FE28:

Enhancing Milling Efficiency and Throughput through control philosophy

SAN DIEGO EXPERIENCE

Speaker : D.K. Goel

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OBJECTIVE

This paper highlights significance of the Control Philosophy and other features for enhancing the milling efficiency and throughput, by adopting:

- Multi set point control loops for individual mill.
- Integration of front end controls with that of the 1st mill.
- Differential Roll Speed.
- Improved system of mill roller grooving

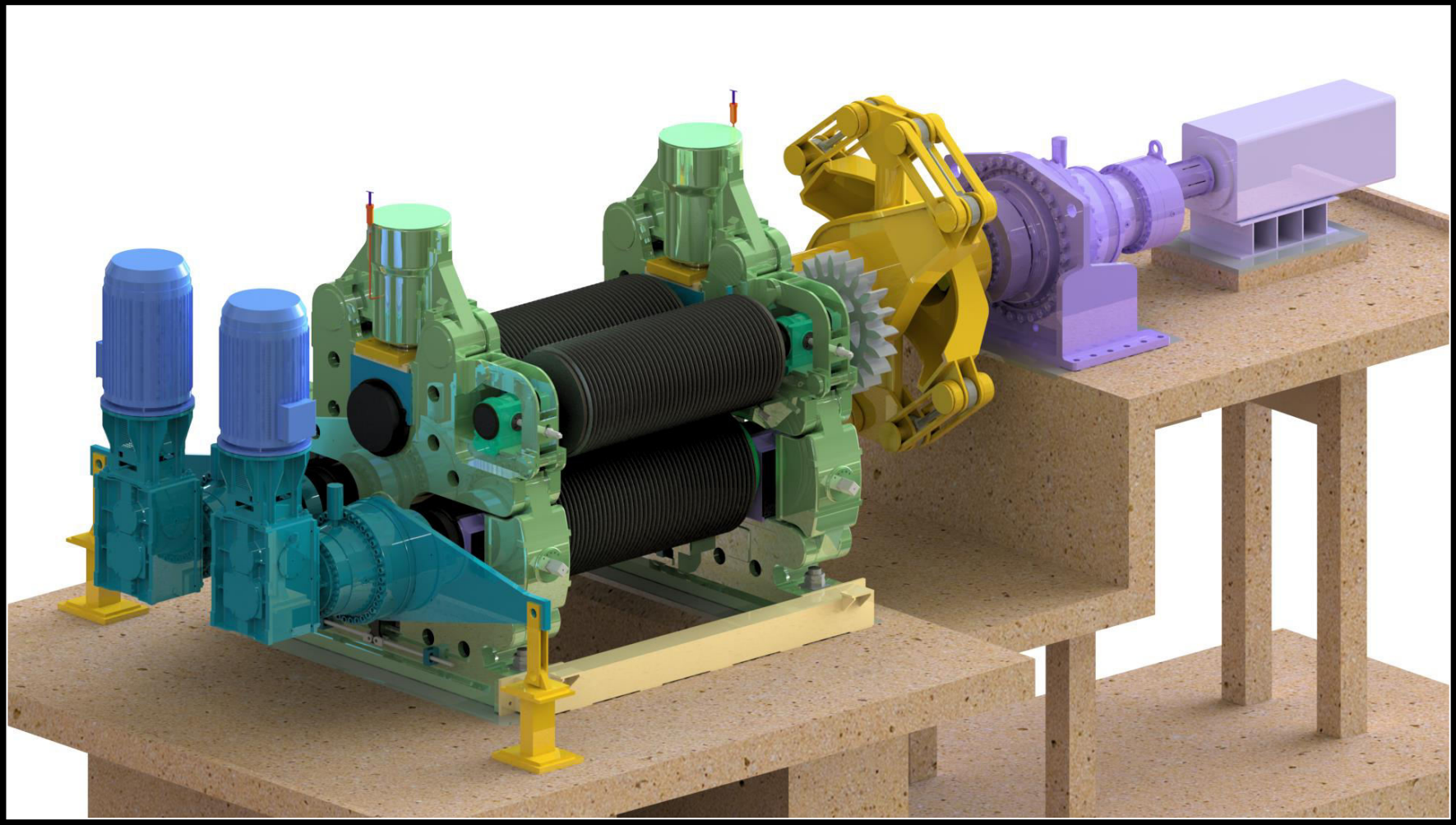
BACKGROUND

San Diego SA, Guatemala recently replaced its existing milling tandem to enhance throughput as well as extraction efficiency. Front end i.e. fibrizor and cutter were retained.

