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Reduction in Steam % Cane and Achievement of Higher Bagasse Saving

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ABSTRACT

Sugar industry plays very important role in global energy consumption, and it is one of the most energy consuming industries. Consumable energy are - electrical, mechanical and thermal for production of sugar as well as cogeneration. There is need to promote recycle economy, energy generation, modern technology, reduce consumption, and protect the environment. Energy efficiency improvement measures in sugar mills are done in the change in vapor bleeding arrangement and addition of energy efficient devices and adopted new technologies in sugar processing. Jaywant Sugars Ltd. Dhawarwadi cane crushing trial season was conducted in 2010-11. Initially plant capacity was 1700 TCD and now it is expanded up to 5600 TCD in four phases and reduced steam consumption successfully from 51 % to 31.00 % on cane by using energy efficient evaporator along with change in bleeding arrangements. Installation of low delta temperature equipment like plate type heat exchangers, direct contact heaters, falling film evaporators, batch pans with mechanical circulator, waste heat recovery system, automation at pan, evaporators and centrifugal station.

Keywords: Falling film evaporator (FFE), bagasse, steam % cane, cleaning frequency

INTRODUCTION

Steam consumption is inversely proportional to the crush rate. Lower the steam consumption more will be the crushing capacity of plant with same amount of steam available. At the initial stage in Jaywant sugar steam % cane was 51 % in the season 2010-11 gradually it is reduced up to 31 % on cane. In the season 2023-24 higher bagasse saving achieved i.e 10.31 % on cane.

Table : Bagasse saving % cane year wise (season wise RT8 (C))

Season	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Bagasse saving % cane	1.95	3.51	4.82	4.31	5.42	3.32	4.23	5.36	5.61	5.41	7.52	7.42	7.05	10.31

Efforts taken for achieving higher bagasse saving % cane

- Necessary modifications and changes done in existing vapour bleeding and efficient uses of waste heat recovery units.
- Use of steam saving devices – cigar, DCH, condensate heater, PHE, mechanical circulators, falling film evaporator.
- Maintain steady operation of sugar plant.
- Maintain the heating surface of evaporator always clean with floating arrangement of evaporator.

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- Re-arrangement of vapour piping /juice piping suitable to evaporator on line tube cleaning
- Rearrangement of evaporator configuration with effective vapour bleeding from quadruple to quintuple.

Table 2 : Details of sugar plant expansion with reduction in steam consumption

Parameter	Initial Phase	Phase-1	Phase-2	Phase-3 (B-Heavy Route)	Phase-4 (B-Heavy+Syrup Route)
Crushing Season	From 2010 to 2014	2014-15	2016-17	2022-23	2023-24
Plant Capacity Expansion (TCD)	1700 -2500	2500-4000	2500-4000	4000-5200	5200-5600
Reduction in Steam Consumption in %	Above 50.00	45.00	36.00	30.00 % BH Route	33 overall (28% on Syp. + BH Route & 34% on C-Heavy Route)
Boiler Capacity (Tons)	60	65	70	70	70
Boiler Pressure	45 kg/cm²	45 kg/cm²	45 kg/cm²	45 kg/cm²	45 kg/cm²

Table 3 : Implementation of evaporator configuration season wise

Effect	2010-2011-2012-2013		2013-14		2014-15		2015-16		2016-17		2017-18	
	Working	Standby	Working	Standby	Working	Standby	Working	Standby	Working	Standby	Working	Standby
First	SK-2000m²	No Standby	SK-2000m²	--	SK-2000m²	--	SK-2000 m²	SK-2800m²	SK-2000 m²	SK-2800m²	SK-2000 m²	SK-2800m²
Second	VC-2000m²		VC-2000m²	VC-3000m²	VC-2000m²	VC-3000m²	VC-3000m²	VC-2000m² (II&III)	VC-3000m²	VC-2000m² (II&III)	VC-3000m²	VC-2000m² (II&III)
Third	600m²		600m²	--	600m²	--	1200m²		1200m²		1200m²	
Fourth	3000m²		3000m²	--	3000m²	--	600m²	600m²	600m²	600m²	600m²	600m²
Fifth							300m²	600m²	300m²	600m²	300m²	600m²

