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Mill Setting Calculation without Re-absorption Factor

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ABSTRACT

In general, the mill setting is calculated using the fibre index method, where the Re-absorption factor is used to arrive the mill setting value. In this article, a new method for calculation of mill setting without considering re-absorption factor, arriving the feed opening without considering the mill ratio and arriving the rest opening without considering the percentage of lift is proposed. In the new method, mill setting is calculated only by considering the different speeds of bagasse and area of openings. As the calculated mill setting value is nearer to the value calculated by the fibre index method, it can be inferred that the new method of the mill setting calculation gives the desired mill setting value and by setting the mill at that value, the desired mill extraction and capacity utilization of the mills can be achieved.

Keywords: Mill setting, fibre index, mill extraction.

INTRODUCTION

A new method based on the different speed and area for the passage of bagasse is proposed for the calculation of the mill setting so as to avoid application of reabsorption factor in calculation of mill setting.

Factors to be considered and factors not to be considered in the calculation of mill setting

Slip factor

Actual volume of bagasse passing through the mills is observed to be more than the calculated escribed volume. It is called slip factor or excess bagasse flow. The different reasons for the actual volume of bagasse passing through the mill to be different from the calculated escribed volume are discussed below:

Speed of Bagasse: One of the reasons for the difference between the actual volume of bagasse to be different from the calculated escribed volume is the speed considered for the calculation of the escribed volume. Bagasse moves in two different modes through the mills opening – one mode is through the groove as groove bagasse and other mode is between the tips of the rollers as bagasse blanket. So the speed to be considered for the calculation of escribed volume is groove bagasse speed for groove bagasse and tip speed for the blanket. If the escribed volume is calculated based on groove area and mean peripheral speed of the rollers, there will not be any difference between the actual volume of bagasse passing through the mill opening and calculated escribed volume.

Calculated area for the passage of bagasse and actual escribed area: If the area required for the passage of the entire bagasse through the groove opening is equal to the available groove area, the calculated area for the passage of bagasse is equal to the escribed area. If the volume of the bagasse is more than the volume which can pass through the groove opening, the total area is the sum of the groove area and the blanket area (blanket height x length of the roller). But, if the actual volume of bagasse is less than the volume which can pass through the groove area, the area required for the passage of bagasse is less than groove area. The top roller will mesh with the bottom roller. It is a negative setting. The calculated area will

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be different from the actual escribed area. This will be one of the reasons for the difference between the actual volume of bagasse passing through the mill opening and escribed volume.

Comparing volume with volume: With the increase of pressure, the decrease in volume of pith and air is found to be more compared to the decrease in volume of fibre and juice. The decrease in volume of bagasse is not proportional to the increase in pressure. Moreover, top roller does not exert the pressure uniformly over the bagasse blanket because of ups and downs in the bagasse blanket and the difference in the height of the blanket throughout the length of the roller. Due to this, the volume change of bagasse by pressure differs. This may be one of the reasons for the difference between the actual volume of bagasse passing through the mills and the escribed volume.

Fineness of bagasse: Depending upon the preparation of cane and nature of the fibre, fineness of bagasse differs. The change of volume of bagasse with change of pressure will not be uniform for the different bagasse with different fineness. Weight of bagasse of different fineness and particle size co-efficient of variation can be compared but the volume of bagasse of different fineness and different particle size co-efficient of variation cannot be compared with each other under identical operational pressure.

Chevron groove and breakage of teeth: In the calculation of the escribed volume, the increase in area due to chevron cutting and broken teeth of grooves is not taken into account. This can be one of the reasons for the difference between the actual volume of bagasse passing through the roller and the calculated escribed volume.

Play: The top roller lifts with the increase of bagasse blanket height. Due to the decrease of the bagasse blanket height, top roller does not return back to its rest opening immediately due to play. Due to slow-closing, the actual volume of bagasse passing through the opening can be more than the volume of bagasse which can pass through the opening.

Reduction in the sides of the groove due to erosion and corrosion: The increase in area due to erosion / corrosion / re-grooving canbe one of the reasons for the difference between the calculated volume of bagasse and actual volume of bagasse passing through the grooves of the rollers.

Working of scrapper: If the working of the scrapper is not satisfactory, the rolling bagasse increases. Due to this, the volume of bagasse passing through the mills differs from the calculated escribed volume.

Lift variation due to the difference in fineness of the bagasse: If the preparation of cane is not alike and the co-efficient of size variation is more, the lift of top roller will be more comparatively. Because of the difference in the lift, the calculated escribed volume of bagasse will differ from the actual volume of bagasse passing through the rollers.

Difficulty in estimating volume of bagasse: Weight of bagasse can be estimated accurately but it is difficult to estimate the actual volume of bagasse accurately because of the difficulty in sampling of bagasse for analysis of moisture % bagasse, brix % bagasse, etc. As it is difficult to estimate the volume of bagasse passing through the mills, the ratio of volume of bagasse passing through the mills to the escribed volume cannot be established.