The new tandem, supplied by ISGEC consists of five 1170 mm dia x 2134 mm (46 x 84 inch) size, 4-roll pinion-less mills.

It is designed for 454 t/h (500 short tons/h) and was commissioned in November 2014.

3D MODEL OF THE NEW 46 X 84 INCH MILL



NEW MILLING TANDEM:
SIZE AND DRIVE DETAILS

Mill Size & type	4-roll , 1170 mm Dia. x 2134 mm (46 x 84 Inch), pinionless mill
No. of Mills	5 Nos
Installed Power / mill	
Top Roller	750 KW (Foot mounted)
Bottom rollers	300 KW each (Shaft mounted)
Top Roll Speed	6.17 RPM @ base speed of motor
Bottom Roll Speed	6.6 RPM @ base speed of motor

NEW MILLING TANDEM: ACTUAL INSTALLATION

Foot Mounted Drive for top roller

NEW MILLING TANDEM: ACTUAL INSTALLATION

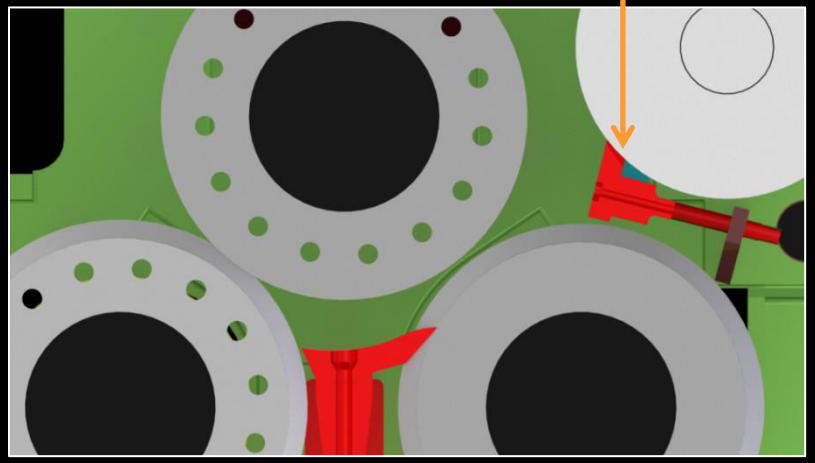
Shaft Mounted Drives at bottom rollers

KEY FEATURES
NEW MILLING TANDEM

KEY FEATURES:

2 TRASH PLATES

Additional trash plate between underfeed roll and cane roll to eliminate drop of cush cush into juice tray



KEY FEATURES:

SUPERIOR GRADE ROLLER SHELL

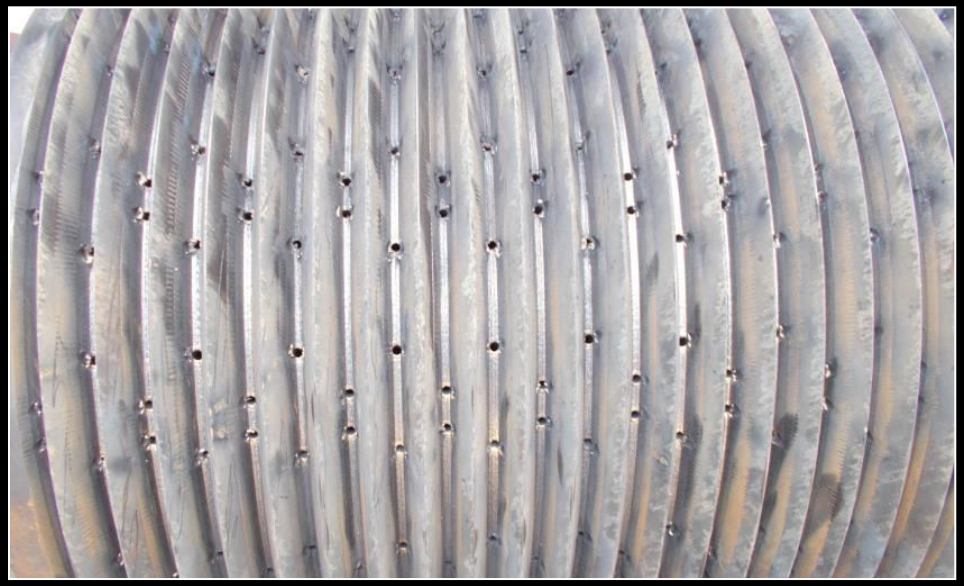
High strength Spheroidal Graphite Iron roller shell

