Proceedings STAI, Factory Engineering
Vol. 82 (2024) : 184-188 doi: 10.69794/82SAC/978-81-969264-0-3/184-188

Improving Milling Tandem Performance by Adopting Hot Juice Imbibition on Prepared Cane

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Received : April 30, 2024; Accepted : June 18, 2024

ABSTRACT

For getting good extraction from mills, three main processes are carried out- cane preparation, squeezing in mills and juice / water imbibition. If only preparation and squeezing carried out which means dry crushing, which give maximum extraction 88-92%. But with modern effective imbibition, few factories have achieved extraction more than 96 %+. Normally in milling tandem, juice imbibition is adopted on bagasse after first mill/primary mill bagasse. In case of whole cane diffuser, juice imbibition is practiced on prepared cane and this results in better extraction than mills. Considering this difference in milling and diffusion process, authors implemented the idea of using hot secondary juice imbibition on prepared cane (M_HJIPC). This increases one stage imbibition effect and overall tandem prepared cane temperature is also increased by 8-9 ^{0}C. This results in increasing primary extraction as well as capacity of milling tandem. Authors developed and designed the concept of hot juice imbibition on prepared cane (M_HJIPC) and is implemented in three sugar factories in India - Durga Sugars (MP), Shakti Sugars (MP) and Kedareshwar Sugars (Gujrat). The results of this study are discussed.

Keywords: Hot juice imbibition, milling tandem, juice heater for secondary juice heating, perforated prepared cane carrier.

INTRODUCTION

To increase imbibition effect and improve mill extraction in milling tandem, he modified bagasse conveyers in milling in to overlapping conveyers to increase conveyer length sufficient to obtain imbibition effect in milling tandem. Van Hangle had designed multi-stage conveyor in 1968 and was built by Fleture and Stewart (1968) in South Africa to increase imbibition effect. It consists of series of units each having form of an inter rake carrier inclined at 300 angle and to great extent over lapping on each other.

Concept of milling with hot juice imbibition on prepared cane (M_HJIPC) system in sugar cane milling:

The imbibition is one of the main factors of mill extraction process. In dry crushing, we get about 88-92 % mill extraction, whereas on same mill with compound imbibition, in modern mill extraction will be increased to 96 %+. The imbibition affectivity depends upon imbibition's quantity, temperature and mixing it with bagasse bed. Table 1 indicates normal Temperature trend in ^{0}C of juice extracted in milling tandem.

The imbibition water temperature used is in the range of 75 ^{0}C to 80 ^{0}C + and it is applied before last mill. In compound imbibition, last mill extracted juice is taken to preceding mill and same continued up to 2nd mill. The juice extracted from 1st mill and 2nd mill is sent to process called mixed juice. The temperature of mixed juice is in the range of 32-33 ^{0}C.

In milling with hot juice imbibition on prepared cane (M_HJIPC) system, secondary juice of temperature

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Table 1 : Temperature trend in ^{0}C of juice extracted in milling tandem

MJ Temp	M-1	M-2	M-3	M-4	M-5	Imb. T	Amb.T
34-35	32-34	39-42	45-48	49-54	60 - 65	80-90	34

39-42 ^{0}C is heated to 75 to 80 ^{0}C by evaporator vapours and spread on prepared cane before first mill. This type of juice imbibition results in increasing sugar extraction than usual method by following ways:

- Juice brix of juice in cane shells is higher than secondary juice brix % almost by 6.0 to 10.0 units. Due to this low brix, the sugar from cane cells travel to low brix liquid – partial diffusion technique
- Due to higher temp of heated secondary juice (75-80 ^{0}C) temperature of prepared cane bed increases by 8-9 ^{0}C. This increased temp of prepared cane will weaken the juice cells and make permeable for effective lixiviation and osmosis phenomenon.
- Above both techniques will improve primary extraction by 3-4 units and in subsequent mills individual mill extraction will increase 0.50 -1.0 units. Overall mill extraction increases by 0.50 -0.70 unit.

In M_HJIPC, to increase imbibition effect, the juice from mill-2 (secondary juice) is screened first with baby DSM screen, pumped to direct contact heater (DCH) and it is heated to 75 to 80 ^{0}C by using evaporator vapours. It is then spread before first mill in the rake carrier at two-three places. The rake carrier is provided with SS screen having 6 mm dia. Holes at 9 mm pitch to screen extra juice. The screened juice collected from first rake carrier and first mill is sent to rotary screen. The strained mixed juice from rotary screen is 40-42 ^{0}C and sent to process as usual.

