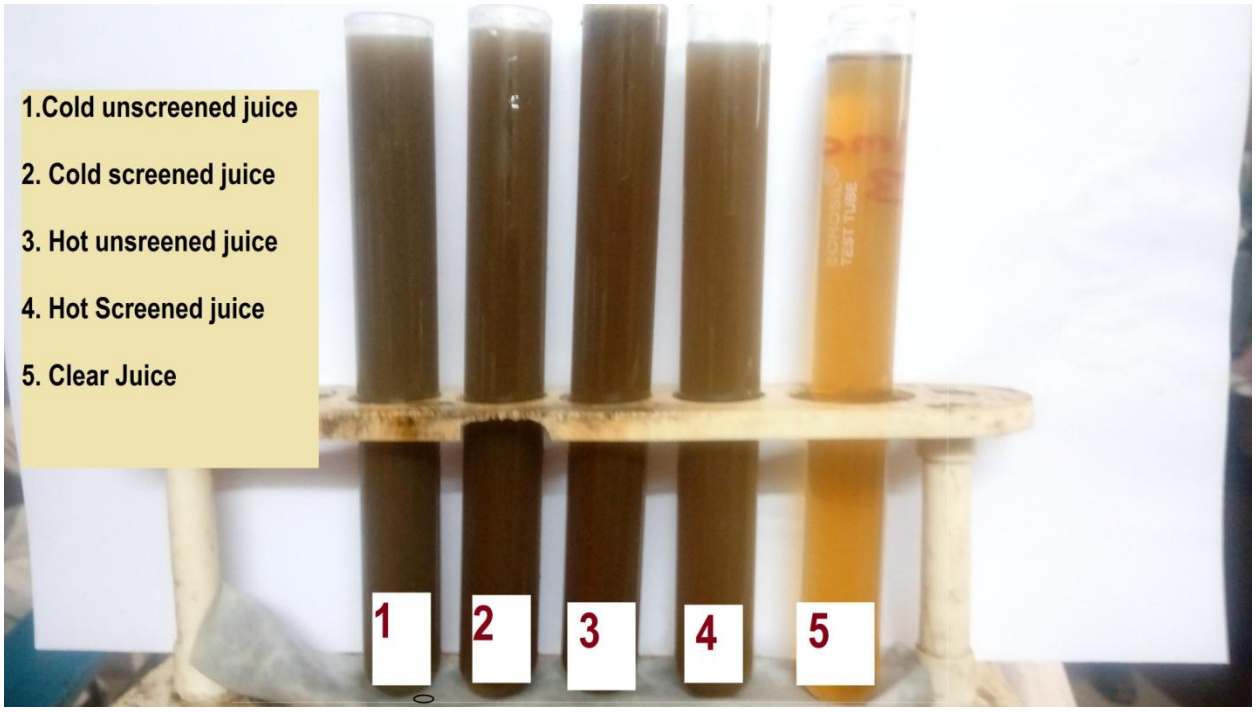

Figure 2

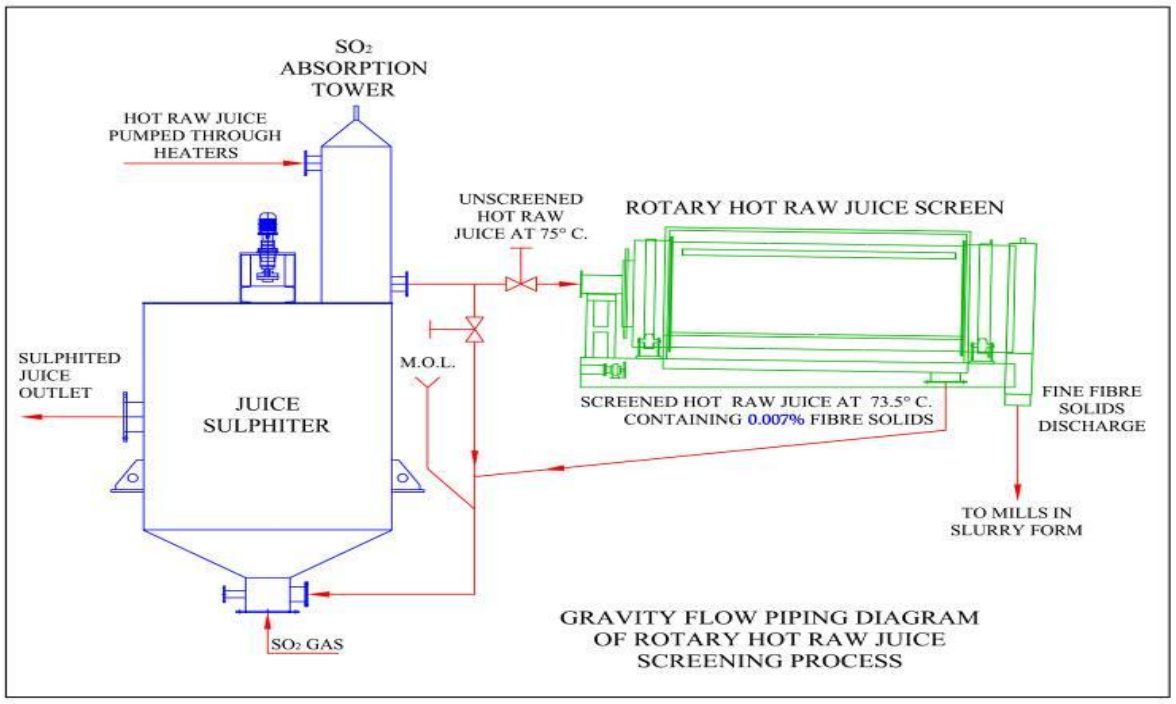

Table no 5

Color removal across the cold juice screening

Sr no	Color before screening	Color after screening	%removal
1	16613	16091	3.14
2	16863	16283	3.42
3	16691	16525	099
4	18018	17244	4,30
5	16422	15836	3.57
6	14978	14226	5.02
Average	**16598**	**16034**	**3.40**

Table no 6

Sugar (S-30) color during season 2014-15 and season 2015-16

Sr no	Color before screening (Season 2014-15)	Color after screening (2015 – 16)
1	107	76
2	109	74
3	102	79
4	121	75
5	111	78
6	129	80
7	112	77
8	115	81