Effect	2018-19		2019-20		2020-21		2021-22		2022-23		2023-24	
	Working	Standby	Working	Standby	Working	Standby	Working	Standby	Working	Standby	Working	Standby
First	SK-2000 m²	SK-2800m²	SK-2000 m²	SK-2800m²	SK-2000 m²	SK-2800m²	SK-2000 m²	SK-2800m²	SK-2000m²	SK-2800m²	SK-2000m²	SK-2800m²
Second	VC-3000m²	VC-2000m² (II&III)	VC-3000m²	VC-2000m² (II&III)	VC-3000m²	VC-2000m² (II&III)	VC-3000m²	VC-2000m² (II&III)	FFE-3500m²	VC-3000m² (II&III)	FFE-3500m²	FFE-3500m² (II& III)
Third	1200m²		1200m²		1200m²		1200m²		VC-2000m²		3000m²	2000m²
Fourth	600m²	600m²	600m²	600m²	600m²	600m²	600m²	600m²	1200m² (Old)	600+600) m²	1200m²	(600+600) m²
Fifth	300m²	600m²	300m²	600m²	300m²	600m²	300m²	600m²	(600+300) m²	1200m²	(600+300) m²	1200m²

Table 4 : Options of evaporator (working and stand by) from season 2010-2011 to 2014-2015 we have used quadruple and from season 2015-16 we are using quintuple evaporator with different options to keep the heating surface clean and for better performance of evaporator

Evaporator option 4000 TCD season 2016-17

Option No	Evaporators					Total	H. S. to Crushing Ratio	Crush Rate	UnderCleaning
	I	II	III	IV	V				
1	2000	2000	1200	600	300	6100	1.8	3389	2800,3000,600,600
2	2000	2000	1200	600	600	6400	1.8	3556	2800,3000,600,300
3	2800	2000	1200	600	300	6900	1.8	3833	2000,3000,600,600
4	2000	3000	1200	600	300	7100	1.8	3944	2800,2000,600,600
5	2800	2000	1200	600	600	7200	1.8	4000	2000,3000,600,300
6	2000	3000	1200	600	600	7400	1.8	4111	2800,2000,600,300
7	2800	3000	1200	600	300	7900	1.8	4389	2000,2000,600,600
8	2000	3000	2000	600	300	7900	1.8	4389	2800,1200,600,600
9	2800	3000	1200	600	600	8200	1.8	4556	2000,2000,600,300
10	2000	3000	2000	600	600	8200	1.8	4556	2800,1200,600,300
11	2800	3000	2000	600	300	8700	1.8	4833	2000,1200,600,600
12	2800	3000	2000	600	600	9000	1.8	5000	2000,1200,600,300

Table 5 : Evaporator options for 5400 TCD (B heavy route) season - 2022-23.