Development and implementation of milling with hot juice imbibition on prepared cane (M_HJIPC) system in sugar cane milling:

- During 2017-18 crushing season, M/s Durga Khandsari Sugars Dist – Barwani, MP carried out expansion of sugar plant to 3000 TCD by planning additions of 33”x 66” size mills. Major difficulty was, there was no space available for fourth mill.
- To overcome this constraint authors designed and implemented the concept of hot juice imbibition on prepared cane (M_HJIPC) and planned 3000 TCD crush rate with three mills of 33” x 66” size with hot secondary juice imbibition on prepared cane.
- Figure 1 shows the arrangement made at Durga Khandsari Sugar for adopting hot juice imbibition on prepared cane (M_HJIPC)

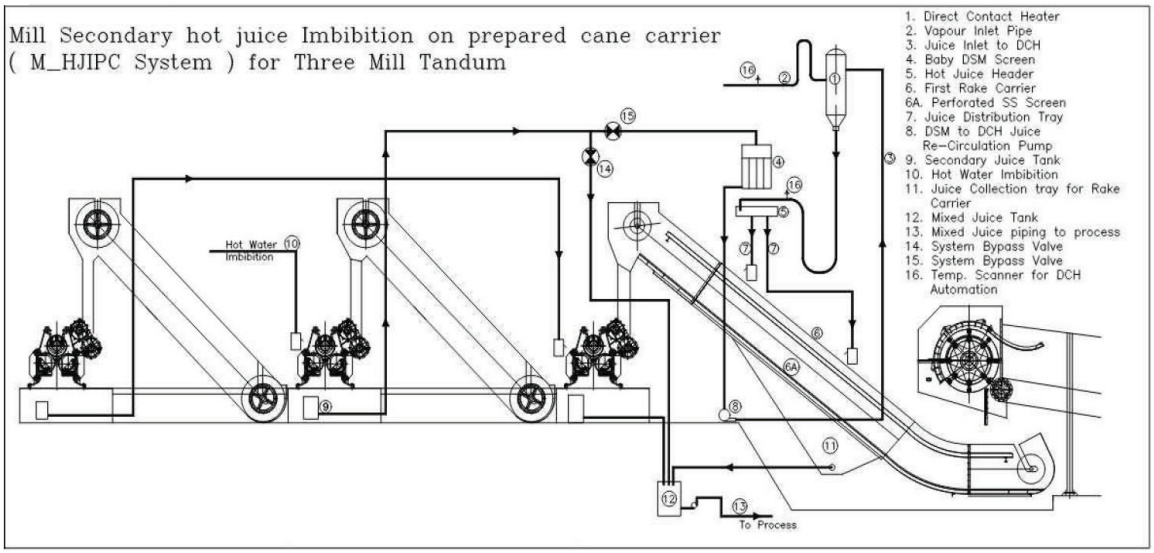

Figure 1 : M_HJIPC schematic Sketch

- Milling tandem performance with three mill and hot juice imbibition (M_HJIPC) on prepared cane was good and results were better than expectation. Factory had achieved pol % bagasse – 1.90 to 2.00 and achieved 95.50 ME at 35.0 % imbibition on cane. M/s Durga Sugar operated this arrangement for two crushing seasons i.e. 2017-18 & 2018-19 for crush rate of 2700 – 3000 TCD.
- In 2019 off season, factory had installed 4th mill – 33" x 66" with GRPF. Even after installation of 4th mill, the hot juice imbibition on prepared cane(M_HJIPC) is continued for five crushing seasons. After using 4 milling tandem with hot juice imbibition on prepared cane, factory had achieved pol % bagasse in the range of 1.70 to 1.80 for crush rate of 4200-4500 TCD
- The 4 milling tandem with hot juice imbibition on prepared cane system (M_HJIPC) is installed in Shakti Sugars (MP) in 2017-18 and in Kedareshwar Sugars (Gujrat) in 2020-21 crushing season. Working of M_HJIPC system at Shakti Sugars (MP) and Kedareshwar Sugars (Gujrat) is good and continued by mill management in subsequent crushing seasons.
- In all three mills, the performance of M_HJIPC system is good and system adopted continuously. The performance of the milling tandem without and with M_HJIPC was tested and observed that there is difference of 0.20 -0.30 units in Pol % Bagasse and 0.25 % moisture in bagasse.
- In this system, the primary extraction increased by about 3.0 – 4.0 units which increased overall extraction by 0.50-0.75 units

M_HJIPC system details installed at M/s - Durga Khandsari Sugar – Season 2017-18

- **Number and Mill size:** Tandem **of 3 mills** of size 33"x66" with TRPF and PI = at 86-88 %
- Equipment added: Secondary heated juice is spread through two number trays before first mill
- Performance parameter

  Crush rate: 2750 TCD and RME= 95 % +

  Primary extraction without M_HJIPC system : 71.0 -71.5 % +

  Primary extraction with M_HJIPC system: 74.50 – 75.0 %

  Rise in PE with system: 3.5-4.0 units

  Bagasse Pol % = 1.95-2.00

  Bagasse moisture=49.0 - 49.5%

  Mill Extraction: 95.50+

  RME(D): 95.90 @ fibre13.5 % on cane.