Moisture % bagasse: Moisture % bagasse differs based on side of the roller, layer depth of bagasse and also depending upon the bagasse blanket and can not be determined accurately. Hence, the estimated bagasse volume cannot be compared with the escribed volume.

Pressure feeders: Continuous feeder like TRPF and GRPF gives dry bagasse to the mill. This increases the bagasse passing through the mill opening. So the actual volume of bagasse passing through the mill opening with or without pressure feeders cannot be compared with the calculated escribed volume equally.

Roller arcing and roller re-grooving: Roller arcing and roller grooving increases the crushing rate without any increase in the escribed volume. So the calculated escribed volume cannot be compared with the actual volume of bagasse of different roller arching and re-grooving state.

Donnelly chute and Donnelly chute level automation: The RPM of the roller changes depending upon the level in the Donnelly chute automatically. So the escribed volume cannot be estimated quantitatively. Due to this actual volume of bagasse passing through the mills increases much more than the calculated escribed volume.

In total, actual volume of the compressed bagasse passing through the mill opening cannot be determined accurately and actual escribed volume also cannot be calculated accurately. So the difference between the actual volume of bagasse passing through mill opening and the calculated escribed volume cannot be considered as a factor which determines the re-absorption. So it is not necessary to consider slip factor / reabsorption factor in the mill setting calculation.

Re-absorption and drainage of juice

Re-absorption in the groove bagasse: At the point of entry into the groove, the bulk density of loose bagasse is less (about 400 Kg/M^3). Due to compression, bagasse passes from low pressure zone to high pressure zone (neutral plane and axial plane). Specific opening in the neutral plane is the ratio of neutral opening to the diameter of the roller. Similarly, specific opening in the axial plane is the ratio of axial opening to diameter of the roller. Magnitude of specific opening in neutral plane is more than the magnitude of specific axial plane. The volume of bagasse decreases without any change in pressure over the bagasse because of separation of juice from the bagasse proportional to the decrease in the area of opening and volume of bagasse. In the groove, as the area – volume ratio is more, the extracted juice drains out through the walls/ sides of the grooves without getting re-absorbed. So, there is much less probability for re-absorption in groove bagasse.

Re-absorption in blanket bagasse: Regarding the bagasse passing through the gap between tips of the two rollers, the quantity of bagasse and thickness of the bagasse blanket is much less. As blanket moves up, the tip of the rollers ploughs inside the blanket. The juice reaches the tips of the grooves and drains through the sides of the grooves. Because of better drainage, the chance for re-absorption is much less.

Drainage of Juice: Top roller compresses the bagasse in the bottom roller. The pressure is the maximum at the tips of the groove and very minimum at the bottom of the groove. In the groove, the pressed-out juice travels either horizontally towards the wall of the groove or vertically downward towards the bottom of that groove. The juice pressed out horizontally moves towards the sides of the groove and drain off through the walls. The pressed-out juice flows vertically downwards and reaches the bottom of the groove where there is no bagasse to absorb the juice. As there is no barrier for the juice flowing horizontally and for the juice descending vertically downward, the chance for re-absorption is much less

Re-absorption percentage: If the re-absorption is 30 % as believed, then prior to re-absorption, the moisture % bagasse should be about 30 % only which is not achievable by mere compression alone.

The possibilities for some other types of re-absorption

Re-absorption due to the escaping air from the compressed bagasse: As the bagasse started entering the roller, due to increase in compression the air in bagasse escapes out, as long as there is passage for the escape of air. Due to maximum compression, the trapped air in the neutral plane / axial plane is in very much compressed state. Bulk density of bagasse at the neutral / axial plane is about 1250 kg/m^3. At the exit, as the pressure on the bagasse decreases, air expands and gets out of bagasse to the atmosphere at higher velocity. It entrains some quantity of the juice and escapes. The entrained juice is absorbed by the loose bagasse which passes out of the axial plane. This is one kind of possible reabsorption but the quantity of re-absorption is very much less.

Juice re-absorption due to juice flooding over the top roller: Once the bagasse becomes compact, the permeability of juice through the compressed bagasse stops. Due to the continuous compression, juice raises through the grooves of the top roller and gets readily absorbed by the top roller exit bagasse. The quantity of this type re-absorption is much less and negligible.

Juice re-absorption due to hold up of Juice in top roller groove: At the neutral plane, the pressed-out juice gets hold up in the inverted cone portion of the top roller grooves. This juice can be released after the separation of bagasse from the groove of the top roller and is re-absorbed by the loose bagasse ahead.

This type of re-absorption will take place only in the feed side compression. The quantity of re-absorption is much less.

From the above discussion, it can be concluded that there are chances for the re-absorption but not to the extent of 30% and hence the reabsorption factor need not be considered in the calculation of mill setting.