SG Iron is 2.2 times stronger than conventional Cast Iron

KEY FEATURES:

IMPROVED NOZZLE PATTERN

1200 nozzles in top and bagasse rolls for quick drainage of juice.



KEY FEATURES:

ROLL GROOVES

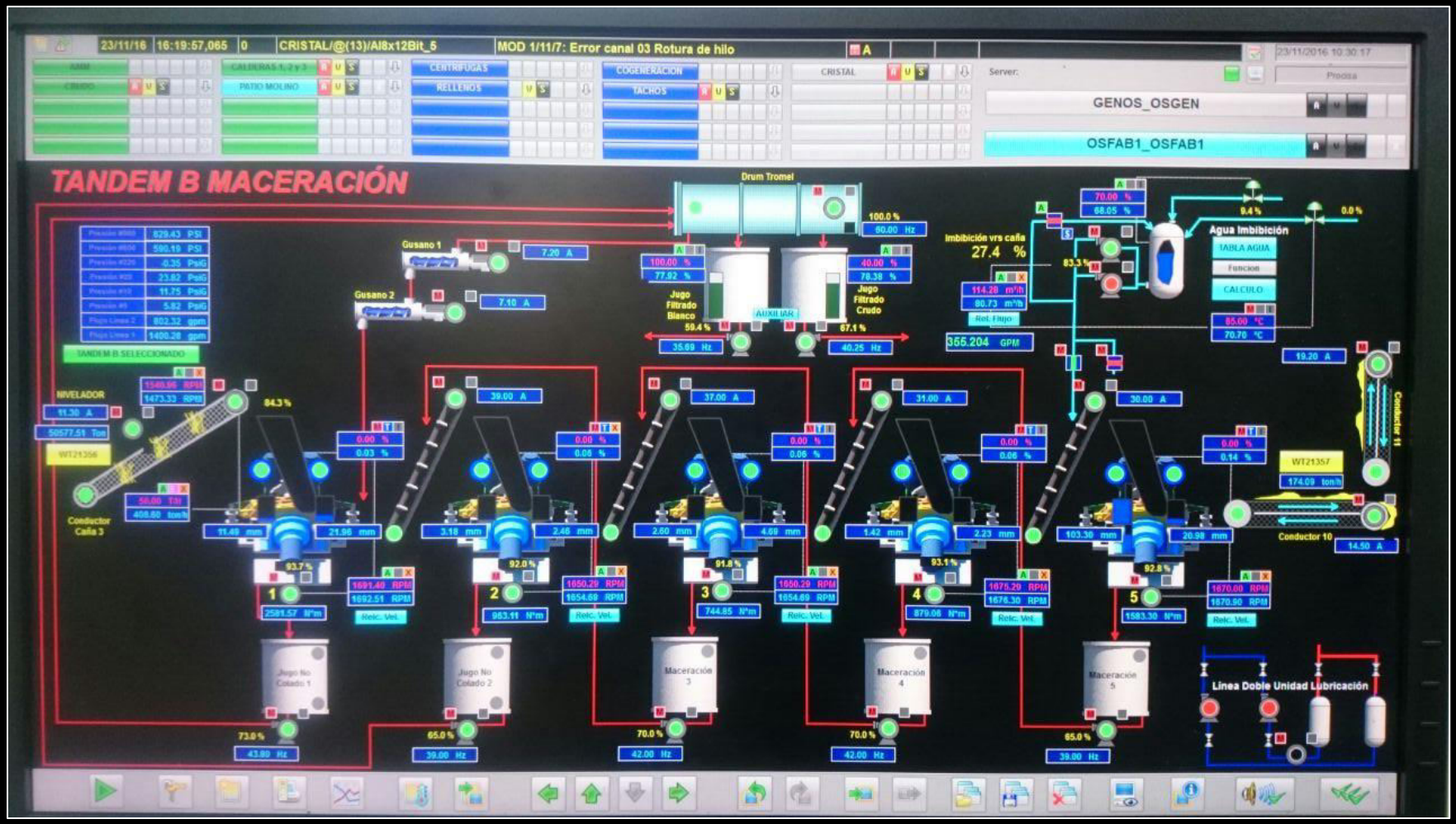
Complete absence of chevron and Messchaert grooves to eliminate low compression area.