Option No	Evaporators							Total Heating Surface	H. S. to Crushing Ratio	Crush Rate =H.S/1.9	Undercleaning				
	I	II	III	IV		V					I	II	III	IV	V
1	2800	3500	3000		1200		1200	**11700**	1.9	6158	2000		2000	600+600	600+300
2	2800	3500	3000		1200	600	300	11400	1.9	6000	2000		2000	600+600	1200
3	2800	3500	3000	600	600		1200	11700	1.9	6158	2000		2000	1200	600+300
4	2800	3500	2000		1200		1200	10700	1.9	5632	2000		3000	600+600	600+300
5	2800	3500	2000	600	600		1200	10700	1.9	5632	2000		3000	1200	600+300
6	2800	3500	2000		1200	600	300	10400	1.9	5474	2000		3000	600+600	1200
7	2800	3000	2000		1200		1200	10200	1.9	5368	2000	3500		600+600	600+300
8	2800	3000	2000	600	600		1200	10200	1.9	5368	2000	3500		1200	600+300
9	2800	3000	2000		1200	600	300	9900	1.9	5211	2000	3500		600+600	1200
10	2000	3500	3000		1200		1200	10900	1.9	5737	2800		2000	600+600	600+300
11	2000	3500	3000	600	600		1200	10900	1.9	5737	2800		2000	1200	600+300
12	2000	3500	3000		1200	600	300	10600	1.9	5579	2800		2000	600+600	1200
13	2000	3500	2000		1200		1200	9900	1.9	5211	2800		3000	600+600	600+300
14	2000	3500	2000	600	600		1200	9900	1.9	5211	2800		3000	1200	600+300
15	2000	3500	2000		1200	600	300	9600	1.9	5053	2800		3000	600+600	1200
16	2000	3000	2000		1200		1200	9400	1.9	4947	2800	3500		600+600	600+300
17	2000	3000	2000	600	600		1200	9400	1.9	4947	2800	3500		1200	600+300
18	2000	3000	2000		1200	600	300	**9100**	1.9	4789	2800	3500		600+600	1200
19	2800	3000	2000	600	600	600	300	9900	1.9	5211	2000	3500		1200	1200
20	2800	3500	3000	600	600	600	300	11400	1.9	6000	2000		2000	1200	1200
21	2800	3500	2000	600	600	600	300	10400	1.9	5474	2000		3000	1200	1200
22	2000	3500	2000	600	600	600	300	9600	1.9	5053	2800		3000	1200	1200
23	2000	3500	3000	600	600	600	300	10600	1.9	5579	2800		2000	1200	1200
24	2000	3000	2000	600	600	600	300	9100	1.9	4789	2800	3500		1200	1200

Table 6 : Evaporator options 5800 TCD (syrup + B heavy route) for season - 2023-24