Groove: As the pitch and depth of grooves play an important role in determining the crushing rate and mill extraction in the proposed area based mill setting calculation method, due consideration is given for the pitch and depth of the grooves.

Individual mill extraction and overall mill extraction: In the proposed mill setting calculation, primary extraction and pol % bagasse are fixed. This indirectly fixes the desired total mill extraction. The expected individual mill feed and delivery extraction based on the primary extraction to achieve the desired final mill extraction is calculated. Fibre % bagasse of each mill is calculated based on individual mill extraction. Volume of feed and discharge bagasse to be passed through mill opening is calculated. Individual mill feed and delivery opening is calculated based on the volume which has to pass through the feed / delivery opening and mean peripheral speed of the roller.

Moisture % bagasse: In the proposed groove area based mill setting calculation method, the expected moisture % bagasse of each mill is to be quantified to achieve the final moisture % bagasse.

Imbibition % fibre / pol % final bagasse: In the proposed mill setting calculation, the desired pol % bagasseis considered in the mill setting calculation. This fixes the imbibition % fibre indirectly.

Mill ratio: At present, the mill ratio is kept as two. It can be based on weight / volume of feed bagasse instead of basing on mill ratio and can be understood better by the following calculation.

Weight of feed bagasse	=	Weight of discharge bagasse.	Juice extraction in discharge compression (Moisture reduction + Brix extraction in discharge compression)

Weight of feed bagasse	=	Weight of bagasse	+	10% of delivery bagasse
Vol. of feed side bagasse	=	Vol. of discharge bagasse	+	15 % delivery bagasse

At present, the mill ratio is fixed on height (mill opening) basis instead of volume basis. The volume of feed bagasse is not necessarily to be equal to two times of discharge bagasse. So, the calculation of feed opening is to be modified suitably without fixing on ratio basis. Feed bagasse weight is to be calculated from the delivery bagasse weight, percentage moisture reduction and percentage of Brix extraction in feed compression. Feed bagasse volume is to be calculated from the calculated feed bagasse weight and specific volume of the feed bagasse and then feed opening is to be calculated like the discharge opening calculation. In the proposed area basedmill setting calculation, the feed opening is calculated from the volume of feed bagasse and speed of the roller.

Top roller lift – Rest opening and delivery opening: For consistent working, the mill is set at 70 % load (instead of lift percentage basis) which can be called rest opening.

Discharge work opening	30 mm
Lift percentage	30 %
Top roller lift [30 x 30%]	9 mm
Discharge Rest opening [Work opening – lift]	[= 30 – 9] 21 mm

The expected load variation is 30% - between 70 % and 100 % but due to fixing the lift on percentage basis, the passage area varies by 65%. So instead of setting the rest opening on the lift per cent age basis to suit the fluctuation in crushing rate, it can be set on bagasse volume basis. In the groove area based mill setting calculation method, it is proposed to calculate the rest opening on the basis of 70 % of full load

Feed lift and discharge lift: At present, lift is fixed on percentage basis [30%] uniformly for both feed and discharge side to calculate the rest opening. Feed work opening is about two times of the discharge work opening. So, the calculated feed lift is two times of discharge lift. It can be well understood by the following calculation.

Discharge opening	30 mm
Feed opening (Mill ratio = 2)	60 mm
Discharge side lift (30%)	9 mm
Feed side lift (30 %)	18 mm
Discharge rest opening (work opening – lift)	[= 30 – 9] 21 mm
Feed rest opening (work opening – lift)	[= 60 – 18] 42 mm

Feed opening is to be between 42 mm and 60 mm while discharge opening is to be between 21 mm and 30 mm. Feed lift is +/- 18 mm and discharge lift is +/- 9 mm. Top roller cannot perform two lifts at a time - one to suit discharge side lift and one to suit feed side lift simultaneously. Moreover, due to 'V' shape of the groove, the opening area (load) increases by square with increase of height (lift). So,in the area based mill setting calculation, percentage based lift is changed to load based lift.

Feed work opening	Feed opening for 100 % load
Delivery work opening	Delivery opening for 100 % load
Feed rest opening 70% load	Feed opening for
Delivery rest opening	Delivery opening for 70 % load

Mill setting calculation based on groove area

In the new area based mill setting calculation, re-absorption factor is not considered. Only groove area, the different speeds, volume of bagasse which has to pass through the mill opening and volume bagasse which can pass through the groove opening are considered for the calculation of the mill setting.