Tear drop arcing on tip of teeth to prevent slippage

KEY FEATURES:
DIFFERENTIAL ROLL SPEED

Assist drive with AC VFD to facilitate mill operations with differential roll speed.

KEY FEATURES: DCS BASED MILL AUTOMATION



NEW MILLING TANDEM:

WORKING RESULTS : FIRST SEASON 2014-15

Total Cane Crushed	1,660,000 tonnes
Average Crush Rate	401 TPH
RME	95.95%
Bagasse Moisture	48.5%
Pol in Bagasse	2.08%
Imbibition % on Cane	25.83%

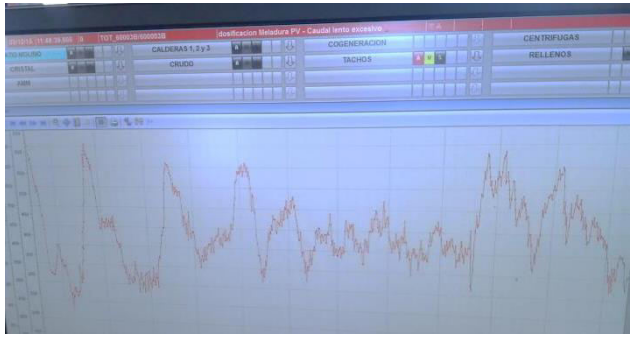
Results fairly good but management felt scope of improvement.

San Diego and Isgec team decided to analyze the data and finalize action plan for improvement

FINDINGS AND CORRECTIVE ACTIONS

FINDING POST 2014-15

- 1st mill was controlled by belt weigher, leading to very wide fluctuations in torque which adversely affected the primary extraction.



- The cane feed from the conveyor was not integrated with the mill controls. The fluctuations experienced in the first mill that were attributed to cane feed were eventually observed in the subsequent mills.

- Mill speed was governed by two set points, one for torque and other for Donnelly chute level. Mill speed was always seeking to meet these two criteria leading to hunting.

Prevalent Control philosophy not conducive for fluctuations in cane feeding

CONTROL PHILOSOPHY CORRECTION

Existing for 2014-15 Conventional Philosophy	Modified for 2015-16 Advanced Philosophy
1. Single point control of Belt feeding the first mill by cane belt weigher.	Control through Belt weighing eliminated. Data used for monitoring only.
2. Cane feed from conveyor not integrated with mill controls.	Cane feed from conveyor integrated with 1st mill top roll drive load. 1st mill top roll speed pre-set to match with desired crush rate. Cane carrier speed is regulated in proportion to D-chute level.

CONTROL PHILOSOPHY

CORRECTION

Existing for 2014-15 Conventional Philosophy	Modified for 2015-16 Advanced Philosophy
3. Mill speed governed by two set points, one for torque and one for D-chute levels.	Mill speed is governed by torque of top roll drive motor through 8 set points. D-chute level provides override signal. Cane and bagasse roll have pre-selected speed ratios wrt top roll. These can be adjusted manually to avoid overloading of drives.

CONTROL PHILOSOPHY FOR 1ST MILL : 2015-16

- Multi set points for donnelly chute, to govern the speed of the cane carrier.

- In case of very low level in D-chute, an alarm shall be raised for operator to change crush rate setting.