Option No	Evaporators								TotalHeating surface	H. S. to Crushing Ratio	Crush Rate = H.S/1.9	Undercleaning					
	I	II		III	IV		V					I	II		III	IV	V
1	2800	3500	(O)	3000		1200		1200	11700	1.9	6158	2000	3500	(N)	2000	600+600	600+300
2	2800	3500	(O)	3000		1200	600	300	11400	1.9	6000	2000	3500	(N)	2000	600+600	1200
3	2800	3500	(O)	3000	600	600		1200	11700	1.9	6158	2000	3500	(N)	2000	1200	600+300
4	2800	3500	(O)	3000	600	600	600	300	11400	1.9	6000	2000	3500	(N)	2000	1200	1200
5	2800	3500	(O)	2000		1200		1200	10700	1.9	5632	2000	3500	(N)	3000	600+600	600+300
6	2800	3500	(O)	2000	600	600		1200	10700	1.9	5632	2000	3500	(N)	3000	1200	600+300
7	2800	3500	(O)	2000		1200	600	300	10400	1.9	5474	2000	3500	(N)	3000	600+600	1200
8	2800	3500	(O)	2000	600	600	600	300	10400	1.9	5474	2000	3500	(N)	3000	1200	1200
9	2800	3500	(O)	3500		1200		1200	**12200**	1.9	6421	2000			3000+2000	600+600	600+300
10	2800	3500	(O)	3500		1200	600	300	11900	1.9	6263	2000			3000+2000	600+600	1200
11	2800	3500	(O)	3500	600	600		1200	12200	1.9	6421	2000			3000+2000	1200	600+300
12	2800	3500	(O)	3500	600	600	600	300	11900	1.9	6263	2000			3000+2000	1200	1200
13	2800	3500	(N)	3000		1200		1200	11700	1.9	6158	2000	3500	(O)	2000	600+600	600+300
14	2800	3500	(N)	3000		1200	600	300	11400	1.9	6000	2000	3500	(O)	2000	600+600	1200
15	2800	3500	(N)	3000	600	600		1200	11700	1.9	6158	2000	3500	(O)	2000	1200	600+300
16	2800	3500	(N)	3000	600	600	600	300	11400	1.9	6000	200	3501	(O)	2000	1200	1200
17	2800	3500	(N)	2000		1200		1200	10700	1.9	5632	2000	3500	(O)	3000	600+600	600+300
18	2800	3500	(N)	2000	600	600		1200	10700	1.9	5632	2000	3500	(O)	3000	1200	600+300
19	2800	3500	(N)	2000		1200	600	300	10400	1.9	5474	2000	3500	(O)	3000	600+600	1200
20	2800	3500	(N)	2000	600	600	600	300	10400	1.9	5474	2000	3500	(O)	3000	1200	1200
21	2000	3500	(O)	3000		1200		1200	10900	1.9	5737	2800	3500	(N)	2000	600+600	600+300
22	2000	3500	(O)	3000		1200	600	300	10600	1.9	5579	2800	3500	(N)	2000	600+600	1200
23	2000	3500	(O)	3000	600	600		1200	10900	1.9	5737	2800	3500	(N)	2000	1200	600+300
24	2000	3500	(O)	3000	600	600	600	300	10600	1.9	5579	2800	3500	(N)	200	1200	1200
25	2000	3500	(O)	2000		1200		1200	9900	1.9	5211	2800	3500	(N)	3000	600+600	600+300
26	2000	3500	(O)	2000	600	600		1200	9900	1.9	5211	2800	3500	(N)	3000	1200	600+300
27	2000	3500	(O)	2000		1200	600	300	**9600**	1.9	5053	2800	3500	(N)	3000	600+600	1200
28	2000	3500	(O)	2000	600	600	600	300	9600	1.9	5053	2800	3500	(N)	3000	1200	1200
29	2000	3500	(O)	3500		1200		1200	11400	1.9	6000	2800			3000+2000	600+600	600+300
30	2000	3500	(O)	3500	600	600		1200	11400	1.9	6000	2800			3000+2000	1200	600+300
31	2000	3500	(O)	3500		1200	600	300	11100	1.9	5842	2800			3000+2000	600+600	1200
32	2000	3500	(O)	3500	600	600	600	300	11100	1.9	5842	2800			3000+2000	1200	1200
33	2000	3500	(N)	3000		1200		1200	10900	1.9	5737	2800	3500	(O)	2000	600+600	600+300
34	2000	3500	(N)	3000		1200	600	300	10600	1.9	5579	2800	3500	(O)	2000	600+600	1200
35	2000	3500	(N)	3000	600	600		1200	10900	1.9	5737	2800	3500	(O)	2000	1200	600+300
36	2000	3500	(N)	3000	600	600	600	300	10600	1.9	5579	2800	3501	(O)	2000	1200	1200
37	2000	3500	(N)	2000		1200		1200	9900	1.9	5211	2800	3500	(O)	3000	600+600	600+300
38	2000	3500	(N)	2000	600	600		1200	9900	1.9	5211	2800	3500	(O)	3000	1200	600+300
39	2000	3500	(N)	2000		1200	600	300	9600	1.9	5053	2800	3500	(O)	3000	600+600	1200
40	2000	3500	(N)	2000	600	600	600	300	9600	1.9	5053	2800	3500	(O)	3000	1200	1200

Table 7 : Operating evaporator configuration (season 2023-24)