Calculation of groove area: [Method -1]	
Total groove area	= Groove area of top roller + groove area of bottom roller
Groove area of top / bottom roller	= No. of grooves x area of opening in one groove
Area of opening of one groove	= Depth of groove x pitch of groove/2
Calculation of groove area: [Method -2]	
Total Groove area	= Average depth of the groove x length of the roller
Average depth of groove	= ½ (Depth of top roller groove + depth of bottom roller groove
Types of Mill Setting Calculations:	
(a) If volume of bagasse which is to be passed through the mill opening is equal to the volume of bagasse which can pass through the groove opening, mill setting (PCD to PCD distance) is equal to the average depth of the roller.	
(b) If volume of bagasse which isto be passed through the mill opening is more than the volume of bagasse which can pass through the groove opening, the excess bagasse has to pass between the tips of the rollers as bagasse blanket. Bagasse blanket height is to be calculated and to be added to the average depth of the groove of roller to get the mill opening (setting) value.	
(c) If volume of bagasse to be passed through the mill opening is less than the volume of bagasse which can pass through the groove opening, there is meshing of the tips of top roller with bottom roller. The depth of the meshing is to be calculated and the meshing depth is to be subtracted from the average depth of groove of the roller to get the mill setting value.	

Mill setting is calculated by fibre index method and by the area based method. It can be observed that the difference in the calculated mill setting value between the both methods is much less. In the fibre index method, re-absorption factor is included to get the calculated value to be equal to the practical value. But in the proposed method, without including the re-absorption factor, only by adopting the different speed by reasoning, the calculated values obtained is very much nearer to the value calculated by the fibre index method.

The mill setting calculation consists of the following steps

1	Kg fibre per minute	
2	Fibre % bagasse	
3	Bagasse % cane including cush-cush	
4	Bagasse density in kg/m^3	
5	Vol of bagasse to be passed through the mill opening in M^3/min.	
6	**Groove area calculation: Method - 1**	
	Roller groove area	= Area of one groove x No. of grooves in the roller
	Total Feed area	= Feed roller groove area + Top roller groove area
	Total delivery area	= Delivery roller groove area + Top roller Groove area
7	**Groove area calculation: Method - 2**	
	Groove Area	= Average depth of the groove x roller length
	Average depth of the groove	= ½ (Depth of groove of the top roller + Depth of groove of bottom roller)
	Dia to be considered for the groove bagasse	= Tip to tip dia of the roller – one–third of depth of groove/3
	Peripheral speed of top roller	= 3.14 x (Tip to tip dia. of the top roller – one–third of depth of groove/3) x RPM
	Peripheral speed of feed roller	= 3.14 x (Tip to tip dia. of the feed roller – Depth of groove /3) x RPM
	Peripheral speed of the delivery roller	= 3.14 x (Tip to tip dia. of the delivery roller – Depth of groove /3) x RPM
	Average speed of feed bagasse in M/min.	= ½ (Peripheral speed of top + Peripheral speed of feed)
	Av. speed of delivery bagasse in M/min.	= ½ (Peripheral speed of top + Peripheral speed of delivery)
8	Volume of bagasse which can pass through the groove in m^3/min.	= Average speed through groove area x Total groove area
9	If volume of bagasse is more than the volume of bagasse which can pass through the groove, it is positive setting. (Bagasse passes through the groove area and between the tips of the rollers.) For positive setting,	

	Volume of bagasse which has to pass between the tips of the grooves of the rollers	= Vol of bagasse which has to pass through the mill opening – Vol of bagasse which can pass through the groove opening
	Bagasse blanket thickness between tips of the top and bottom rollers in mm	= Vol of bagasse which has to pass between the tips of the grooves of the rollers / Average peripheral speed of the roller
	Average Peripheral speed of the roller M^3/min.	= ½ (Peripheral speed of the top roller + Peripheral speed of bottom roller)
	Peripheral speed of the roller	= 3.14 x tip to tip dia of roller x RPM
	Mill setting (in mm)	= distance between PCD of top roller and bottom roller
		= Average depth of the groove of the rollers in mm + bagasse blanket height between the tips of the rollers in mm.
10	If the volume of bagasse which has to pass through the mill opening is equal to the volume of bagasse which can pass through the groove,	
	Mill setting	= Distance between PCD – PCD of top and bottom roller
		= Average depth of the groove of the roller
	Average depth of the groove of the roller	= ½ (Depth of top roller + depth of bottom roller)
11	If volume of bagasse which has to pass through the mill opening is less than the volume of bagasse which can pass through the groove opening, it is negative setting.	
	Excess groove vol	= Vol of bagasse which can pass through the Groove opening M3/min – Vol of bagasse which has to pass through mill opening M3/min
	Excess groove area mm^2	= Excess groove volume M^3/min x 1000 x 1000 / Peripheral speed of the roller M/min
	Peripheral speed of the roller	= 3.15 x (Tip to tip dia.- depth of groove /3) RPM
	Excess groove area per groove	= Excess groove area / Number of groove in the roller
	Depth of groove	= 35.5 mm = d
	Pitch of groove	= 50 mm = p
	Pitch / depth ratio	= 50 / 35.5 = 1.4 = p/d
	Meshing area	= depth x pitch / 2 = depth x ratio of pitch to depth /2 = d x 1.4 x d
	Excess groove area per groove	= meshing area = 1.4 d^2
	Meshing depth in mm	= Square root of excess groove area / 14
	Mill setting in mm	= distance between PCD of top and PCD of bottom roller = Average depth of the groove roller – meshing depth