Speed set points for different crush rate for 1st mill

Crushing rate (t/h)	350	400	450	475	500	525	550	575
Top roll speed (rpm)	3.8	4.4	4.9	5.2	5.4	5.7	6.0	6.2

CONTROL PHILOSOPHY
FOR 1ST MILL : 2015-16

Prepared cane carrier speed vs 1st Mill D-chute level

D-chute sensor	L-1 (no level)	L-2	L-3	L-4	L-5	L-6	L-7 (high)	L-8 (high high)
D-chute level (%)	0	12	25	37	50	62	80	100
Conveyor speed (%)	100	90	80	70	60	50	10	0

Override signals details for Mill Control for 1st Mill

Override controls	Mill motor load high	No Donnelly chute level	Donnelly Chute level high	Screened Juice tank level low	Screened Juice tank level high
Signal	Lower conveyor speed	Conveyor speed to maximum	Conveyor speed to zero	Increase conveyor speed	Conveyor speed to minimum

CONTROL PHILOSOPHY:

FOR 2ND-5TH MILL : 2015-16

- Speed of 2nd and subsequent mills shall be governed by top roller drive load through 8 set points.
- D-chute level shall provide override signals to speed up/ slow down the mill

Top Roll	load (A)	60	70	80	85	90	100	115	129
	(rpm)	5.48	5.57	5.65	5.74	5.82	6.00	6.08	6.17
D-chute level (%)		0	12	25	37	50	62	80	100

Override controls	No Donnelly chute level	Donnelly chute level high	Inter-carrier trip
Signal	Top roller speed to minimum	Top roller speed to maximum	Trip all the preceding carriers

DIFFERENTIAL ROLL

SPEED RATIO: 2015-16

- Initially top to baggase roll ratio (Rb) set at 1.02
- While top to cane roll ratio (Rc) set at 1.03
- After observing mill working, speed ratios fine tuned as per following table, to avoid any of the drive from overloading.

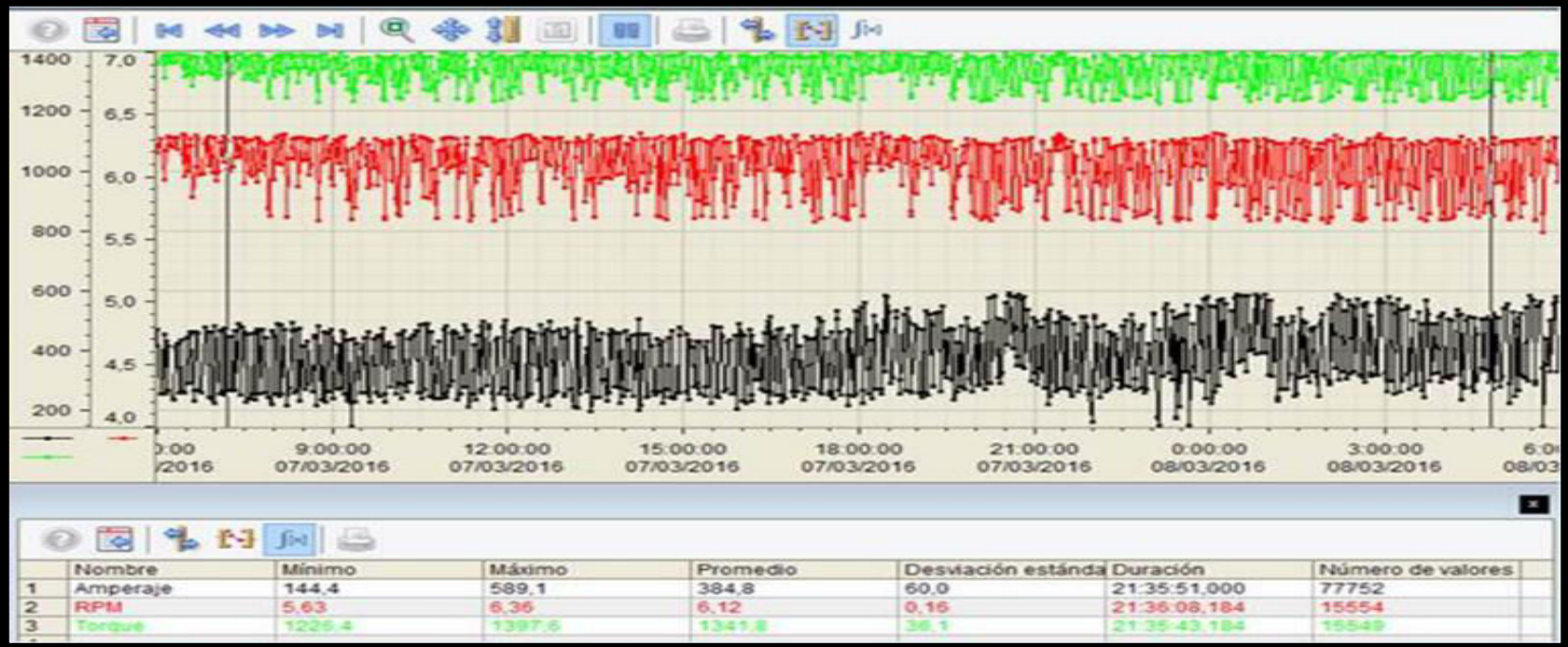
Mill no.	Surface speed ratios in 2014-15		Proposed surface speed ratios at the beginning of 2015-16		Actual surface speed ratios during 2015-16	
	R	R	R	Rb	Rc	Rb
1	0.985	0.935	1.03	1.02	1.03	1.02
2	0.985	0.935	1.03	1.02	0.93	0.95
3	0.985	0.935	1.03	1.02	1.03	1.02
4	0.985	0.935	1.03	1.02	1.03	1.02
5	0.985	0.935	1.03	1.02	1.01	1.04