- **List of equipment to be added for secondary juice heating by 1st / 2nd vapor through DCH;**

  DCH -1 number for heating second mill juice to 75 – 85 ^{0}C

  Baby DSM screen -1 no to screen secondary juice

  Centrifugal Pump -1 no. to pump secondary juice to DCH

  Centrifugal Pump -1 no. to pump Rake Carrier juice to primary juice tank

  SS screen: Rake Carrier (from Fibrizer to mill) is to be provided with SS screen at bottom of trough for excess juice to separate and it is to be sent to primary extracted juice tank and further whole quantity to be sent to rotary screen and then to process.

  Vapour connection and temperature controller: Vapour connection from 2nd body to DCH and juice temperature controller

Performance of M_HJIPC system at different mills:

Durga sugars:

3 mills 33" x 66" with TRPF -Crushing season 2017-18 to 2018-19:

Crush rate -115 TCH, Pol % Bagasse = 1.90-2.00 and moisture % bagasse = Less than 49.5

4 mills 33" x 66" with GRPF 1st and last and rest TRPF - from 2019-20 to 2023-24 season:

Crush rate - 188 TCH (4500 TCD), Pol % Bagasse = 1.70 - 1.80 and moisture % bagasse = Less than 48.5%

In 4 mills PE (primary extraction) increased by 5 units to get practical result in pol % bagasse = 1.70

Kedareshwar Sugars

5 mills: First and last mills 33"x66" and rest 3 mills 24"x 48" with all TRPF - Crushing season 2020-21 to 2022-23:

Crush rate -120 TCH, pol % bagasse = 1.90 -2.0 and moisture % bagasse = Less than 49.5

4 mills 33"x66" with all TRPF - Crushing season 2023-24:

Crush rate -150 TCH, pol % bagasse = 1.80-1.90 and moisture % bagasse = Less than 49.0

Shakti Sugars:

4 mills 38"x78" with all TRPF - Crushing season 2017-18 to 2020-21:

Crush rate - 175 TCH, Pol % Bagasse = 1.70 -1.75 and moisture % bagasse = Less than 48.5

In 4 Mills PE increased by 3.50 units to get practical result in pol % bagasse = below 1.75

5 mills: 1st mill 40" x 80" and rest 4 mills 38"x78" with all TRPF - Crushing season 2021-22 to 2022-23:

Crush rate - 250 TCH, pol % bagasse = 1.60 -1.75 and moisture % bagasse = Less than 49.0

Advantages of secondary juice heating by DCH

- Improves imbibition effectivity
- Primary extraction improves by 3.0-4.0 units to (74- 75%) from 71.0 % and subsequent mills by 0.50-1.0 %
- Higher extraction with less number of mills
- Reduction of moisture in last bagasse = 0.25%

Disadvantages of secondary juice heating by DCH

- Increase in steam consumption - 0.50 to 1.50 % on cane – depends on use of vapors.
- 1.00 % steam means 0.43 % bagasse burning more @ S/B ratio=2.2.
- Bagasse required MT = 0.45/100 x100000 = 450 MT
- Less due to effect of moisture reduction=131.25 MT
- Bagasse cost for 1.0 lac MT crushing = (450-131.25) x 2000 = Rs. 6.38 Rs lacs
- Power export due to one mill less for 1.0 LT crushing = 1.45x115x24x36dx4.5 = Rs. 6.48 lacs

Net saving and payback period:

- Reduction in sugar loss % cane = 0.20 x 28 / 100 = 0.056
- Increase in Sugar production per 1.0 lac ton crushing = 0.056 x100000/100 = 56 MT sugar
- Increased revenue due to increased sugar = 56 x 30000 = Rs. 16.80 lacs
- Net revenue = 16.80 + 6.48 – 6.38= Rs. 16.9 lacs per lac ton crushing

CONCLUSION

Milling with hot juice imbibition on prepared cane (M_HJIPC) system was found effective in reducing sugar loss in bagasse as well as reducing moisture % bagasse. In M_HJIPC system hot secondary juice of 75 ^{0}C is spread on prepared cane entering 1st mill. This process weakens the cane cells and increases permeability of sucrose through cells and further results in increasing primary extraction and overall extraction. M_HJIPC system also helps to reduce moisture % bagasse to the tune of 0.25 to 0.3 units.

ACKNOWLEDGEMENT

Our Sincere thanks to Director Mr. Nitin Goelji M/s Durga Khandsari (Sugar) Mill Mendrana, MP and Director Mr. Vivek Maheshwariji, Shakti Sugar Mill, Kodiya MP for giving permission to share information for writing article and publication.

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