Comparing the mill setting calculation by fibre index method and groove area based method:

1	**Calculation of Mill Setting by Fibre Index method:**				
S.No.	**Particulars**	**I Disc**	**II Dis**	**III Dis.**	**IV Dis**
1.01	TCH	250	250	250	250
1.02	Fibre % Cane	13.5	13.5	13.5	13.5
1.03	Kg Fibre per min	562.50	562.50	562.50	562.50
1.04	Fibre loading per meter roller length	281.250	281.250	281.250	281.250
1.05	Fibre % Bagasse	32.000	42.000	47.000	52.000
1.06	Bagasse density	1217.89	1261.87	1291.14	1305.80
1.07	Re-absorption factor	1.3	1.3	1.3	1.3
1.08	Fibre Index [kg/m^3]	506.6	689.0	788.9	882.7
1.09	Roller dia (Tip to tip dia. - groove depth	978.50	978.50	982.25	982.25
1.1	RPM of the roller	4.5	4.5	4.5	4.5
1.11	Peripheral speed of the roller	13.8	13.8	13.9	13.9
1.12	Discharge Work opening	40.15	29.52	25.69	22.96
2	**Calculation of mill setting by groove area based method:**				
2.01	Crushing rate in TCH	250	250	250	250
2.02	Fibre % Cane	13.5	13.5	13.5	13.5
2.03	Kg Fibre per min	562.50	562.50	562.50	562.50
2.04	Fibre % Bagasse	32.000	42.000	47.000	52.000
2.05	Bagasse density	1217.89	1261.87	1291.14	1305.80
2.06	Kg Bagasse/minute	1757.81	1339.29	1196.81	1081.73
2.07	Bagasse/minute	1.44	1.06	0.93	0.83
2.08	Pitch of groove in mm	60.00	60.00	50.00	50.00
2.09	Depth of groove in mm	43	43	35.5	35.5
2.1	No. of grooves/roller	33	33	39	39
2.11	Groove area	86000	86000	71000	71000
2.12	One -third of the depth	14.3	14.3	11.83	11.83
2.13	Top roller dia. = Tip to tip dia. - one - third of depth of roller	985.7	985.7	988.2	988.2
2.14	Feed bagasse speed [M/ Min.] = 3.14 x RPM x PCD	13.9	13.9	14.0	14.0
2.15	Vol Bagasse which can through groove of the roller in M^3/min. = groove area x speed of bagasse through groove	1.198	1.198	0.991	0.991
2.16	Vol of bagasse to be passed between the bagasse blanket as blanket	0.2			
2.17	Setting	+ve	-ve	-ve	-ve

2.18	Bagasse blanket speed between the tips of the rollers = 3.14* tip to tip dia. x RPM	14.1			
2.19	Blanket thick = Vol. of bagasse /speed x roller length	8.7			
2.2	Delivery opening of I Mill	51.7			
2.21	Volume of bagasse to be passed through the groove negative setting		1.061	0.927	0.828
2.22	Mean dia of roller (dia. of the roller - depth x 100) = PCD		978.500	982.250	982.250
2.23	Speed of bagasse = 3.14*PCD*RPM		13.826	13.879	13.879
2.24	Area required through the groove for the passage of bagasse = Vol. of bagasse / speed		76763.7	66786.3	59686.8
2.25	Groove area available		86000.0	71000.0	71000.0
2.26	Groove area to be reduced		9236.3	4213.7	11313.2
2.27	Groove area to be reduced per roller = Groove area to be reduced / 2		4618.2	2106.9	5656.6
2.28	Groove area to be reduced per groove = groove area to be reduced per roller / No. of groove in the roller		139.9	63.8	145.0
2.29	Pitch of groove		60.0	50.0	50.0
2.30	Depth of groove		43.0	35.5	35.5
2.31 2.32	Ratio of pitch to groove Pitch of groove = depth of groove x 1.4 Area of groove = depth x height /2 = 1.4*ht*ht /2 = 0.7*ht * ht		1.4	1.4	1.4
2.33	0.7 x ht x ht		139.9	63.8	145.0
2.34	ht x ht		199.9	91.2	207.2
2.35	Meshing depth		14.13	9.6	14.4
2.36	Mill setting by area based method		28.9	26.0	21.1
3	Difference between the fibre index method and area based method calculated mill setting				
3.01	Mill setting value calculated by fibre index method	40.2	29.5	25.7	23.0
3.02	Mill setting value calculated by area based method.	51.7	28.9	26.0	21.1
3.03	Difference between the fibre index method and area based method	11.5	0.7	-0.3	1.9

Inference: The difference between the calculated mill setting by both methods is much less.