Option No	Evaporat os									Total Heating surface	Ratio	Total Crushing (MT)	Actual Avg. crush Rate	Crush Rate = H.S/1.9	Under cleaning	Effect	Individual Evap. Body Crushing MT)	Start Date	Close Date	Duration (Days)
	I	II		III		IV		V												
1	2000	3500	(O)	2000		600	600	600	300	9600	1.9	35400	5210	5053	2000	III	35400	29/10/23	7/11/23	9
2	2000	3500	(O)	3000		600	600	600	300	10600	1.9	24100	5571	5579	3500	II	59500	7/11/23	11/11/23	3
3	2000	3500	(N)	3000		600	600	600	300	10600	1.9	18000	5669	5579	600+300	V	77500	11/11/23	14/11/23	3
4	2000	3500	(N)	3000		600	600		1200	10900	1.9	18000	5929	5737	600+600	IV	9500	14/11/23	17/11/2 3	3
5	2000	3500	(N)	3000			1200		1200	10900	1.9	6100	5974	5737	3000	III	66200	17/11/23	18/11/23	1
6	2000	3500	(O)	3500	(N)		1200		1200	11400	1.9	12250	5214	6000	2000 & 3500	(I) / (II)	113850/54350	18/11/23	20/11/23	2
7	2800	3500	(O)	2000			1200		1200	10700	1.9	17870	5866	5632	2000	III	17870	20/11/23	23/11/23	3
8	2800	3500	(O)	3000			1200		1200	11700	1.9	29000	5759	6158	1200	V	83220	23/11/23	28/11/23	5
9	2800	3500	(O)	3000			1200	600	300	11400	1.9	11355	5445	6000	3500	II	70475	28/11/23	30/12/23	2
10	2800	3500	(N)	3000			1200	600	300	11400	1.9	21055	5114	6000	1200	IV	97630	30/12/23	4/12/23	5
11	2800	3500	(N)	3000		600	600	600	300	11400	1.9	10245	5638	6000	3000	III	71655	4/12/23	6/12/23	2
12	2800	3500	(o)	3500	(N)	600	600	600	300	11900	1.9	27780	5566	6263	600+300	V	70435	6/12/13	11/12/23	5
13	2800	3500	(o)	3500	(N)	600	600		1200	12200	1.9	21525	5380	6421	3500	II	80605	11/12/23	15/12/23	4
14	2800	3500	(o)	3000		600	600		1200	11700	1.9	15870	5290	6158	3500	II	65175	15/12/13	18/12/23	3
15	2800	3500	(N)	3000		600	600		1200	11700	1.9	11430	5715	6158	600+600	IV	86850	18/12/23	20/12/23	2
16	2800	3500	(N)	3000		1200			1200	11700	1.9	38770	5538	6158	2800	I	204900	20/12/23	27/12/23	7
17	2000	3500	(N)	3000		1200			1200	10900	1.9	0	5410	5737	3000	III	66070	27/12/ 23	27/12/23	1
18	2000	3500	(O)	3500	(N)	1200			1200	11400	1.9	5410	5410	6000	1200	V	93005	27/12/23	28/12/23	1
19	2000	3500	(O)	3500	(N)	1200		600	300	11100	1.9	32105	5350	5842	3500	II	87715	28/12/23	3/1/24	6
20	2000	3500	(O)	3000		1200		600	300	10600	1.9	9845	4923	5579	1200	IV	86130	3/1/24	5/1/24	2
21	2000	3500	(O)	3000		600	600	600	300	10600	1.9	25040	5008	5579	3500	II	72400	5/1/24	10/1/24	5
22	2000	3500	(N)	3000		600	600	600	300	10600	1.9	25170	5034	5579	2000	I	97570	10/1/24	16/1/24	6
23	2800	3500	(N)	3000		600	600	600	300	11400	1.9	7030	3515	6000	3000	III	67085	16/1/24	18/1/24	2
24	2800	3500	(O)	3500	(N)	600	600	600	300	11900	1.9	9490	4745	6263	600+300	V	108680	18/1/24	20/1/24	2
25	2800	3500	(O)	3500	(N)	600	600	1200		12200	1.9	10050	5025	6421	600+600	IV	76780	20/1/24	22/1/24	2
26	2800	3500	(O)	3500	(N)	1200		1200		12200	1.9	19405	4851	6421	3500	II	71145	22/1/24	26/1/24	4
27	2800	3500	(O)	3000		1200		1200		11700	1.9	35535	5076	6158	1200	V	64990	26/1/24	2/2/24	7
28	2800	3500	(O)	3000		1200		600	300	11400	1.9	15205	5068	6000	3500	II	89685	2/2/24	5/2/24	3
29	2800	3500	(N)	3000		1200		600	300	11400	1.9	18720	4680	6000	1200	IV	88865	5/2/24	9/2/24	4
30	2800	3500	(N)	3000		600	600	600	300	11400	1.9	16480	4120	6000	3000	III	85940	9/2/24	13/2/24	4
31	2800	3500	(O)	3500	(N)	600	600	600	300	11900	1.9	34800	4971	6263	600+300	V	85205	13/2/24	20/02/24	7
32	2800	3500	(O)	3500	(N)	600	600		1200	12200	1.9	9725	4863	6421	3500	III	79725	20/02/24	22/02/24	2
33	2800	3500	(O)	3000		600	600		1200	11700	1.9	19970	4993	6158	2800	I	196410	22/02/24	26/02/24	4
34	2000	3500	(O)	3000		600	600		1200	10900	1.9	20145	5036	5737	600+600	IV	101120	26/02/24	1/3/2024	4
35	2000	3500	(O)	3000		1200			1200	10900	1.9	4890	4890	5737	3500	II	89530	1/3/24	2/3/24	1
36	2000	3500	(N)	3000		1200			1200	10900	1.9	14985	4995	5737	1200	V	69715	2/3/24	5/3/24	3
37	2000	3500	(N)	3000		1200		600	300	10600	1.9	25325	5065	5579	3000	III	85315	5/3/24	10/3/24	5
38	2000	3500	(O)	3500	(N)	1200		600	300	11100	1.9	43705	4856	5842	3500	III	84015	10/3/24	19/03/24	9
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Regular practices (action plan) to reduce the steam consumption (M.B. Londhe)