Top Roll kept at higher surface speed than bottom rolls except 2nd mill

WORKING RESULTS

2015-16: MILL NO. 1

Achieved narrow band of fluctuations in load and speed



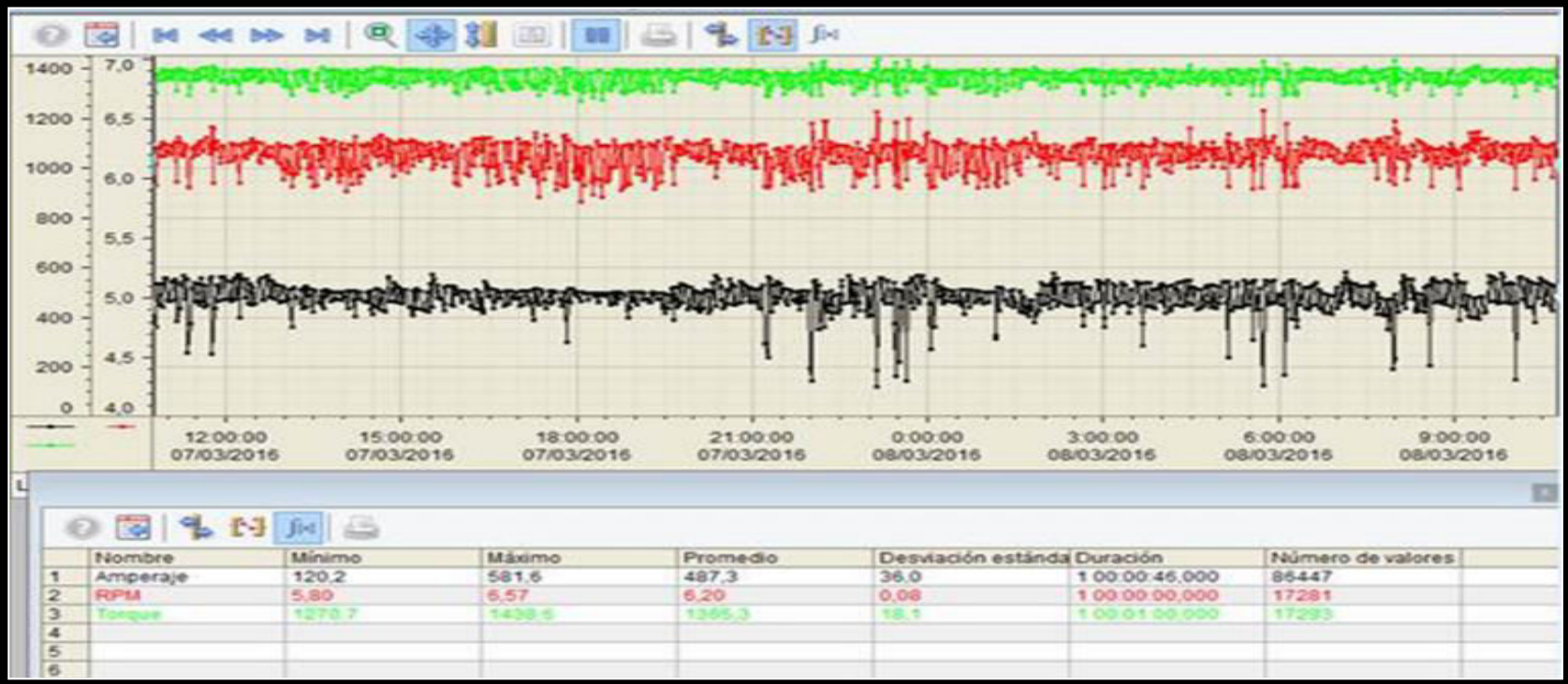
	Nombre	Mínimo	Máximo	Promedio	Desviación estánda	Duración	Número de valores
1	Amperaje	144,4	589,1	384,8	60,0	21:35:51,000	77752
2	RPM	5,63	6,36	6,12	0,16	21:36:08,184	15554
3	Torque	1226,4	1397,6	1341,8	36,1	21:35:43,184	15549