The following parameters are to be fixed for the calculation of mill setting by the new method.

1	Crushing rate
2	Fibre % Cane
3	Pol % Cane
4	Purity of Mixed juice
5	Pol % Bagasse
6	Moisture % Bagasse
7	Last Expressed juice purity
8	Primary extraction and overall extraction to be achieved
9	Individual mill extraction to be achieved to achieve the final overall mill extraction.
10	Fixing a ratio between feed extraction and delivery extraction
11	II Mill bagasse is more by 3 % and III Mill Bagasse is more by 2% because of the cush-cush.

Procedure for the calculation of area based mill setting:

Step I: Calculation of kg fibre per minute	
Fibre % Cane	12.5%
TCH	250
Tons Fibre per hour [TFH]	= TCH x Fibre % Cane / 100 = 31.5
kg Fibre per minute	= TFH x 1000 / 60 = 520.83 kg/min.

Particulars	Quantity at							
	I Feed	**I Disc**	**II Feed**	**II Dis**	**III Feed**	**III Dis.**	**IV Feed**	**IV Dis**
TCH	250	250	250	250	250	250	250	250
Fibre % Cane	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Fibre kg/min.	520.83	520.83	520.83	520.83	520.83	520.83	520.83	520.83

II: I Feed, I delivery, II F, II D, IIIF, III Dis. IV F and IV D bagasse % cane

Particulars	**I Feed**	**I Dis.**	**II Feed**	**II Disc.**	**III Feed**	**III Disc**	**IV Feed**	**IV Disc**
Fibre % bagasse	17.30	28.07	33.30	38.54	42.03	45.51	47.26	49.00
Bagasse % cane	72.25	44.53	37.54	32.43	29.74	27.47	26.45	25.51
cush - cush recirculation %			3.00	3.00	1.00	1.00		
Bagasse % cane with cush - cush	72.25	44.53	39.56	34.19	30.34	28.02	26.45	25.51

III: Calculation of density of bagasse and volume of bagasse (M^3/min)

Calculation of bagasse density	= [Fibre /bagasse x fibre density] + (1–Fibre/ bagasse x Juice density)
Vol. of Bag. M^3/min.	= Kg bagasse per min/ Density of bagasse

Particulars	**I Feed**	**I Dis.**	**II Feed**	**II Disc.**	**III Feed**	**III Disc**	**IV Feed**	**IV Disc**
kg Bagasse per min	3010.60	1855.48	1648.52	1424.39	1263.98	1167.33	1102.06	1062.93

Density of bagasse	1172.66	1217.89	1239.86	1261.87	1276.53	1291.14	1298.49	1305.80
Vol. of Bag. per min	2.57	1.52	1.33	1.13	0.99	0.90	0.85	0.81

IV: Mean diameter of top and feed roller and Mean diameter of top and delivery roller.	
Size of roller in mm (Tip to tip dia. x roller length)	
Roller Groove size (pitch x depth) in mm	
Dia. to be taken for top roller	= Tip to tip dia. - one -third of depth of roller
Feed roller dia. to be taken for peripheral speed Calculation in mm	Tip to tip dia. -groove depth
Mean dia. of top and feed roller in mm	= (PCD of top + PCD of feed)/2
Mean dia. of top and discharge roller	= (PCD of top + PCD of delivery)/2
Roller diameter= Tip to tip dia– epth of the groove x 1/3 (or)	= Root dia + depth of groove x 2/3

Particulars	**I Feed**	**I Dis.**	**II Feed**	**II Disc.**	**III Feed**	**III Disc**	**IV Feed**	**IV Disc**
Size of roller m	1000 x 2000	1000 x 2000	1000 x 2000	1000 x 2000	1000 x 2000	1000 x 2000	1000 x 2000	1000 x 2000
Roller Groove size	60 x 43	60 x 43	60 x 43	60 x 43	50 x 35.5	50 x 35.5	50 x 35.5	50 x 35.5
One -third of depth	14.3	14.3	14.3	14.3	11.83	11.83	11.83	11.83
Dia. to be taken for top roller	985.7	985.7	985.7	985.7	988.2	988.2	988.2	988.2
One-third of depth	14.3	14.3	14.3	14.3	11.8	11.8	11.8	11.8
Feed roller dia. to be taken	985.7		985.7		988.2		988.2	
Mean dia. of top and feed roller in mm	985.7		985.7		988.2		988.2	
Mean dia. of top and discharge roller in mm		985.7		985.7		988.2		988.2