- We have maintained back pressure turbine from 0.70 to 1.10 kg/cm^2 according to cleaness of heating surface.
- Due to low back pressure vapour temperature decreases in some extent, mechanical circulators help to pan boiling at low vapours temperature.
- Last evaporator vacuum is maintained 500 to 550 mm/hg. In that case VLJH temp. Increased as well as condensate temperature also increased.
- Maintain low vacuum at evaporator increases all vapour temperature in some extent.

  (www.sugarprocesssteps.com)
- Juice flow stabilization and FFE automations helps to reduce the steam consumption.
- Flow meters at various stages also helpful to reduce steam consumption in process house..
- We have experienced that when evaporator heating surface is clean at that time Specific steam consumption of turbine found reduced.

	EFFECTS									
	I		II		III		IV		V	
Vacuum (mm of Hg)	**500**	**600**	**500**	**600**	**500**	**600**	**500**	**600**	**500**	**600**
Pressure	**Temperature ^{0}C**									
1.1	115.30	114.70	108.00	106.70	99.40	96.90	88.40	83.80	72.40	61.40
1.0	113.90	113.30	106.80	105.40	98.30	95.80	87.70	82.90	72.40	61.40
0.9	112.40	111.80	105.50	104.10	97.30	94.60	87.00	82.10	72.40	61.40
0.8	110.90	110.30	104.10	102.70	96.20	93.40	86.20	81.20	72.40	61.40
0.7	109.30	108.70	102.70	101.20	95.00	92.20	85.50	80.30	72.40	61.40

Table 8 : Comparison of bagasse saving and evaporator cleaning cost (cleaning chemicals, labour charges of jet cleaning and brushing materials)

Season	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24
Bagasse Saving % Cane	5.61	5.41	7.52	7.42	7.05	10.31
Cleaning costRs./ MT Cane	3.68	2.58	3.12	3.93	5.91	6.50
Bagasse sale Qty. in MT	32700.00	22131.240	48821.530	40610.020	38225.050	49090.560
Bagasse Sale Value in Rs. In Cr.	3.92	4.73	4.98	7.26	5.00	12.88

(*Season wise RT8(C))

RESULTS AND CONCLUSIONS

For maximum bagasse saving we have adopted above practices regularly,consistently, minimum down time with Proper Utilization of all equipments. Efficient performances of all equipments are very important.

Following benefits are observed during the last three seasons

- We have avoided shutdown for cleaning of evaporators and periodical tube cleaning.

- We have totally eliminated down time for process house tube cleaning.
- We have achieved additional bagasse saving due to clean heating surface of evaporator.
- Additionally saved bagasse sold directly to outside parties like brick, paper mill, particle board and other factory and it will be used in the incineration boiler as a additional fuel with coal and spent wash.

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