Typical DCS trend of bagasse roll of Mill no. 1

WORKING RESULTS

2015-16: MILL 2 TO MILL 5

- Uniform feed from 1st mill passed on to subsequent mills.
- Stable load and speed in all subsequent mills



	Nombre	Mínimo	Máximo	Promedio	Desviación estánda	Duración	Número de valores
1	Amperaje	120,2	581,6	487,3	36,0	1 00:00:46,000	86447
2	RPM	5,80	6,57	6,20	0,08	1 00:00:00,000	17281
3	Torque	1270,7	1438,6	1365,3	18,1	1 00:01:00,000	17293
4							
5							
6							

Typical DCS trend of bagasse roll of Mill no. 3

CONTROL PHILOSOPHY

RESULTS: BEFORE/AFTER

- Date of start of season 2015-16 : 20 Nov 2015
- Date of implementation of new Control philosophy : 02 Dec 2015

Date	RME (%)	Bagasse Pol (%)	Bagasse moisture (%)	Imbibition % cane
1 Dec 2015	96.28	1.92	47.90	26
29 Dec 2015	97.45	1.21	47.11	27

After implementation of new control philosophy, there was sharp reduction in bagasse Pol and moisture

COMPARISON OF KEY PERFORMANCE INDICATORS

Comparison of milling efficiency of 2014-15 and 2015-16

Parameter	2014-15	2015-16	Improvement
Total cane crushed, tonnes	1,660,455	2,103,940	26 %
Crop average, pol % cane	13.03	12.73	
Average cane crushing per crop day, t/d	9,630	12,135	26 %
Average crush rate, t/h	401	505	26 %
Imbibition water % cane	25.83	27.42	6 %
Bagasse Pol, %	2.08	1.58	32 %
Bagasse moisture, %	48.49	48.16	1 %
RME, %	95.95	96.92	1 %

Throughput improved by 26% and mill extraction efficiency improved by 1%

FINANCIAL GAIN

2400 tonnes additional sugar, worth 1.2 million dollars, produced during 2015-16 due to improved milling efficiency

SEASON-WISE COMPARISON: ROLL POWER SHARING

Power sharing between rolls during 2014–15 Vs 2015-2016

Roll	Season 2014-15 (Data for 4 Jan 2015) Cane crushed: 10,407 t			Season 2015-16 (Data for 16 Dec 2015) Cane crushed: 13,457 t		
	AMP	kW	Surface speed ratio	AMP	kW	Surface speed ratio
Top roll	83	389	100	78.5	407.8	100
Cane roll	376	194	98.34	330.6	184.8	103
Bagasse roll	385	190	93.41	488.7	287.4	102

CONCLUSION

- Multi set point control philosophy stabilizes the cane feed, thereby improving throughput by upto 25%.
- This also helps in operating the drives over a narrow band of torque and speed, eliminating hunting mode.
- It helps to improve the milling efficiency without having to alter the basic configuration of mills.
- Fine tuning of the roll speed ratio can increase RME by one percentage and reduce bagasse moisture by half percentage point.

Thank You

Presented By

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