V: Calculation of available groove area for the passage of feed and delivery bagasse	
Roller groove area	= Area of one groove x No. of groove
Feed opening through groove	= Top roller groove area + feed roller groove area.
Delivery opening through the groove	= Top roller groove area + delivery roller groove area
Feed/ Discharge bagasse speed in M/ min	= 3.14 x RPM x PCD
Groove Area for the passage bagasse per groove	= (groove x depth)/2
No. of grooves per roller	= Roller length / groove pitch
Area available for passage bagasse through feed roller	= Area of one groove x No. of grooves

Vailable groove area for feed opening				top roller groove area + feed roller groove area				
Available groove area for delivery opening				top groove area + delivery roller groove area				
Particulars	**I Feed**	**I Dis.**	**II Feed**	**II Disc.**	**III Feed**	**III Disc**	**IV Feed**	**IV Disc**
RPM of the roller	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Feed bagasse speed	13.93		13.93		13.96		13.96	
Delivery bagasse speed		13.93		13.93		13.96		13.96
Top roller Groove Pitch	60	60	60	60	50	50	50	50
Top Roller groove Depth	43	43	43	43	35.5	35.5	35.5	35.5
Groove Area for the passage bagasse / groove	1290	1290	1290	1290	887.5	887.5	887.5	887.5
No. of grooves per roller	33.0	33.00	33.00	33.00	39.00	39.00	39.00	39.00
Available Area for passage bagasse through top roller in mm^2	42570	42570	42570	42570	34612.5	34612.5	34612.5	34612.5
Feed Roller Pitch	60		60		50		50	
Feed Roller depth	43		43		35.5		35.5	
Available groove Area for passage bagasse through one grooveof feed roller mm^2	120		1290.0		887.5		887.5	
No. of grooves per roller	33.0	33.0	33.0	33.0	39.0	39.0	39.0	39.0
Area available for passage bagasse through feed roller	42570.0		42570.0		34612.5		34612.5	
Available Groove area for feed opening	85140		85140		69225		69225	
Available groove area for delivery opening		85140		85140		69225		69225

Step VI: Calculation of vol of bagasse which can pass through the groove area and volume of bagasse which has to pass between the tips as blanket, setting and thick of the bagasse blanket between the tips

Volume of bagasse which can pass through the feed groove opening / delivery opening	Groove area x average speed of the roller
Bagasse blanket height	= Vol. of bagasse which is more than the vol. of bagasse which can pass through the groove / (peripheral speed of the roller x roller length)
Mill setting for +ve setting	= Average depth of the roller + bagasse blanket height
If the volume of bagasse which has to pass through the mill-opening is equal to volume of bagasse which can pass through the groove, mill setting (PCD – PCD distance) = groove depth	
Vol of bagasse which has to pass through the tips	= Total vol. of bagasse to be passed through the opening - Vol. of bagasse to be passed thro. groove
Bagasse blanket thk between the tip of the rollers	= Vol of bagasse x 1000 / (tip to tip dia. x roller length)

Particulars	**I Feed**	**I Dis.**	**II Feed**	**II Disc.**	**III Feed**	**III Disc**	**IV Feed**	**IV Disc**
Vol. of bagasse which can pass through feed / discharge opening	1.2	1.19	1.2	1.19	1.0	0.97	1.0	0.97
Vol of bagasse which has to pass through the tips	1.4	0.3	0.1	-0.1	0.0	-0.1	-0.1	-0.2
Setting +ve/ -ve	+ve	+ve	+ve	-ve	+ve	-ve	-ve	-ve
Peripheral speed based on tip to tip	14130	14130	14130	14130	14130	14130		
Vol of bagasse which has to pass between the tip - tip of the roller	1.38	1.00	0.14		0.02			
Bagasse blanket thk between the tip of the rollers	48.9	35.4	5.1		0.8	0.0		
Depth of top roller	43.0	43.0	43.0		35.5	35.5	35.5	35.5
Depth of the feed / discharge roller	43	43.0	43	43.0	35.5	35.5	35.5	35.5
Average depth of roller	43.0	43.0	43.0	43.0	35.5	35.5	35.5	35.5
Mill setting = PCD to PCD	91.9	78.4	48.1		36.3			

Step VI: If the volume of bagasse which has to pass through the mill opening is less than what it can pass through the groove, it is negative setting. Negative setting is to be calculated as given below.	
For negative setting only: Vol. of bagasse which can pass through the groove – Vol. of bagasse to be passed through the mill opening (Cu. mm per min.)	
Volume of bagasse which is less than the volume which can pass through the groove	= Vol. of bagasse which has to pass through mill opening – volume of bagasse which can pass through the mill opening.
Meshing area	= Volume of bagasse which is less than the volume of which can pass through the groove / peripheral speed (Tip to tip dia. speed).
Meshing area per groove	= Meshing area / No. of groove. = a Sq. mm
Depth of groove	= h = 35.5 mm
Pitch of groove	= p = 50 mm
Height – pitch ratio	= h / d = 50 / 35.5 = 1.4
Area of meshing	= Meshing depth x Meshing depth x 1.4
Meshing depth	= Square root of (Area of meshing / 1.4)
PCD to PCD mill setting for negative setting	=Average depth of groove – meshing depth

VII: Calculation of the meshing depth: (height of tip of the top roller meshing with bottom roller groove and mill setting for negative setting):

Particulars	I Feed	I Dis.	II Feed	II Disc.	III Feed	III Disc	IV Feed	IV Disc
negative setting				56993259			117851867	152571444
Speed of the roller in mm per min				13927.5			13962.8	13962.8
Meshing area				4092.1			8440.4	10927.0
No. of grooves				33			39	39
Meshing Groove area per groove				124			216	280
Depth of groove				43.0			35.5	35.5
Pitch of groove				60			50	50
Height / Pitch ratio				1.40			1.41	1.41
Area of groove = hx1.41x h				124			216	280
h x h				89			154	199
h = Root of h				9.45			12.45	14.11
Working opening	91.89	78.39	48.09	33.55	36.33	35.50	23.1	21.4

Mill setting is calculated for 100 % load (equal to work opening) and for 70% load which is equal to rest opening. The calculated mill setting values are tabulated below.

VIII Comparison of work opening (100 % load) & Rest opening (70%) for area based mill setting calculation								
Particulars	**I Feed**	**I Dis.**	**II Feed**	**II Disc.**	**III Feed**	**III Disc**	**IV Feed**	**IV Disc**
Working opening (100 % load)	91.89	78.39	48.09	33.55	36.33	35.5	23.1	21.4
Rest opening (70 % load)	64.63	29.36	23.05	18.16	16.52	14.54	13.46	12.76
Difference between for 100 % load and 70 % load	27.25	49.03	25.04	15.39	19.81	20.96	9.59	8.63

IX Calculation of mill setting by fibre index method:								
Particulars	**I Feed**	**I Dis.**	**II Feed**	**II Disc.**	**III Feed**	**III Disc**	**IV Feed**	**IV Disc**
TCH	250	250	250	250	250	250	250	250
Fibre % Cane	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Kg Fibre per min	520.83	520.83	520.83	520.83	520.83	520.83	520.83	520.83
Fibre loading per meter roller length	260.42	260.42	260.42	260.42	260.42	260.42	260.42	260.42
Fibre % Bagasse		28.07		38.54		45.51		49.00
Bagasse density		1217.9		1261.9		1291.1		1305.8
Re-absorption factor		1.33		1.33		1.33		1.36
Fibre Index in Kg per Cu. M		454.68		646.81		781.51		870.19
Roller dia RPM of the roller		927.75 4.5		960.44 4.5		969.66 4.5		973.55 4.5
Peripheral speed of the roller		13.1		13.6		13.7		13.8
Discharge Work opening		43.69		29.67		24.32		21.75
Feed work opening	87.38		59.34		48.64		43.51	
Lift % age	26.21	13.11	17.80	8.90	14.59	7.30	13.05	6.53
Rest opening	61.17	30.58	41.53	20.77	34.05	17.02	30.46	15.23

X Comparison of mill setting calculated work opening value between fibre index method and area based method:								
Particulars	**I Feed**	**I Dis.**	**II Feed**	**II Disc.**	**III Feed**	**III Disc**	**IV Feed**	**IV Disc**
Calculated Work opening by fibre index method	87.38	43.69	59.34	29.67	48.64	24.32	43.51	21.75
Calculated value of mill setting for 100 % load by area based method	91.89	78.39	48.09	33.55	36.33	35.50	23.05	21.39
Difference between fibre index method and area based method	-4.50	-34.7	11.25	-3.88	12.31	-11.2	20.46	0.36

XI Comparison of the calculated rest mill setting value - fibre index method and area based method:								
Particulars	**I Feed**	**I Dis.**	**II Feed**	**II Disc.**	**III Feed**	**III Disc**	**IV Feed**	**IV Disc**
Calculated Rest opening by fibre index method	61.17	30.58	41.53	20.77	34.05	17.02	30.46	15.23
Calculated value of mill setting for 70 % load by area based method	64.63	29.36	23.05	18.16	16.52	14.54	13.46	12.76
Difference in rest opening between fibre index method and area based method	-3.47	1.22	18.48	2.61	17.53	2.48	17.00	2.47

CONCLUSION

It is observed that actual volume of bagasse passing through the mill opening is more than the calculated escribed volume. The increase is attributed to re-absorption. There can be a little re-absorption but not equal to 30 % as being factored in mill setting calculation. So, a new method for the calculation of mill setting based on the groove area is proposed. The calculated mill setting value shall be very nearer to the value calculated by the fibre index method

One of the expected objections for the area based mill setting calculation may be that the calculation procedure is lengthy. At present, computer facility is available. Software can be developed. The mill setting can be calculated quickly.

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